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RESEARCH PAPER

The use and assessment of ketamine–medetomidine–butorphanol combinations for field anaesthesia in wild European badgers (*Meles meles*)

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Abstract

Objective To evaluate the effectiveness of four ketamine-based anaesthetics in badgers using a quantitative anaesthesia assessment technique.

Study design Prospective randomized 'blinded' experimental trial.

Methods The quality of induction, of anaesthesia (at 5-minute intervals) and of recovery were assessed in 93 badgers, given either one of three ketamine (K)–medetomidine (M)–butorphanol (B) combinations: group A – M K B at 20/40/80 μg kg^{-1}; group B – M K B at 20/40/60 μg kg^{-1}; and group C – M K B at 20/60/40 μg kg^{-1}, or ketamine (K) alone at 2 mg kg^{-1} (group D). The assessor was ignorant of the combination administered. Physiological variables (heart and respiratory rates and rectal temperature) were measured at 5-minute intervals during anaesthesia. Gingival mucus membrane colour was also recorded.

Results Induction to anaesthesia was most rapid with ketamine (2 mg kg^{-1}) although induction quality did not differ between techniques. Ketamine used alone gave the poorest score for anaesthesia quality. Heart rate (HR) and scores for gingival mucus membrane colour were higher in animals anaesthetized with ketamine alone. Rectal temperature did not differ significantly between the techniques at any time during anaesthesia. Ketamine used alone produced the poorest quality of recovery.

Conclusion and clinical relevance The M–K–B combinations investigated overcame several side effects associated with ketamine anaesthesia, but at the expense of more variable induction times, lower HRs, and poorer mucus membrane coloration.

Keywords anaesthesia, badgers, butorphanol, field studies, ketamine, medetomidine.

Introduction

Ketamine has been used in many mammalian species, including badgers (*Meles meles*) since the 1970s (Hunt 1976; Ramsden et al. 1976; Bush 1996; Thornton et al. 2005). In comparison with other chemical restraint techniques, the drug tends to preserve cardiopulmonary function, but when used alone, produces inadequate muscle relaxation (and sometimes inadequate anaesthesia) for surgery performed under 'field' conditions; it may induce muscle tremors and excessive salivation (Wolfensohn & Lloyd 1998). The pharmacokinetics of

ketamine in wild mammals have only been studied in one species, the southern elephant seal *Mirounga leonina* (Woods et al. 1999) and the cause of undesirable side-effects is not well understood. However, combining the drug with other anaesthetics and/or sedatives, can yield techniques which produce surgical anaesthesia whilst preserving the positive characteristics of ketamine (Wolfensohn & Lloyd 1998).

A number of ketamine-based anaesthetic techniques are now available for use by field biologists in wild mammals (Wolfensohn & Lloyd 1998). However, despite their practical value and the welfare implications of chemical *versus* physical restraint (Fernandez-Moran et al. 2001) it is important that techniques are properly assessed and refined in terms of safety and predictability. In an attempt to refine anaesthetics in badgers (see also Thornton et al. 2005) we report here principally on the efficacy of ketamine and three ketamine-based anaesthetics in badgers. We report on the design and implementation of a scheme to assess the quality of anaesthetics under field conditions. The objective was to determine whether ketamine-based combinations preserved the positive characteristics of ketamine in badgers, whilst suppressing the undesirable effects associated with its use as a sole agent. We also wanted to develop an anaesthesia quality assessment technique that could be used in the field with the minimum of equipment. The current study is part of an ongoing badger population research project, which involves providing short duration (up to 20 minutes) anaesthesia for minor procedures, e.g. body measurement and blood sampling by jugular venepuncture. We chose to compare ketamine used alone (Ketaset; Southampton, Hants, UK) with ketamine combined with medetomidine (Domitor; Pfizer Limited, Sandwich, Kent, UK) and butorphanol (Torbugesic; Southampton, Hants, UK). Medetomidine–ketamine–butorphanol (M K B) combinations were chosen because of their apparent popularity and efficacy for minor operations in domestic mammals in the UK (Hedenqvist et al. (2001). Medetomidine is a potent α_2-agonist and produces dose-dependent sedation and analgesia that appears to operate synergistically with ketamine (Wolfensohn & Lloyd 1998; Bush et al. 2001). It was used in the study in an attempt to improve muscle relaxation. The dose ratios were determined with the objective of minimizing the ketamine, and fixing the medetomidine content; the latter causes respiratory depression in badgers (Thornton et al. 2005).

Materials and methods

Badgers were trapped in peanut-baited cage traps set in Wytham Woods, Oxfordshire, UK, between 3 and 17 June 2001 as part of a long-term study (Macdonald & Newman 2002). At this time of year animals do not breed and generally have lower body fat than at other times (Macdonald & Newman 2002). Eighty traps were set each night adjacent to setts, for a total of 12 nights. After three nights in one area, traps were moved to a new area of the woods. Work was carried out under English Nature licence 1991537 and Home Office licence PPL 30/1826.

The traps were checked each morning between 06:30 hours and 07:00 hours. Captured badgers were transferred to holding cages before being transported to a central processing site. Each animal was weighed in its holding cage, the mass of which was subtracted to give the animal's mass to the nearest 0.1 kg. Animals were then given one of four anaesthetics: group A received M, K, and B at 20/40/80 μg kg^{-1} respectively. Group B received M, K, and B at 20/40/60 μg kg^{-1} and in group C, the proportions of M K and B were 20/60/40 μg kg^{-1}. Group D animals were injected with ketamine alone (2 mg kg^{-1}). The M K B combinations therefore contained considerably less ketamine. All injections were made using a 21 SWG (0.8 × 25 mm) needle into the quadriceps muscle. Juvenile animals under 5 kg were excluded from the trial. The assessor who was to subsequently monitor and record the duration of anaesthesia and score its quality was unaware of the treatment given.

The induction of anaesthesia was deemed complete at the loss of righting reflexes – determined by rolling the handling cage onto its side. Induction time, measured to the nearest minute, was the interval between injection and the loss of righting reflexes. Heart and respiratory rates and rectal temperature were measured as soon as induction was complete. Measurements were repeated every 5 minutes until venous blood samples had been obtained and the badger had been marked, measured, and returned to its holding cage. The gingival mucus membrane colour was monitored and scored as 0 (pink), 1 (pale), 2 (white), or 3 (blue), and this was recorded once during the procedure. Marking and sampling took approximately 15 minutes, after