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Authors: Travaini, Alejandro, Ferreras, Pablo, Delibes, Miguel, and Aldama, Juan J.

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Xylazine Hydrochloride-ketamine Hydrochloride Immobilization of Free-living Red Foxes (*Vulpes vulpes*) in Spain

Alejandro Travaini, Pablo Ferreras, Miguel Delibes, and Juan J. Aldama, Consejo Superior de Investigaciones Científicas, Estación Biológica de Doñana, Apartado 1056, 41080 Sevilla, Spain

ABSTRACT: A combination of xylazine hydrochloride-ketamine hydrochloride was used to immobilize 83 wild red foxes (*Vulpes vulpes*) (15 pups and 68 adults) at Doñana National Park (Spain). Mean ketamine hydrochloride doses were 17.1 mg/kg (SE = 1.53) and 12.3 mg/kg (SE = 0.4) for pups and adults, respectively, and mean xylazine hydrochloride doses for the same groups were 6.2 mg/kg (SE = 0.63) and 4.7 mg/kg (SE = 0.14), respectively. Mean induction times and first reaction times were 1.6 minutes and 22.5 minutes for pups and 3.8 minutes and 39.4 minutes for adults, respectively. Recommended doses for wild adult foxes of unknown weight are 75 mg of ketamine hydrochloride and 20 mg of xylazine hydrochloride.

Key words: immobilization, ketamine hydrochloride, red fox, *Vulpes vulpes*, xylazine hydrochloride, Spain.

The use of a combination of xylazine hydrochloride and ketamine hydrochloride has been highly recommended for immobilization of red foxes (*Vulpes vulpes*) (Kreeger et al., 1990), but most previous studies were conducted on captive individuals. We report the successful use of this combination to immobilize wild red foxes at Doñana National Park in southwestern Spain (37°00′N, 06°30′W). Xylazine hydrochloride acts as a nonnarcotic sedative analgesic (Seal and Kreeger, 1987) while ketamine hydrochloride induces dissociative or cataleptoid anesthesia (Wright, 1982; Jalanka and Roeken, 1990).

Fifteen 6- to 10-wk-old fox pups excavated from their dens (mean total weight = 1,845 g; SE = 120; range = 720 to 2,550 g) and 68 live-trapped adult (33 males and 35 females) red foxes (mean total weight = 5,580 g; SE = 126; range = 3,200 to 8,500 g) were captured and tested from December 1989 through February 1991. Recaptured animals were not used in order to avoid pseudoreplication (Hurlbert, 1984). Pups and adults were physically restrained and injected intramuscularly in the hindquarters with a combination of 2 to 35 mg of xylazine hydrochloride (Rompun, Bayer, Barcelona, Spain) and 10 to 100 mg ketamine hydrochloride (Ketolar, Parke-Davis, El Prat de Llobregat, Spain). After anesthetic induction, all foxes were weighed. They also were placed in right lateral recumbency, with their rectal temperature monitored throughout the immobilization period. The eyes were covered with a cloth to avoid corneal damage. Ambient temperature during immobilizations ranged from 18 to 23 C. Animals were left to recover in covered containers in dark, quiet areas.

Induction time was defined as the time from injection of the anesthetic to loss of consciousness. First recovery time was defined as the time from loss of consciousness to first head movements. Foxes were released at the same place of capture 20 to 30 hr after the initial anesthetic and ran away fully recovered with no apparent adverse effects. As our data satisfied the requirements of parametric statistical tests we used a one way Anova (Sokal and Rohlf, 1979) in all comparisons. Acceptance of significant differences was set at $P < 0.05$.

The mean xylazine hydrochloride doses used were 6.2 mg/kg (SE = 0.63; range = 1.3 to 11.7; $n = 15$) for pups and 4.7 mg/kg (SE = 0.14; range = 2.7 to 8.7; $n = 68$) for adults; the mean ketamine hydrochloride dose was 17.1 mg/kg (SE = 1.53; range = 5.71 to 27.78; $n = 15$) for pups and 12.3 mg/kg (SE = 0.4; range = 3.80 to 18.75; $n = 68$) for adults. We used higher doses with pups because the doses used with

adults were insufficient for pups in preliminary trials.

The mean induction time was 1.6 min (SE = 0.31; range = 1 to 4; n = 15) for pups and 3.8 min (SE = 0.15; range = 2 to 7; n = 68) for adults. Mean first recovery time was 22.5 min (SE = 6.3; range = 7 to 37; n = 5) for pups and 39.4 min (SE = 2.3; range = 16 to 109; n = 68) for adults. Xylazine hydrochloride doses were greater for pups than for adults (P = 0.002, F = 9.8) and the same was true for ketamine hydrochloride doses (P = 0.003, F = 9.4). Induction time was significantly shorter for pups than for adults ($P < 0.001$, F = 23.3). There was no significant difference in the first recovery times between pups and adults.

Xylazine hydrochloride and ketamine hydrochloride induced complete immobilization in all the foxes with all doses used. We found no significant differences between male and female induction times or first recovery times during the whole study period, or when considering only the breeding season (from December through April). The relationship between induction time and body weight for all individuals is described by the equation Y= 1.24 + 0.000442 X (r = 0.49, $P < 0.01$, n= 76), where Y is the induction time in minutes and X is the body weight in grams. However there was no significant relationship between first reaction time and body weight.

The advantages of xylazine hydrochloride-ketamine hydrochloride anesthesia have been well-documented (Parry et al., 1981; Seal and Kreeger, 1987; Jalanka, 1989; Maddock, 1989; Kreeger et al., 1986, 1990) and confirmed in this study: wide safety margin, rapid induction time, normal body temperature and profound analgesia and amnesia (Seal and Kreeger, 1987).

Excessive hypo- or hyperthermia were not recorded in our study; mean rectal temperature among adults was 37.9 C (SE = 0.67, range = 36.4 to 40.5 C; n = 39).

While ketamine hydrochloride can induce convulsions in canids (Wright, 1982), no cases of convulsions were observed in the 83 foxes used in this study. The safety of a xylazine-ketamine combination has not been established for pregnant foxes, but three adult females immobilized and radiotagged during late winter were pregnant and successfully gave birth.

In contrast to other studies, all animals we used were wild; thus, they probably represented a wide spectrum of nutritional and physiological conditions during immobilization. The wide safety margin provided by a xylazine-ketamine combination is of great value in field work, where animals rarely can be weighed and have their condition evaluated before immobilization. Our observed mean times from immobilization to first reaction in pups (22.5 min) and adults (39.4 min) are sufficient to conduct many routine field procedures.

Based on our results, we recommend the following dosages for immobilization of free-ranging red foxes: 15 mg/kg ketamine hydrochloride plus 5 mg/kg xylazine hydrochloride. For an unweighed adult red fox (between 4 to 7 kg in Europe) we recommend a dose of 75 mg of ketamine hydrochloride plus 20 mg of xylazine hydrochloride. This should allow for a handling time of about 40 min.

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