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Postpartum Immobilization of Adult Female Moose using Xylazine, Ketamine and Yohimbine Hydrochlorides

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ABSTRACT: Twenty-two free-ranging adult female moose (*Alces alces*) were immobilized with a 1:4 mixture of xylazine hydrochloride (XH) and ketamine hydrochloride (KH). Mean (SD) dosages/animal for XH and KH were 419 (148) and 1565 (433) mg, respectively. Mean (SD) induction time was 18.4 (9.7) minutes. Reversal with yohimbine hydrochloride using a mean dosage of 83 mg/animal resulted in a mean (SD) recovery time of 22.8 (28.5) minutes.

Key words: Immobilization, postpartum, moose, *Alces alces*, xylazine hydrochloride, ketamine hydrochloride, yohimbine hydrochloride.

A wide variety of wildlife species have been immobilized successfully using xylazine hydrochloride (XH) in combination with ketamine hydrochloride (KH), including members of the family Cervidae. Golightly and Hofstra (1989) reported success in immobilizing Roosevelt elk (*Cervus elaphus roosevelti*) using XH-KH reversed with yohimbine hydrochloride (YH). This combination also has been effective on mule deer (*Odocoileus hemionus*) (Jessup et al., 1983) and white-tailed deer (*O. virginianus*) (Mech et al., 1985).

Schwab et al. (1984) reported the use of XH-KH for immobilizing moose (*Alces alces*) during winter. However, they did not recommend its use for future studies because of the variability in animal response. We used XH-KH for immobilizing female moose following parturition and report the application of XH-KH for immobilizing postpartum female moose with YH used as an antagonist.

During each spring from 1990 to 1992, adult female moose were captured as part of an ongoing demographic study in Algonquin Provincial Park, Ontario, Canada (45°39′N, 78°39′W). The Park lies within south-central Ontario in which many lakes with islands and peninsulas are present. Islands and peninsulas in the Park are known calving areas for female moose (Addison et al., 1990).

From mid-May to early June, crews searched islands and peninsulas for females with newborn calves by walking abreast, maintaining contact with one another visually, by voice, or through the use of portable radios. Once located, adult females were immobilized with a 1:4 (100 mg/ml) mixture of XH-(Rompun®, Bayvet Division Chemagro, Ltd., Etobicoke, Ontario) KH (Rogarsetic®, Rogar/STB Inc., London, Ontario) delivered intramuscularly (IM) from Cap-Chur equipment (Palmer Chemical and Equipment Company, Douglasville, Georgia, USA) or pole syringes. Due to the dilutions of the immobilizing drugs, all moose (n = 22) required >1 injection (range = 2 to 4; $\bar{x}$ = 2.5).

Once immobilized, all moose received an eartag and a mortality sensing radio collar (Advanced Telemetry Systems Inc., Isanti, Minnesota, USA). Calves were captured by hand and received an eartag and a break-away mortality sensing radio collar (Lotek Engineering Inc., Newmarket, Ontario, Canada). Adult females in deep narcosis were given 5 mg/ml YH (Antagonil® Janssen Pharmaceutical, Mississauga, Ontario, Canada) intravenously and IM as an antagonist.

Drug doses are reported as mg administered/animal rather than mg/kg of body weight because of the difficulty of weighing moose in the field. We assumed live weights of adult females were similar to those reported by Quinn and Aho (1989). They reported a mean live weight of 435 kg for adult female moose in Algonquin

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TABLE 1. Drug dosages and induction and recovery times of immobilized postpartum female moose in Algonquin Provincial Park, Ontario, Canada, 1990 to 1992.

	n[a]	Mean (SD)	Range
Xylazine hydrochloride (mg/animal)	22	418.6 (148.1)	280.0–820.0
Ketamine hydrochloride (mg/animal)	22	1,564.6 (432.9)	1,120.0–2,560.0
Induction time (min)	14	18.4 (9.7)	4.0–39.0
Yohimbine hydrochloride (mg/animal)	20	82.9 (11.0)	50.0–112.0
Recovery time[b] (min)	9	22.8 (28.5)	1.0–71.0

[a] Number of moose tested.
[b] Time to standing.

Park. Induction time was recorded as the time (in min) from first injection until sternal or lateral recumbency was attained. Recovery time was the interval from injection of YH to standing.

Upon reversal, adult females were visually monitored until stable. All adult females and their calves were released at the capture site. After release, animals were monitored on a daily basis to the end of June. A weighted regression (SAS Institute Inc., 1990) was used to test for an effect of day of month captured on the amount of XH and KH used to achieve immobilization. Regression weights were computed as the inverse of the standard deviation (SD) of the mean dose of XH and KH per day. Days where only one moose was immobilized were not included in the analysis. We tested the regression slopes (β_1) against the null hypothesis that $\beta_1 = 0$ using t-tests (SAS Institute Inc., 1990).

Twenty-two adult female moose were immobilized. Mean (SD) dosage/animal for XH was 419 (148) mg and mean (SD) dosage/animal for KH was 1565 (433) mg. Mean (SD) induction time was 18.4 (9.7) minutes. Reversal with YH resulted in a mean recovery time of 22.8 (28.5) min (Table 1). The amount of XH used to achieve immobilization was significantly ($\beta_1 = 18.1$, $t = 2.2$, $P = 0.08$) affected by day of the month. Similarly, the amount of KH used also was affected ($\beta_1 = 81.0$, $t = 3.7$, $P = 0.01$). In total, an addition of approximately 100 mg/day of XH-KH was required to achieve effective immobilization as the calving season progressed.

The XH-KH combination produced satisfactory results for immobilizing postpartum adult female moose in this study. In contrast, Schwab et al. (1984) reported that immobilization of moose using XH-KH was not satisfactory during winter. We believe the disparate results may be related to the different physical and physiological status of the moose. Postpartum moose would be at a low annual physical and physiological state. Drawbacks of using XH-KH in this application included the large amounts (>1 injection at the concentration used) of drug required for immobilization, and the wide variation in induction times between animals.

The quantity of XH-KH could have been reduced significantly by concentrating the mixture through lyophilization. Variation in induction time between animals appeared to be a function of excitement level of the animal, which we believe was influenced by pursuit time (i.e., animals with longer pursuit times had longer induction times), and possibly by the strength of the cow-calf bond.

Larsen and Gauthier (1989), using a carfentanil, fentanil, XH, hyaluronidase (CFXH) mixture, attributed low survival of calves to both short-term and long-term effects of the drugs. They reported that using CFXH prepartum changed the female's normal defense behavior, which resulted in decreased postpartum calf survival. There was no evidence in our study that immobilization with XH-KH influenced either cow attentiveness to their young or postpartum calf survival. How-

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ever, one calf died from injuries sustained when its partially immobilized mother fell on it. No adult mortality occurred as a result of XH-KH immobilization.

The increase of approximately 100 mg of drug/day needed to achieve effective anesthesia in this study raises the possibility of a metabolic effect on induction time through the calving season. Metabolic rate in moose is influenced by plant phenology (Van Ballenberghe and Miquelle, 1990). Leafout in our study area occurs coincident with calving in mid- to late May. Moose, like other northern cervids, have an increase in metabolic rate in a summer as compared to winter (Regelin et al., 1985). We suggest that increased metabolic rate affected the amount of drug needed for anesthesia. Future studies could address this hypothesis to identify time specific factors producing more effective immobilization of cervids.

Golightly and Hofstra (1989) reported that injection of YH $\geq$ 35 minutes post-induction for elk always resulted in successful reversal. However, in our study recovery of moose following injection of YH was variable regardless of the time administered. Nevertheless, we recommend its use when using XH-KH for immobilizing moose.

While carfentanil currently is considered the drug of choice for moose (Franzmann et al., 1987), our primary reasons for recommending the use of XH-KH are adequate response by postpartum cow moose and operator safety. These responses included total survival of immobilized animals, wide dosage tolerance, adequate induction times, effective level of anesthesia, no adverse side effects, and potential reversibility. We contend that XH-KH is a desirable immobilizer for moose under the circumstances similar to those reported herein.

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