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Immobilization of Gray Wolves (*Canis lupus*) with Sufentanil Citrate

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ABSTRACT: Gray wolves (*Canis lupus*) were immobilized with 0.5 mg/kg xylazine plus 7.5 μg/kg of either sufentanil (n = 8), etorphine (n = 8), or carfentanil (n = 2). Drug doses used in this study were selected to provide consistency for comparison and are not recommended doses for effective immobilization of wolves. Induction times were similar among groups (11.9 ± 1.0 min). Thirty min after induction, wolves were given either 0.5 mg/kg naloxone hydrochloride plus 0.15 mg/kg yohimbine hydrochloride or saline only intravenously. Arousal times for wolves given naloxone and yohimbine (1.2 ± 0.1 min) were shorter than wolves given saline (35.5 ± 6.4 min). Respiratory rates were similar among the three drug groups (6.9 ± 1.0 breaths/min). One animal given sufentanil then saline was found dead 108 min after induction. Presumptive diagnosis was renarcotization and hypothermia. Results indicated that sufentanil is an effective opioid immobilizing agent for gray wolves.

Key words: *Canis lupus*, carfentanil, chemical immobilization, etorphine, gray wolves, naloxone, sufentanil, yohimbine, xylazine, experimental study.

Gray wolves (*Canis lupus*) have been immobilized with several different drugs or drug combinations (Seal and Kreeger, 1987). Opioid agents used on wolves have included etorphine hydrochloride (Fuller and Keith, 1981; Ballard et al., 1982; Tobey and Ballard, 1985) and the potent fentanyl congener, carfentanil citrate (Wiesner et al., 1984). Several other congeners of fentanyl have been developed for use in human medicine. Of these, sufentanil citrate has been shown to be both potent and safe (Marsboom, 1985). In this note, we report on the use of sufentanil to immobilize captive gray wolves as well as compare its use to immobilizations with etorphine and carfentanil.

These studies were conducted from December 1988 through January 1989 in east central Minnesota. Four male and four female captive, adult wolves were used and some wolves were used for more than one experiment. Males weighed 40.2 ± 1.3 kg (mean ± SE) and females weighed 31.5 ± 2.2 kg. The locality and husbandry of these animals has been previously described (Kreeger et al., 1987, 1990) and some of these wolves were used in earlier immobilization studies. Wolves were immobilized with 0.5 mg/kg xylazine (100 mg/ml; Rompun®, Miles Laboratory Inc., Shawnee, Kansas 66201, USA) plus 7.5 μg/kg of either sufentanil citrate (50 μg/ml; Sufenta®, Janssen Pharmaceutica, Piscataway, New Jersey 08854, USA), etorphine hydrochloride (1 mg/ml; M99®, Lemmon Co., Sellersville, Pennsylvania 18960, USA), or carfentanil citrate (3 mg/ml; Wildnil®, Wildlife Laboratories, Inc., Fort Collins, Colorado 80524, USA). Drugs were administered simultaneously via pole syringe in the proximal hip muscles. Despite differences in potencies, drug doses were kept constant in order to provide systematic comparison. Thirty min after induction (loss of consciousness), anesthesia in wolves given sufentanil (n = 8), etorphine (n = 8), or carfentanil (n = 2) was antagonized by 0.5 mg/kg naloxone hydrochloride plus 0.15 mg/kg yohimbine hydrochloride (Sigma Chemical Co., St. Louis, Missouri 63178, USA) administered simultaneously in the cephalic vein. Naloxone was prepared as a 10 mg/ml solution and yohimbine was prepared as a 5 mg/ml solution as previously described (Kreeger et al., 1987, 1988). Some wolves were anesthetized again with sufentanil (n = 3) or etorphine (n = 4) and given only saline 30 min after induction. Time to arousal (head up) was noted in all cases. Respirations were

counted just prior to antagonist or saline administration. Trials were conducted at the same time of day at least 14 days apart.

Induction times were similar for wolves given sufentanil (11.4 ± 1.1 min), etorphine (13.1 ± 2.2 min), or carfentanil (9.5 ± 1.5 min). One wolf given sufentanil and one given etorphine did not lose consciousness and these animals were not included in these data. These two animals were sedated, but were easily aroused and unsafe to handle. Respiratory rates were similar among wolves given sufentanil (8.4 ± 1.5 breaths/min), etorphine (5.4 ± 1.0 breaths/min), or carfentanil (4.0 breaths/min). One wolf given carfentanil had a respiratory rate of 48 breaths/min immediately after induction. Mean arousal time was 1.2 ± 0.1 min among the three groups after naloxone/yohimbine was administered. Narcotic antagonism appeared to be rapid and complete with wolves subjectively appearing normal within a few minutes. There was no evidence of renarcotization after antagonism for any of the three groups. Arousal time was 35.5 ± 6.4 min for wolves given saline only. Fewer animals were given saline after anesthesia because we halted this portion of the study after the death of one animal; a female given sufentanil lost consciousness in 8 min and was given saline 30 min later. Thirty-eight min after the saline was given, she aroused, moved to another location, and then laid down. Forty minutes after this arousal, she was found dead and was cool to the touch. Rectal temperature was not taken. Ambient temperature was −17 C. Necropsy conducted at the University of Minnesota Veterinary Diagnostic Laboratory (St. Paul, Minnesota 55108, USA) revealed no gross abnormalities. A presumptive diagnosis of hypothermia was made.

Sufentanil is approximately 4,500 times (Marsboom, 1985), etorphine 1,000 times (Dobbs, 1968), and carfentanil 9,400 times (Marsboom, 1985) more potent than morphine analgesia in rats. Sufentanil, however, has a safety margin 2.5 times that of carfentanil (Marsboom, 1985). In wolves, sufentanil and etorphine appeared equally potent because induction and recovery times were similar and each failed to completely immobilize one of the eight wolves. The total dose of etorphine used in this study (0.29 ± 0.01 mg) was much lower (range: 1.5–2.5 mg) than previously reported for free-ranging wolves (Fuller and Keith, 1981; Ballard et al., 1982; Tobey and Ballard, 1985). The failure to fully immobilize all wolves indicated that the 7.5 μg/kg dose of sufentanil or etorphine combined with 0.5 mg/kg xylazine was probably minimal for captive animals.

Despite desiring to equalize dosages among the three drugs tested, we used carfentanil on only two wolves. The carfentanil dose used was at least twice as high as previously reported (Wiesner et al., 1984). After adverse reactions noted in the first two immobilizations, we ceased testing at this dose. The tachypnea we observed upon induction in one wolf was noted also by Wiesner et al. (1984) in two of five immobilizations. This wolf also had very pale gums and a slow capillary refill time (>2 sec). The relatively slow respiratory rate (four breaths/min) in both wolves necessitated constant monitoring. We previously immobilized wolves (n = 4) with 10 μg/kg carfentanil which caused respiratory arrest upon induction in every case (T. J. Kreeger, unpubl.). Based on this limited experience, we feel that a dose of 7.5 μg/kg carfentanil in wolves is higher than necessary for safe immobilizations.

The death of the one wolf given sufentanil remains enigmatic. Renarcotization coupled with compromised thermoregulation is suspected. The loss of this animal underscores the need to antagonize narcotics and to recognize inherent risks in immobilizing animals under severe environmental conditions.

This is the first known report on the use of sufentanil to immobilize wild animals. This study was not intended to be comprehensive, rather it was designed to inform potential users of sufentanil's exis-

tence. Sufentanil is a potent opioid having a high safety margin and has potential as a wildlife immobilizing agent. Relative to accidental human exposure, sufentanil may also be safer than drugs such as carfentanil because of sufentanil's dilute concentration and lesser potency (Marsboom, 1985). It is widely available in human pharmacies should a substitute for etorphine be necessary. In studies where such matters are important, sufentanil is also a very specific μ-receptor agonist (Leysen et al., 1983) being more specific than etorphine (Rosenbaum et al., 1984). Disadvantages of sufentanil include a dilute preparation requiring relatively large volumes (up to 6.5 ml in this study) for animal immobilization plus its relative high cost ($86.00/mg).

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