CHEMICAL RESTRAINT AND ANESTHESIA IN WHITE RHINOCEROS *(Ceratotherium simum)* FOR REPRODUCTIVE EVALUATION, SEMEN COLLECTION AND ARTIFICIAL INSEMINATION

C. Walzer,[1] F. Gšritz,[2] H. Pucher,[1] R. Hermes,[2] T. Hildebrandt,[2] and F. Schwarzenberger[3]*

[1]Salzburg Zoo Hellbrunn, A-5081 Anif, Austria; [2]Institute for Zoo Biology and Wildlife Research, D-10315 Berlin, Germany; [3]Institute of Biochemistry, University of Veterinary Medicine, Vienna, Austria

Abstract

In order to elucidate the problems of poor reproductive performance in captive white rhinoceros (*Ceratotherium simum*)[8] the EEP committee has encouraged intensive and serial reproductive monitoring in this species. Although the reasons for these problems have not been identified definitively, a multi-disciplinary, multi-institutional research proposal aims to work on possible solutions. The overall objectives of this project are to use an integrated approach to enhance breeding of southern white rhinoceroses in the EEP. Focus is placed on older non-breeding animals (F0 and F1). These older animals are targeted in order to conserve their genetic potential within the breeding program. Our combined approach to enhance breeding and overcome reproductive problems includes endocrine monitoring, transfer of animals to enhance natural breeding, and the development of artificial insemination (AI) techniques.

The transfer of animals between institutions requires only minimal applications of chemical restraint. Although several authors have demonstrated that ultrasonographic evaluation of the genital tract and semen collection are possible on unrestrained animals,[4,6,7,9] this requires the commitment of a minimal training program and zoo management/keeper compliance. Presently with exception of the Salzburg Zoo,[9] no rhinoceros chutes are available within the EEP. Various authors have described anesthetic procedures in white rhinoceroses.[1-3]

During the period March 1999 to March 2000 a total of 20 anesthetic events were performed on 11 individual animals. Using the experience gained with the combination of detomidine-HCl (Domosedan®, Orion Corporation, Farmos Finland) and butorphanol (Turbugesic®, Fort Dodge Animal Health, IA) in the standing sedation of white rhinoceroses, and the experience with this combination and additional etorphine-acepromazine (Large Animal Immobilon® C-Vet Veterinary Products, Lancs UK) in Przewalski's horses (*Equus prezwalskii*)[10] we elected to apply this combination in the white rhinoceros.

All animals (estimated weight range 2000-2800 kg) were induced with a combination of etorphine 3.1 ± 0.6 mg; acepromazine 12.5 ± 2.5 mg; detomidine-HCl 10 ± 2 mg; and butorphanol 10 mg. This combination was injected into the neck muscles caudo-ventral to the ear using a dart pistol and 3.5-ml plastic darts with a 60-mm needle (Dan-inject International Gelsenkirchen, Germany). In most procedures (n = 15) an additional i.v. application of ketamine 300 ±100 mg (Narketan®, Chassot AG, Bern, Switzerland) was used to reduce the time to lateral recumbency, and thus facilitate the

correct placement of the animal within the enclosure. In order to facilitate semen collection procedures (penile prolapse) additional muscle relaxation was achieved using i.v. xylazine 40 ± 20 mg (Rompun®, Bayer AG, Leverkusen, Germany). A heavy-duty tire inner tube was placed beneath the shoulder in order to alleviate possible compressive trauma. All animals received supplemental oxygen at a rate of 15 L/min through a nasal tube. The mean duration of anesthesia was 76 ± 48 min and a total time of 25 hr has been accumulated during the 20 procedures. Anesthesia was reversed in all cases with an i.v. combination of naltrexone 250 mg (Trexonil®, Wildlife Laboratories Inc., Fort Collins, CO) and atipamezole 20 mg (Antisedan®, Orion Corporation, Farmos Finland). Reversal was smooth and without signs of excitation. All animals were standing and alert approximately 2 min following administration of the antagonists.

Once in lateral recumbency, rhinoceros monitoring included measurement of heart by direct cardiac auscultation and respiratory rate by direct observation of thoracic excursions. The percent oxygen saturation of hemoglobin (SpO_2) was continuously monitored using a hand-held pulse oximeter (Nellcor NP-20, Hayward, CA). The ideal placement of the probe was established to be on the medio-proximal aspects of the front leg. An alternative placement site was the mammary gland. This site was however frequently disturbed by manipulations of the reproductive tract and thus only used when initial probe placement failed. Additionally sequential venous blood samples were drawn from auricular veins. Arterial blood samples for monitoring purposes were drawn from the auricular artery using an 18-ga needle. All attempts at obtaining satisfactory arterial samples using a smaller gauge needle failed. The arterial blood samples were processed immediately with a portable blood gas analyzer (i-Stat®, SDI Sensor Devices Waukesha, WI).

Mean heart rate was 97 ± 47 bpm and in most cases decreased over the duration of the anesthesia. Mean respiratory rate was 6 ± 3 breaths/min, and in most cases remained stable during the procedure after a phase of initial stabilization (mean 20 min). Both the heart rate and the respiratory rate were influenced by the procedures (ultrasound, electroejaculation, etc.) being carried out and must be evaluated in this context. Mean SpO_2 values were 77 ± 16 % with supplemental nasal O_2 (measured over the total time frame). SpO_2 gradually increased over the duration of anesthesia in all individuals.

Collection of sequential arterial blood samples from the auricular artery proved difficult under the field conditions but markedly improved with experience. The evaluation of the arterial samples revealed an extremely low mean pH of 7.24 ± 0.08; The arterial carbon dioxide partial pressure (PCO_2) revealed a marked hypercapnia 78 ± 14 mm Hg, which remained relatively constant in each individual over the complete duration of anesthesia. The arterial oxygen partial pressure (PO_2) varied greatly between individual animals but on the whole demonstrated a mean tissue oxygenation of 93 ± 31 mm Hg. In all animals where sequential samples were obtained, PO_2 increased over the duration of the procedure. Oxygen saturation (SO_2), the amount of oxyhemoglobin expressed as a fraction of the total hemoglobin able to bind oxygen, is a useful predictor of the amount of oxygen that is available for tissue perfusion. In all measured samples SO_2 were elevated when compared to the pulse oximetry derived oxygen saturation values. Low SpO_2 values always corresponded to low S02 values and should be acted on accordingly. While this partially validates the use of pulse oximetry, severe pitfalls are possible and the reader is referred to Saint John (1992) for a discussion

of the limitations. Elevated mean Base Excess (BE) 10 mmol/L and HCO_3 34 mmol/L values demonstrate a primary respiratory acidosis with metabolic (compensatory) alkalosis.

Similar to the experiences in Prezwalski's horses,[10] the combination of etorphine, butorphanol, and detomidine provided a relatively safe and reliable method for long term anesthesia in the white rhinoceros. These initial findings correspond in principle to those described by other authors.[1,2,3] In our experience the agonistic/sedative properties of butorphanol seem to outweigh any possible antagonistic properties in this species, although this is unknown. As we already described in the Przewalski horse,[10] the pacing–a normal side effect with etorphine–is greatly reduced due to the addition of butorphanol and enhances the safety of the procedure in many enclosures. The animals suffer from marked hypercapnia and severe hypoxemia. As observed by Heard et al. 1992, this recorded hypoxemia may be adequate for tissue oxygenation due to higher oxygen affinity of hemoglobin and lower tissue metabolic rate in large mammals.

Additionally it is important to note that the SpO_2 values were higher than those described by Kock et al. (1995) under free-ranging conditions using various etorphine combinations prior to partial reversal using nalorphine.[3] It is possible that our incorporation of butorphanol into the initial dart protocol may have helped partially antagonize some of the respiratory depressant effects of etorphine and thus improve SpO_2 values in this study. The average arterial carbon dioxide partial pressure measured in our procedures is markedly elevated when compared to those described by Heard et al. (1992) in one animal.[2] Prolonged recumbency in white rhinoceroses is associated with hypoventilation resulting in hypercapnia and respiratory acidosis. Through the provision of supplemental oxygen the severity of hypoxemia can be limited. Pulmonary shunting and ventilation/perfusion mismatch also likely play a role in recumbent anesthesia of the white rhinoceros.

LITERATURE CITED

1. Hattingh, J., C.M. Knox, and J.P. Raath. 1994. Arterial blood pressure and blood gas composition of white rhinoceroses under etorphine anaesthesia. S. Afr. J. Wildl. Res. 24: 1-2, 12-14.
2. Heard, D.J., J.H. Olsen, and J. Stover. 1992.Cardiopulmonary changes associated with chemical immobilization and recumbency in a white rhinoceros *(Ceratotherium simum)*. J. Zoo Wildl. Med. 23: 2, 197-200.
3. Kock, M.D., P. Morkel, M. Atkinson, and C. Foggin. 1995. Chemical immobilization of free-ranging white rhinoceros *(Ceratotherium simum simum)* in Hwange and Matopos National Parks, Zimbabwe, using combinations of etorphine (M99), fentanyl, xylazine, and detomidine. J. Zoo Wildl. Med. 26: 2, 207-219.
4. Radcliffe R.W., N.M. Czekala and S.A. Osofsky. 1997. Combined serial ultrasonography and fecal progestin analysis for reproductive evaluation of the female white rhinoceros *(Ceratotherium simum simum)*: Preliminary results. Zoo Biol. 16: 445-456.
5. Saint John, B.E. 1992. Pulse oximetry: theory, technology and clinical considerations. Proc. Am. Assoc. Zoo Vet./Am. Assoc. Wildl. Vet. pp. 223-229.
6. Schaffer N.E., B. Beehler, R.S. Jeyendran and B. Balke. 1990. Methods of semen collection in an ambulatory greater one-horned rhinoceros *(Rhinoceros unicornis)*. Zoo Biol. 9: 211-221.
7. Schaffer N.E., W.M. Bryant, D. Agnew, T. Meehan and B. Beehler . 1998. Ultrasonographic monitoring of artificially stimulated ejaculation in three rhinoceros species *(Ceratotherium simum, Diceros dicornis, Rhinoceros unicornus)*. J. Zoo Wildl. Med. 29: 386-393.
8. Schwarzenberger, F., C. Walzer, K. Tomasova, J. Vahala, J. Meister, K.L.Goodrowe. J. Zima, G. Strau§,and M. Lynch. 1998. Faecal progesterone metabolite analysis for non-invasive monitoring of reproductive function in the

white rhinoceros *(Ceratotherium simum)* J.Anim.Rep.Sci. 53: 173-190.
9. Walzer, C., H. Pucher, F. Schwarzenberger. 2000 (in press). A restraint chute for semen collection in white Rhinoceros *(Ceratotherium simum simum)* Ð Prelimary results. Proc. European Assoc. Zoo Wildl. Vet. (EAZWV) Paris, France.
10. Walzer, C., Baumgartner, R., Robert, N., Suchebaatar, Z. and Bajalagmaa, N. 2000 (in press). Medical considerations in the reintroduction of the Przewalski Horse *(Equus przewalskii)* to the Dzungurian Gobi, Mongolia. Proc. European Assoc. of Zoo and Wildl. Vet. (EAZWV) Paris, France.