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Immobilization of Black Bears (*Ursus americanus*) with a Combination of Butorphanol, Azaperone, and Medetomidine

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ABSTRACT: Sixteen captive and five free-ranging black bears (*Ursus americanus*) were immobilized with a combination of butorphanol, azaperone, and medetomidine (BAM). The BAM drug combination was premixed using 0.5 ml butorphanol (30 mg/ml), 0.25 ml azaperone (50 mg/ml), and 0.25 ml medetomidine (20 mg/ml) per milliliter to yield a final mix of (15 mg butorphanol + 12.5 mg azaperone + 5 mg medetomidine)/ml. This combination, dosed at 0.4 ml BAM/~23 kg estimated body weight, provided a mean induction time of 10 min (95% confidence interval [CI] = 2 min), consistent anesthesia without apparent adverse effects, and smooth recovery (mean = 15 min, 95% CI = 4 min) after antagonism with atipamezole (5 mg/mg medetomidine) alone or in combination with naltrexone (5 mg/mg butorphanol). Based on our initial observations, BAM appears to be a reversible and accessible drug combination for immobilizing black bears that merits further evaluation for field use.

Key words: Atipamezole, azaperone, black bear, butorphanol, chemical immobilization, medetomidine, naltrexone, *Ursus americanus*.

A number of drug combinations have been effectively used to immobilize bears (*Ursus* spp.), the most common of which typically include a dissociative and a tranquilizer (e.g., zolazepam and tiletamine, ketamine and xylazine or medetomidine; Addison and Kolenosky, 1979; Bush and Custer, 1980; Gibeau and Paquet, 1991; White et al., 1996; Cattet et al., 1997; Caulkett and Cattet, 2002; Kreeger et al., 2002). Telazol® (Fort Dodge, Fort Dodge, Iowa, USA), a formulated combination of tiletamine and zolazepam, is used extensively in wildlife medicine and management due to its wide margin of safety, its broad spectrum of species efficacy and its lyophilized form that allows for reconstitution at variable concentrations. However, legal restrictions on distribution and use of Telazol® (e.g., its classification by the US Drug Enforcement Administration [DEA] as a schedule CIII drug) and slow recovery from immobilization (there is not an effective antagonist for Telazol®) are significant drawbacks to using this drug under field conditions.

Alternative drug combinations that would be most valuable to wildlife managers handling bears and other species should be at least as safe, effective, versatile, and more accessible than drugs already available for these applications. Consequently, we have recently focused on evaluating a combination of butorphanol, azaperone, and medetomidine (BAM) for use in capturing a variety of wildlife species, including black bears (*Ursus americanus*). All three of the drugs comprising BAM have been used previously in anesthetizing wildlife species. Butorphanol is a narcotic agonist/antagonist, analgesic, and mild tranquilizer (Allen et al., 1998). Azaperone is a neuroleptic butyrophenone commonly marketed as a tranquilizer in pigs that also has been used in a variety of wildlife (Colly, 1992; Hall et al., 2001). Medetomidine is a potent alpha 2 agonist with significant analgesia, muscle relaxation, and sedation that can be antagonized with atipamezole (MacDonald et al., 1988; Virtanen et al., 1988). Medetomidine has been used in combination with other drugs such as ketamine and butorphanol in a variety of wild animals from wood rats to gazelles (Jalanka and Roeken, 1990; Chittick et al., 2001; Larsen et al., 2002; Hahn et al., 2005); using medetomidine in

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combination with other drugs often reduces the total requirement (Jalanka and Roeken, 1990).

Preliminary data in several North American wild ungulate species (L. L. Wolfe, unpubl. data) show that BAM is an effective, reversible chemical immobilization combination. Moreover, this drug combination is more accessible than traditional combinations that incorporate opioids or dissociatives: butorphanol is a DEA schedule CIV, and neither azaperone nor medetomidine are scheduled in the US. Here, we describe our initial experiences using the BAM combination and atipamezole for reversible immobilization of black bears.

All black bears were handled as part of routine clinical or field work. Sixteen orphaned, yearling black bears held at the Colorado Division of Wildlife's Frisco Creek Wildlife Rehabilitation Center (Del Norte, Colorado, USA) were anesthetized in either April or September 2007 for prerelease examination and ear tagging with a combination of BAM delivered intramuscularly (IM) with the use of a pole syringe (Dan-Inject, Dan-Inject North America, Fort Collins, Colorado, USA). In addition, five free-ranging black bears were immobilized during July 2007 with BAM delivered IM via hand injection to three trapped bears or dart gun (Dan-Inject, Dan-Inject North America) to two treed bears in order to apply GPS collars in conjunction with an ongoing study (Baruch-Mordo, 2005).

For all 21 bears, the specific BAM combination that we used was premixed by combining 0.5 ml butorphanol (30 mg/ml, Wildlife Pharmaceuticals, Fort Collins, Colorado, USA), 0.25 ml azaperone (50 mg/ml, Wildlife Pharmaceuticals, Fort Collins, Colorado, USA) and 0.25 ml medetomidine (20 mg/ml, Wildlife Pharmaceuticals, Fort Collins, Colorado, USA) to yield a final combination of 15 mg butorphanol/ml, 12.5 mg azaperone/ml, and 5 mg medetomidine/ml. The total volume of drug administered was based on 0.4 ml BAM per estimated 50 pounds (~23 kg) body weight; we estimated each bear's weight (in pounds) visually prior to injection and then measured the actual weight (in pounds) under anesthesia; weights were subsequently converted from pounds to kilograms for reporting.

Anesthetic induction was measured as the time (nearest minute) after injection to the bear showing partial sedation and ataxia (level 2), becoming sternally recumbent but still responsive or with its head up (level 3), and becoming recumbent and relaxed with its head down (level 4). While the bears were anesthetized, we measured oxygen saturation (SpO_2) and heart rate (beats per min [bpm]) with a pulse oximeter (SergiVet, Smith-Medical, Waukesha, Wisconsin, USA), as well as rectal body temperature, at about 10-min intervals (T1, T2, and T3). Once handling was complete (about 30–40 min after induction), we gave atipamezole (5 mg/mg medetomidine) IM by hand injection to antagonize the medetomidine; no antagonist was given for the butorphanol in captive bears, but we administered naltrexone at 5 mg/mg butorphanol IM by hand injection to free-ranging bears. Recovery was measured as time (min) to the bear showing increased respiration (level 2R), holding its head up (level 3R), and standing (level 4R).

Drug doses calculated after measuring actual weights averaged 0.3 mg/kg butorphanol (standard error [SE]=0.02; range=0.2–0.47), 0.25 mg/kg azaperone (SE=0.01; range=0.17–0.39), and 0.10 mg/kg medetomidine (SE=0.01; range=0.07–0.16). Although we attempted to deliver a standard BAM dosage to these bears, disparities between estimated and actual weights resulted in our administering the BAM combination across an approximately twofold range of dosages.

In the captive bears, induction time to level 2 was 2.5 min (95% confidence interval [CI]=0.6 min; range=1–4 min); however, this was difficult to assess because they often hid in a corner after

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they were injected. Mean time to level 3 was 5 min (CI=0.8 min; range=2–8 min) and to level 4 was 8 min (CI=1.2 min; range=5–13 min). Overall muscle relaxation and ease of handling was excellent. Rectal body temperature ranged from 37.1–38.5 C among individuals and was stable throughout handling; average ambient temperature was about 14 C. Mean SpO_2 for captive bears was 85.6% (SE=1.7%) at T1, 84.6% (SE=1.6%) at T2, and 88.3% (SE=2.0%) at T3. Mean heart rate for captive bears was 53.1 bpm (SE=4.6 bpm) at T1, 47.1 bpm (SE=3.9 bpm) at T2, and 42.0 bpm (SE=5.0 bpm) at T3.

In the free-ranging bears, mean time to level 2 was 6 min (CI=3 min; range=2–9 min), to level 3 was 10 min (CI=6 min; range=3–15 min), and to level 4 was 12 min (CI=7 min; range=6–20 min). Average rectal body temperature ranged from 36.6–38.4 C among individuals and remained stable; average ambient temperature ranged from 1 to 34 C. Mean SpO_2 for free-ranging bears was 85.3% (SE=8.4%) at T1, 86.8% (SE=2.5%) at T2, and 90.0% (SE=2.5%) at T3. Mean heart rate for free-ranging bears was 55.0 bpm (SE=7.8 bpm) at T1, 45.8 bpm (SE=8.2 bpm) at T2, and 49.5 bpm (SE=7.6 bpm) at T3. Heightened excitement in free-ranging bears prior to BAM delivery probably contributed to the somewhat longer induction times we observed despite our tendency to overestimate body weights on these individuals.

All 21 bears recovered from BAM anesthesia without incident; 20 bears received antagonist, and one free-ranging individual recovered during transport and was not given antagonists. For the 16 captive bears that received IM atipamezole, the mean recovery time to level 2R was 5 min (CI=1 min; range=2–10 min), to level 3R was 12 min (CI=3 min; range=5–22 min), and to level 4R was 13 min (CI=3 min; range=6–23 min). During recovery, we stimulated captive bears about 7–10 min after antagonist injection by massaging them and changing their body position. For free-ranging bears the time to level 4R was 9 min (CI=9 min; range 4–15 min). Despite overestimating the weights of four of the five free-ranging bears, recovery times were comparable to those of captive bears that were dosed closer to their actual weight.

The combination of butorphanol, azaperone, and medetomidine used here provided reliable induction, anesthesia, and recovery without apparent adverse effects. BAM-anesthetized bears were relaxed and were not aroused by painful stimulation (e.g., ear tagging). Anesthetic recovery was smooth and relatively rapid compared to our and others' experiences with black bear recoveries from drug combinations that incorporate dissociatives. White et al. (1996) reported mean induction times in black bears of 17.7 min (SE=2.4 min) when using Telazol® and 16.5 min (SE=2.0 min) when using a ketamine-xylazine combination. Previous capture in Colorado in conjunction with an ongoing study (Baruch-Mordo, 2005) reported average induction time (estimated as time from first injection to time of first handling bears when taking rectal temperature) of 20 min (SE=2; n=26) for black bears immobilized with Telazol® while in cage traps, and 49 min (SE=21; n=3) for bears darted in trees. The relatively rapid recovery rates associated with antagonism with atipamezole is perhaps the biggest single advantage of using the BAM combination in black bears: White et al. (1996) reported mean recovery rates of 150.5 min (SE=8.6 min) following Telazol® anesthesia and 61.2 min (SE=4.6 min) following yohimbine antagonism of ketamine-xylazine immobilization; Baurch-Mordo (2005) observed recovery times of 1–3 hr in bears immobilized with Telazol®. Mean heart rates and oxygenation in BAM-immobilized bears remained within acceptable limits; the slightly lower heart rates that we observed here compared to values report-

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ed in black bears immobilized with a combination of medetomidine, zolazepam, and tiletamine (Caulkett and Cattet, 1997) or xylazine and ketamine (White et al., 1996) were most likely because BAM lacks a dissociative to stimulate cardiac activity. No side effects such as vomiting reported with Telazol in bears (White et al., 1996; Bush and Custer, 1980; Baurch-Mordo, 2005) were observed. We saw no evidence that using BAM affected either recovery or survival in immobilized bears; as with other drug combinations that incorporate potent α_2 agonists, oxygen supplementation could be used to further minimize potential adverse effects when indicated. Based on our observations, further evaluation of BAM for use in anesthetizing black bears under field conditions appears warranted.

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