EVALUATION OF MEDETOMIDINE-INDUCED IMMOLIZATION IN ARABIAN ORYX (ORYX LEUCORYX): CLINICAL, HEMATOLOGIC AND BIOCHEMICAL EFFECTS

Arnaud Greth, D.V.M., Marc Vassart, D.V.M., and Saud Anagariyah, D.V.M.

Abstract: Medetomidine was used to immobilize 50 handreared Arabian oryx (Oryx leucoryx) for various minor clinical procedures. Compared to the effects of different drugs tried on the same animals, medetomidine at the dose of 53 ± 9 µg/kg (39–75 µg/kg), administered i.m. in a single dart, gave excellent results. The induction stage was particularly quiet, with complete recumbency in 11.05 ± 4.8 min (4.1–26.6 min). The immobilization was characterized by good to excellent myorelaxation, normal rectal temperatures, bradycardia, a low but stable respiratory rate, and no significant change in hematologic and serum chemistry values. Atipamezole, two-thirds given i.v. and one-third given i.m. at a dose of five times the medetomidine dose, led to standing recovery in 2.6 ± 2.3 min (0.75–8.9 min). No deaths and no major adverse effects were noted during immobilization or after reversal. The use of medetomidine as a mild sedative agent at low doses was also investigated. A dose of 25 ± 3 µg/kg (21–30 µg/kg) induced a sedation in males sufficient to facilitate transport of the animals.

Key words: Arabian oryx, Oryx leucoryx, immobilization, medetomidine, atipamezole, hematology, serum chemistry.

INTRODUCTION

The National Wildlife Research Center (NWRC) in Taif breeds Arabian oryx (Oryx leucoryx) as part of a reintroduction program in Saudi Arabia carried out by the National Commission for Wildlife Conservation and Development. An outbreak of tuberculosis in the founder herd resulted in the removal of calves from the infected herd immediately after birth for handrearing. These oryx, although tame, could not be manipulated for routine procedures such as pregnancy diagnosis, translocation, or collection of samples without sedation. Routine use of an etorphine/azaperone mixture, xylazine alone, or detomidine alone was not fully satisfactory.

Medetomidine (Domitor forte, 10 mg/ml, Farmos Group Ltd., Turku, Finland) is a potent, selective α₂-adrenoceptor agonist, being used successfully combined with ketamine in several species. The use of medetomidine alone has been reported in bactrian camels (Camelus bactrianus), svalbard reindeer (Rangifer tarandus platyrhynchos), markhor (Capra falconeri megareros), Alpine ibex (Capra ibex ibex), Barbary sheep (Ammotragus lervia), and white-tailed deer (Odocoileus virginianus). Only in semidomesticated Norwegian reindeer (Rangifer tarandus tarandus) did medetomidine alone give satisfactory immobilization.

For manipulation of handreared oryx, an efficient drug, easy to use under field conditions, safe for the user, without adverse effects in the animals, and reversible was needed. This paper reports a trial of medetomidine and atipamezole (Antisedan, 5 mg/ml, Farmos Group Ltd., Turku, Finland), a reversal agent, to assess their safety and effects in Arabian oryx.

MATERIALS AND METHODS

Animals

In April and May 1991, medetomidine was administered to 50 handreared Arabian oryx (28 males and 22 females). The mean age of the males was 28 mo (13–53 mo) and of the females 29 mo (17–41 mo). The animals were weighed on a platform scale (561SG, GIM, Beaupreaut, France) after
immobilization, with an accuracy of ±0.1 kg. The males weighed 87.5 ± 11.7 kg (61.7–109.5 kg) and the females 90.6 ± 10.2 kg (64.1–104.4 kg). All the animals were kept in 2–25-ha enclosures in groups of one to six individuals, and were clinically healthy and in good physical condition. The animals were fed 14% protein pellets, alfalfa hay, grass hay, and had free access to water. Animals were not fasted prior to immobilization. They received their last feed of pellets the evening of the previous day but had access to hay. The animals were darted in the mornings or in the evenings. The mean environmental temperature at time of immobilization was 30.1 ± 4.9°C (21–40°C). The Center is situated at 1,450 m altitude.

General procedure

Medetomidine was administered i.m. in the hindquarters, using a CO₂-powered dart gun (GUT 50, Telinject, Römerberg, Germany), and a needle of 1.5 × 30 mm long, from a maximum range of 10 m. The animals were usually calm before darting. After darting, the oryx were observed from a car, at a 15-m distance to avoid disturbance. After darting, the times to the first signs of sedation (initial effect) judged by locomotory changes, position of the head, or ataxia, to final recumbency, to handling the animal, to administering i.v. injection of the antagonist, and to stand up were recorded with a stopwatch. During immobilization, the degree and quality of immobilization were always evaluated by the same observer, using a scale from 0 to 5 (0 = no effect, 1 = insufficient [violent reactions, animal difficult to restrain, animal able to rise, or another injection necessary], 2 = moderate [tractable but mild struggling when handled, noticeable muscular tension of the legs or head], 3 = complete immobilization [good muscle relaxation and no arousal after handling], 4 = narcosis too deep [apnea, significant adverse effects], 5 = death due to drug overdose). On this scale a 3 notation represented the desired stage of immobilization. Reaction to observation, to stimulation with a clap on the croup, and to a sudden change of posture of the animal from sternal recumbency to lateral recumbency were recorded at 15, 30, and 45 min (and 10 min, if possible) after darting and also taken into account to evaluate the degree of immobilization. Heart rate (beats per minute: bpm), respiratory rate (breaths per minute: bpm), rectal temperature (°C), the degree of myorelaxation using a 1–5 gradation scale (1 = no myorelaxation, 5 = complete myorelaxation), mucosal membrane color, tongue and jaw relaxation, and capillary refill time were recorded at 15, 30, and 45 min (and 10 min, if possible) after darting. Venous blood samples were collected from the jugular vein in EDTA vacutainers (Venoject, Terumo, Japan) for hematology (packed cell volume [PCV] and or in plain vacutainers for serum chemistry (creatine kinase [CK], sorbitol dehydrogenase [SDH], protein, urea, sodium [Na], potassium [K], and chloride [Cl]) at the indicated time intervals.

Determination of PCV was done within 2 hr on a microcentrifuge (Compur M1101, Bayer Diagnostic, Munich, Germany). Samples for serum chemistry were stored at −80°C. CK was analyzed according to the Scandinavian recommended methods,2 SDH according to Gerlach and Hiby,3 total protein with the biuret method, modified by Weichselbaum,17 and urea enzymatically.12 Na, K, and Cl levels were determined using a Kone Microlyte Ion Specific Analyzer (Kone Corp., Espoo, Finland).

The 50 individuals included in the study were divided into three clinical groups, as follows:

Group I, initial clinical trial

Eight males selected randomly were darted with doses of medetomidine ranging from 18 μg/kg to 144 μg/kg (Table 1). These doses were based on the range of doses cited in the literature.10,13

Group II, serial monitoring

The results from study of group I allowed us to determine the effective range of doses and to plan individual doses based on es-
timed weights and other factors (see Discussion) for 36 individuals. Clinical, hematologic, and serum chemistry values were measured (Tables 2, 3). Three animals that did not become recumbent were not included in Table 2.

Group III, translocation dose

This group of six adult aggressive males, that were systematically attacking the keepers, received low doses of medetomidine to evaluate its use as a light sedative, allowing short transportation of an individual without strong physical restraint and risks to the handlers.

Reversal

Atipamezole was administered i.v. and i.m. on 50 occasions to all medetomidine-immobilized animals. The atipamezole:medetomidine ratio was always 5 (w/w). All the animals were observed 1 or 2 hr after reversal and their behavior recorded. Reversal was judged successful if there were no signs of sedation and behavior was normal. If reversal was incomplete, responses to stimuli were diminished and activity was reduced. Resedation was a return to recumbency. During the following days, all the animals were checked twice daily.

Statistical methods

Data obtained at 15, 30, and 45 min for degree of immobilization, rectal temperature, heart rate, respiratory rate, degree of myorelaxation as well as for PCV, CK, SDH, protein, urea, Na, K, and Cl (obtained at 10, 15, 30, 45 min) during the serial recordings were compared by Friedman two-way ANOVA for the entire set of dependent data as well as by a Wilcoxon signed ranks test for paired data (Systat Inc. 1990. Version 5.0, SAS Institute, Evanston, Illinois 60204, U.S.A.).

RESULTS

The results for each individual in group I are given in Table 1. Only one animal did not become recumbent. In view of these initial results, a dose of 40–70 μg/kg was
Table 2. Results (mean ± SD [range]) of the use of medetomidine and atipamezole in 33 Arabian oryx that were serially monitored (group II).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>13</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>Age (mo)</td>
<td>26 ± 12 (13–53)</td>
<td>28 ± 8 (17–41)</td>
<td>27 ± 10 (13–53)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>84.3 ± 14.6 (61.7–109.5)</td>
<td>90.3 ± 10.5 (64.1–104.4)</td>
<td>88 ± 12.4 (61.7–109.5)</td>
</tr>
<tr>
<td>Medetomidine dose (µg/kg)</td>
<td>45 ± 4 (39–52)</td>
<td>58 ± 7 (47–75)</td>
<td>53 ± 9 (39–75)</td>
</tr>
<tr>
<td>Initial effect (min)</td>
<td>3.9 ± 0.9 (2.7–5.3)</td>
<td>4.9 ± 2.0 (3–12)</td>
<td>4.5 ± 1.7 (2.7–12)</td>
</tr>
<tr>
<td>Time to recumbency (min)</td>
<td>10 ± 4.2 (5.5–16.5)</td>
<td>11.7 ± 5.2 (4.1–26.6)</td>
<td>11.05 ± 4.8 (4.1–26.6)</td>
</tr>
<tr>
<td>Time to handling (min)</td>
<td>11.4 ± 3.6 (6.5–17)</td>
<td>13.2 ± 4.85 (6–27.25)</td>
<td>12.5 ± 4.4 (6–27.25)</td>
</tr>
<tr>
<td>Quality of immobilization (0–5)</td>
<td>2.9 ± 0.1 (2.7–3)</td>
<td>2.9 ± 0.1 (2.6–3)</td>
<td>2.9 ± 0.1 (2.6–3)</td>
</tr>
<tr>
<td>Total atipamezole dose (µg/kg)</td>
<td>227 ± 20 (197–272)</td>
<td>288 ± 34 (234–374)</td>
<td>264 ± 42 (197–374)</td>
</tr>
<tr>
<td>Atipamezole i.v. dose (µg/kg)</td>
<td>147 ± 15 (119–164)</td>
<td>191 ± 25 (148–250)</td>
<td>174 ± 31 (119–250)</td>
</tr>
<tr>
<td>Time of antagonist injection T&lt;sub&gt;T&lt;/sub&gt; (min)</td>
<td>49.4 ± 2 (47.1–53.8)</td>
<td>51.5 ± 2.6 (47.75–55.75)</td>
<td>50.7 ± 2.6 (47.1–55.75)</td>
</tr>
<tr>
<td>Time to stand after antagonist injection (min)</td>
<td>2 ± 1.6 (0.75–7.6)</td>
<td>3 ± 2.6 (1.25–8.9)</td>
<td>2.6 ± 2.3 (0.75–8.9)</td>
</tr>
</tbody>
</table>

<sup>a</sup> 3.0 represents desired immobilization.

<sup>b</sup> For males n = 14, for females n = 22, and total n = 36.
adopted for a complete immobilization in group II.

In group II, all the immobilizations were successful. Medetomidine doses and the clinical effects are given in Table 2. Three animals (one male and two females) with obvious sedative effects but with no recumbency after 17, 20, and 24 min were caught by hand easily and were laid down without any struggle. These individuals were not included in Table 2 except for the reversal effect.

The clinical effects induced by medetomidine were reproducible and constant in all animals. The induction period was remarkably calm. A few minutes after darting, the animals became sedated, had a limited response to stimuli, and stood with the head lowered. When moving, they were uncoordinated and had an uncertain gait. They then laid down quietly in sternal recumbency in a controlled manner. Lateral recumbency was observed in one case (male 71, Table 1). The animals were easily caught and blindfolded 1–2 min after recumbency, with a physical reaction in only five cases. These five individuals tried to stand, and handlers had to restrain them in sternal recumbency for 1 or 2 min. Five minutes after handling, the animals showed a good to excellent myorelaxation, did not gnash their teeth, but snored and grunted frequently. Most of the time, the corneal reflex remained but the oculopalpebral reflex was less marked. The eyes sank into the orbits. Reactions to change of posture occurred 10 times on 96 occasions. Three females and five males reacted during the immobilization by kicking suddenly. The capillary refill times were normal, ranging from 2 to 4 sec.

Data on the serial recordings and determinations of clinical, hematologic, and serum chemistry values are presented in Table 3 for groups I and II. Wilcoxon signed ranks test showed a significant increase in the degree of immobilization between 15 and 30 min ($P < 0.001$) revealing an increase in the effect of the drug until 30 min. Rectal temperatures decreased slightly but significantly ($P < 0.001$) during the immobilization (see Discussion). Medetomidine induced bradycardia. Heart rates significantly ($P < 0.01$) decreased between 15 and 45 min. Arrhythmia was noted in one male and one female. ECG would have been necessary to assess the clinical significance of these arrhythmias. Respiratory rates were slow, with deep and strong thoracic movements. No significant differences appeared for the overall sample or between the rates at 15, 30, and 45 min. Hyperventilation was noted in two females and five males, even when ambient temperatures were moderate. The degree of myorelaxation showed a significant increase ($P < 0.01$). No significant differences were noted in PCV. CK decreased until 30 min and then significantly increased ($P < 0.001$). For SDH, no significant variation was recorded. Protein concentrations significantly ($P < 0.001$) decreased. For urea, a slight decrease ($P < 0.05$) was noticed between the 10-min sampling and the others. Na concentrations decreased significantly ($P < 0.001$). K concentrations were almost constant, with no significant differences for the overall sample. Only a slight increase was recorded at 45 min ($P < 0.05$). CI concentrations decreased significantly ($P < 0.001$) and regularly during the experiment.

No animal required an additional dose in group II. In groups I, II, or III, no deaths occurred during the study or over the month following the immobilization. No regurgitation, no apnea, and no hyperventilation were noted during the immobilization. Only a moderate ruminal tympany occurred in three females, and these signs disappeared after the reversal of the immobilizing drug. Most of the animals showed moderate salivation. A local reaction at the injection site appeared in one male and four females. The hairs were raised in an area up to 20 cm². Medetomidine was used in five females that were pregnant (3, 3, 6, 7, and 8 mo). No abortion or adverse effects on pregnancy were noted. and all the females gave birth at full term.
Table 3. Results (mean ± SD [range]) of serial recordings and determination of clinical, hematologic, and serum chemistry measures during medetomidine-induced immobilization of Arabian oryx (groups I and II).°

<table>
<thead>
<tr>
<th>Measure</th>
<th>Time after injection (min)</th>
<th>10</th>
<th>15</th>
<th>30</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>18°</td>
<td>39</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Quality of immobilization (0–5)</td>
<td></td>
<td>2.8 ± 0.2°</td>
<td>2.9 ± 0.1°</td>
<td>2.9 ± 0.1°</td>
<td></td>
</tr>
<tr>
<td>Clinical</td>
<td></td>
<td>(2.5–3.1)</td>
<td>(2.6–3.2)</td>
<td>(2.6–3.1)</td>
<td></td>
</tr>
<tr>
<td>Rectal temperature (°C)</td>
<td></td>
<td>39.1 ± 0.6°</td>
<td>38.9 ± 0.6°</td>
<td>38.8 ± 0.7°</td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td></td>
<td>40 ± 14°</td>
<td>36 ± 5°</td>
<td>34 ± 4°</td>
<td></td>
</tr>
<tr>
<td>Respiratory rate (bpm)</td>
<td></td>
<td>5 ± 6 sight 1–40</td>
<td>6 ± 12 sight 1–80</td>
<td>5 ± 9 sight 1–60</td>
<td></td>
</tr>
<tr>
<td>Myorelaxation (1–5)</td>
<td></td>
<td>3 ± 1.8°</td>
<td>3.8 ± 1.6°</td>
<td>4.15 ± 1.4°</td>
<td></td>
</tr>
<tr>
<td>Hematologic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCV (%)</td>
<td></td>
<td>38.8 ± 4.3 °</td>
<td>38.9 ± 3.4 °</td>
<td>38.6 ± 3.1 °</td>
<td>38.6 ± 3.4 °</td>
</tr>
<tr>
<td>Creatine kinase (IU/L)</td>
<td></td>
<td>167 ± 78.8</td>
<td>153.4 ± 91.7°</td>
<td>149.15 ± 79.4°</td>
<td>177.2 ± 90.2°</td>
</tr>
<tr>
<td>Sorbitol dehydrogenase (IU/L)</td>
<td></td>
<td>9.9 ± 6.5</td>
<td>9.8 ± 5.3</td>
<td>9 ± 4.9</td>
<td>9.3 ± 4.1</td>
</tr>
<tr>
<td>Protein (g/L)</td>
<td></td>
<td>59.35 ± 2.5°</td>
<td>59 ± 3.9°</td>
<td>56.5 ± 3.3°</td>
<td>55 ± 4.4°</td>
</tr>
<tr>
<td>Urea (mmol/L)</td>
<td></td>
<td>9.3 ± 1.7°</td>
<td>9 ± 1.9°</td>
<td>9 ± 1.9°</td>
<td>9.1 ± 1.8°</td>
</tr>
<tr>
<td>Na (mmol/L)</td>
<td></td>
<td>146.6 ± 1.8°</td>
<td>145.9 ± 1.8°</td>
<td>144.4 ± 2.1°</td>
<td>143.9 ± 2.1°</td>
</tr>
<tr>
<td>K (mmol/L)</td>
<td></td>
<td>4.5 ± 0.4°</td>
<td>4.5 ± 0.5°</td>
<td>4.5 ± 0.3°</td>
<td>4.7 ± 0.4°</td>
</tr>
<tr>
<td>Cl (mmol/L)</td>
<td></td>
<td>107.25 ± 1.9°</td>
<td>105.8 ± 2.1°</td>
<td>104.7 ± 2.4°</td>
<td>103.9 ± 2.2°</td>
</tr>
</tbody>
</table>

° Medetomidine dose 57 ± 18 μg/kg (39–144 μg/kg).
°° n = 16 for serum chemistry values.
°°°° Values on the same line with different superscripts are significantly (P < 0.05) different.
Table 4. Results of the use of medetomidine for translocation of males in Arabian oryx group III.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Age (mo)</td>
<td>30 ± 6</td>
<td>23–36</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>92.1 ± 4.2</td>
<td>86–97.6</td>
</tr>
<tr>
<td>Medetomidine dose (µg/kg)</td>
<td>25 ± 3</td>
<td>21–30</td>
</tr>
<tr>
<td>Initial effect (min)</td>
<td>6.3 ± 2.7</td>
<td>3.9–9.8</td>
</tr>
<tr>
<td>Number in final recumbency</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Time to final recumbency (min)</td>
<td>15.1 ± 7.2</td>
<td>6.3–25</td>
</tr>
<tr>
<td>Time to handling (min)</td>
<td>14.6 ± 3.6</td>
<td>10–18.5</td>
</tr>
<tr>
<td>Quality of immobilization (0–5)</td>
<td>2.2 ± 0.4</td>
<td>1.5–2.6</td>
</tr>
</tbody>
</table>

* 3.0 represents desired immobilization.

Clinical results of group III are in Table 4. A dose of 25 ± 3 µg/kg (21–30 µg/kg) induced mild sedation in six adult males. It allowed the keepers to restrain the animals manually. They could then be put in a pick-up truck and transported, or even directed to another enclosure by walking alongside them. Most of them went down after a mean time of 15 min, and it was difficult to make them stand again, even with heavy stimulation.

Reversal

Atipamezole proved to be effective in reversing medetomidine-induced immobilization in Arabian oryx at a ratio of atipamezole:medetomidine of 5 ± 0.05 (5–5.3), two-thirds given i.v. and one-third given i.m. (Table 2). First signs of arousal were minor ear movements, increased tension in the neck muscles, and increased respiratory rates. After slight stimulation, the animals got up and began to walk. Although still showing signs of sedation for the first few minutes, behavior became normal in less than 15 min in most cases. No resedation requiring another injection of atipamezole was noted. Two females and three males remained dull and slow to respond for 1–12 hr after the injection of atipamezole but without serious consequences.

DISCUSSION

Medetomidine alone induced reliable and safe immobilization in handreared Arabian oryx at doses of 40–70 µg/kg. These doses can be increased to 60–80 µg/kg to obtain a deeper immobilization and a good myorelaxation. The degree of sedation seems dose dependent, as it is possible to induce a heavy anesthesia (144 µg/kg) or to obtain a mild sedation sufficient for translocation (25 µg/kg).

The dose should be adjusted to the individual according to three criteria. Females seem to require higher dosages (10–20 µg/kg more) than males. This could be due to the behavior of the females that are more timid than males that are imprinted on man and therefore confident and aggressive toward men. The relative wildness and the temperament of the individual should also be taken into account. Some individuals are more anxious and fearful and require higher doses. The predarting behavior could be a good indicator when the animal is approached or trapped in a confined space. The results suggest that 10–14-mo-old oryx are more excitable than juveniles or adults, perhaps because they have not yet developed dominant and territorial patterns. They would thus require higher dosages.

The induction period when using medetomidine was particularly calm when compared to immobilization of Arabian oryx with combinations of etorphine-azaperone, etorphine–xylazine, etorphine–acepromazine, etorphine–detomidine, xylazine, or detomidine alone in our own experience.

A wait of 5 min after recumbency before
handling is recommended, as the quality of immobilization and the degree of myorelaxation increased between 15 and 30 min. A few individuals struggled when handled immediately after recumbency. It is also likely that the three oryx of group II that were handled before recumbency would have gone down later.

Study of the clinical values revealed no major deviations from normal. A slight hypothermia was noted due to the interference of the drug with thermoregulation. Bradycardia was apparent, which has also been found in other artiodactyl species. The Arabian oryx displays the same respiration pattern as fallow deer, reindeer, and Rocky Mountain goats (Oreamnos americanus), but bradypnea seems to be more noticeable. It may be due to the use of medetomidine alone, compared with the combination of medetomidine and ketamine used for immobilization of the other species cited.

Serum biochemical and hematologic values remained within physiological limits. PCV did not decrease during the immobilization. A decrease in PCV has been seen in markhors, and is cited in the literature. This difference may be explained by a lack of adrenalin increase when darted or by differences in reactivity of the spleen in this species. The slight increase in CK after 45 min of immobilization did not signify a pathological change, as the level remained low compared with that found in animals with clinical capture myopathy (up to 1,461,000 IU/L). The wide range for the values for this enzyme may be explained by variations in the individual histories of muscle activity in the hours or days before darting. SDH, as an hepatic and cytoplasmic enzyme, did not reflect any changes due to immobilization. No significant changes were noted in serum urea and K, in accordance with the findings of Jalanka in markhors. The decreases in Na and Cl levels were similar to those seen in markhors and may be due to the action of α₂-adrenoceptor agonists on kidney tubules. The decrease in serum protein may be related to the change of position of the animals, with recumbency itself having an effect on the state of relaxation.

Medetomidine should now be tried in the NWRC captive oryx, which were not handreared. It is likely that the results will not be so satisfactory. With other wild artiodactyls, medetomidine used alone has given poor results. The only other report of good results was in semidomesticated Norwegian reindeer (Rangifer tarandus), with doses of 50–200 μg/kg, which represents a case similar to that of the handreared Arabian oryx.

CONCLUSIONS

1. In handreared Arabian oryx, medetomidine alone provides a safe and effective method for chemical immobilization for minor procedures, with an exceptionally quiet induction stage.

2. Dosage ranges from 40 to 70 μg/kg are recommended. The dose can be increased to obtain deeper sedation for use in nervous animals, or decreased to 20–30 μg/kg for translocation purposes.

3. Atipamezole allows a safe, rapid, and complete recovery when two-thirds of the doses as given i.v. and one-third is given i.m. at a total ratio of atipamezole:medetomidine of 5 to 1.

Acknowledgments: This work was carried out under the auspices of H.R.H. Prince Saud Al Faisal and Dr. A. Abuzinada, Secretary General of the National Commission for Wildlife Conservation and Development. The study was conducted under the practical advice of Harry Jalanka, D.V.M., Helsinki Zoo. The authors thank Mr. Wecksell, Farmos Group Ltd., Finland, who kindly provided part of the drugs and S. Sankari, D.V.M., Ph.D., who performed the biochemistry analyses at the Central Laboratory, College of Veterinary Medicine, Helsinki. The authors also thank the NWRC mammal team for assistance in the field. M. Saint Jalme, Ph.D., and P. Richez, D.V.M., from the DataVet Research Society, for help in the statistical analysis of the data and F. Claro, D.V.M., J. Flamand, Vet.M.B., F. Rietkerk, D.V.M., P. Toutain, D.V.M., and
two anonymous reviewers for useful comments on the manuscript.

LITERATURE CITED


Received for publication 19 January 1992.