Evaluation of the use of anesthesia and analgesia in reptiles

Matt R. Read, DVM, MVSc, DACVA

Objective—To determine anesthetic techniques and the drugs used to provide anesthesia and analgesia to reptiles.

Design—Mail-out questionnaire.

Sample Population—367 members of the Association of Reptile and Amphibian Veterinarians.

Procedure—1,091 members listed in the 2002 directory of the Association of Reptile and Amphibian Veterinarians were asked to complete a questionnaire regarding anesthesia and analgesia.

Results—367 of 1,091 (33.6%) individuals completed the questionnaire; 88.8% used inhalants (particularly isoflurane) for anesthesia, and ketamine, propofol, and butorphanol were the most commonly used injectable agents. Intubation, fluids, and having a dedicated anesthetist were most commonly used for patient support, and pulse oximetry and Doppler ultrasonography were most commonly used for monitoring. Respiratory depression, difficulty monitoring anesthetic depth, prolonged recovery, and hypothermia were the most frequent complications. Nearly all respondents believed that reptiles feel pain, but analgesics were used infrequently for many reasons.

Conclusions and Clinical Relevance—Providing anesthesia in reptiles is difficult, especially regarding anesthetic depth and vital parameters, and methods of support are used less frequently than in domestic species. Provision of analgesia is uncommon. Research regarding pain and its assessment, response to analgesics, and drug pharmacokinetics is needed. Dissemination of this information to practitioners needs to be improved for enhancement of the standard of care for reptiles. (*J Am Vet Med Assoc* 2004;224:547–552)

Reptiles are becoming increasingly popular as pets and are commonly found in zoological collections in North America. Like other species in captivity, reptiles are evaluated by veterinarians for a variety of medical and surgical diseases. Frequently, sedation or general anesthesia is required for physical examination and diagnostic testing and general anesthesia is required for surgery.[1] Although research has been conducted to investigate the effects of various anesthetics in various reptile species,[1] overall, our knowledge of reptile anesthesia continues to lag behind our understanding of anesthesia in domestic species. In addition, providing adequate pain management for animals has become very important to veterinarians, and recent research has been directed at validating methods of identifying animal pain, determining the pharmacokinetics of commonly used analgesic agents in various species, and developing methods of assessing analgesic efficacy. Little research has been directed at pain management in reptiles, and this topic continues to be a source of frustration for veterinarians because so little relevant information is available on which to base clinical decisions.

Recently, several surveys have been developed to determine the techniques most commonly used for anesthesia and analgesics in veterinary medicine.[2-5] These surveys focus the interest and attention of veterinarians on the topic and are useful because they compile data from large study populations. This information is used by practitioners to compare their methods of practice with those of their colleagues, determine areas for improving instruction of veterinary students, identify areas of interest of veterinarians to be discussed at continuing education meetings, and stimulate research in areas identified as being deficient.

The purpose of the survey reported here was to investigate anesthesia and pain management techniques used by reptile veterinarians.

Materials and Methods

A single questionnaire to investigate reptile anesthesia and pain management techniques and concerns was sent to the 1,091 members of the Association of Reptile and Amphibian Veterinarians (2002) who resided in North America. The membership of this association includes veterinarians, veterinary students, technicians, and others with a professional interest in reptiles and amphibians, reflecting practitioners working in private practice, zoological facilities, and academic institutions. A cover letter was used to explain that the anonymous survey was initiated by a faculty anesthesiologist at the University of Georgia's College of Veterinary Medicine to assess current practices of anesthesia and pain management by veterinarians actively involved in reptile practice. The questionnaire[a] consisted of 21 questions. Not all respondents answered all questions. A database program[b] was used to total responses with categoric data and search written answers and comments for common elements. Descriptive statistics were calculated.

Results

Demographics—The survey was conducted between July and October of 2002. Of the 1,091 surveys mailed, 374 (34.3%) were returned and 367 (33.6%) were included in the final analysis. The 7 excluded surveys were returned by participants with an interest in reptiles, but who were not actively involved in reptile medicine. Of the included participants, 365 were veterinarians and 2 were veterinary technicians; 243 (66.6%) of veterinary participants worked in predominantly small animal practices, 64 (17.5%) were in zoological medicine, 45 (12.3%) were in exclusively exotics practices, 7 (1.9%) were in

From the Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA 30602. Dr. Read's present address is Veterinary Emergency Clinic, 920 Yonge St, Ste 117, Toronto, ON, Canada M4W 3C7.

mixed animal practices, and 6 (1.6%) described their type of practice as other. Because of the anonymity of the respondents, geographic location of respondents could not be determined.

Mean ± SD number of years since graduation from veterinary college was 14 ± 8 (range, 1 to 53 years), and mean number of years in reptile or exotic practice was 12 ± 7 years (range, 1 to 36 years). The majority of participants (320 [87.3%]) did not have any specialized board certification, 30 (8.3%) had American Board of Veterinary Practitioners certification in an unspecified specialty, 11 (3.1%) were board-certified by the American College of Zoological Medicine, and 4 (1.3%) were certified by other specialty groups (eg, American College of Veterinary Surgeons).

Among respondents, 350 (95.4%) treated lizard species, 323 (88.0%) treated snakes, 321 (87.5%) treated chelonians, and 63 (17.2%) treated crocodilians in their routine practice (defined as treating > 1 animal of the group/month).

Anesthesia—Participants reported various degrees of client concern regarding anesthesia of their patients (**Table 1**). For the majority of responses (246 [67.0%]), participants described less than half their clients as being concerned about anesthesia in their reptiles.

Obtaining a complete history and performing a physical examination were the most common preoperative assessments reported, with 350 (95.4%) and 354 (96.5%) responses each, respectively. Preoperative blood analysis was also considered to be important, with serum biochemical analyses (193 [52.6%] responses), CBC (176 [48.0%] responses), and PCV (84 [22.9%] responses) reported as being required prior to anesthesia. Fewer participants required imaging techniques prior to anesthesia. Preoperative radiographs, ultrasound, or both were only required by 79 (21.5%) participants, although many respondents commented that these particular diagnostic tests were considered required on a case-by-case basis rather than mandatory, as were the other parts of their diagnostic regimens.

The majority of participants (326 [88.8%]) used inhalational techniques for anesthesia rather than injectable techniques (29 [7.9%]). A small group of participants reported using a combination of inhalational and injectable techniques (11 [3.0%]).

Responses were reported for anesthetic drugs used in practice, methods of monitoring and providing patient support, reflexes used to monitor depth of anesthesia, and frequently encountered anesthesia-related complications (**Tables 2–5**). The 5 anesthetic agents most commonly used were isoflurane, ketamine, butorphanol, propofol, and local anesthetics (lidocaine and bupivacaine). Less than 30% of participants reporting using the other agents.

There was wide variation in the methods reported for use in patient monitoring and providing patient support during anesthesia. The most common methods indicated on a supplied list were intubation, assignment

Table 1—Results of a survey of veterinarians regarding owners (No. [%]) who express concern about anesthesia and analgesia in reptiles

Percentage of owners	Anesthesia	Analgesia
0–25	151 (41.1)	181 (49.3)
26–50	95 (25.9)	81 (22.1)
51–75	52 (14.2)	50 (13.6)
76–100	42 (11.4)	33 (9.0)
No response	27 (7.4)	22 (6.0)

Table 2—Results of a survey (No. [%] of veterinarians) on the use of various anesthetic agents in reptile practice

Drug	Usage
Tranquilizers	
Diazepam	48 (13.1)
Midazolam	20 (5.4)
Acepromazine	19 (5.2)
α_2 Agonists	
Medetomidine	70 (19.1)
Xylazine	15 (4.1)
Injectables	
Ketamine	219 (60.0)
Propofol	159 (43.3)
Telazol	105 (28.6)
Opioids	
Butorphanol	171 (46.6)
Buprenorphine	42 (11.4)
Morphine	7 (1.9)
Hydromorphone/oxymorphone	5 (1.3)
Meperidine	1 (0.3)
Inhalants	
Isoflurane	335 (91.3)
Sevoflurane	63 (17.2)
Halothane	0 (0.0)
Desflurane	0 (0.0)
Other	
Local anesthetics	120 (32.7)
Atropine	21 (5.7)
Glycopyrrolate	20 (5.4)

Table 3—Results of a survey (No. [%] of veterinarians) on the use of various anesthesia monitoring and patient support techniques in reptile practice

Technique	Usage
Patient support	
Intubation	294 (80.1)
Dedicated anesthetist	275 (74.9)
Fluid support	147 (40.1)
Mechanical ventilator	50 (13.6)
Intra-osseous catheter	33 (9.0)
IV catheter	22 (6.0)
Monitors	
Pulse oximeter	156 (42.5)
Doppler monitor	150 (40.9)
Temperature	112 (30.5)
ECG	61 (16.6)
Esophageal stethoscope	14 (3.8)
Capnograph	10 (2.7)
Apnea alert alarm	2 (0.5)

Table 4—Results of a survey (No. [%] of veterinarians) on the use of different reflexes to monitor depth of anesthesia in reptile patients

Reflex	Usage
Pedal (toe pinch)	315 (85.8)
Righting	229 (62.4)
Tail pinch	175 (47.7)
Palpebral	165 (45.0)
Corneal	132 (36.0)
Tongue withdrawal	118 (32.2)

of an anesthetist to the patient, use of pulse oximetry, use of an ultrasonic Doppler flow monitor, and provision of fluid support during anesthesia. Other methods were reported to be less commonly used (Table 3).

The pedal (toe-pinch) reflex was the most commonly reported reflex used to monitor depth of anesthesia, followed by the righting reflex, tail-pinch reflex, palpebral reflex, corneal reflex, and tongue withdrawal reflex (Table 4).

On the basis of their own experiences, participants were asked to describe the 3 most common anesthesia-related complications that they encounter. By far, the most commonly reported anesthesia-related complications were respiratory depression or apnea, difficulty monitoring and maintaining constant anesthetic depth, prolonged recovery period following sedation or anesthesia, and intraoperative or postoperative hypothermia. All other complications were reported by < 15% of the participants (Table 5).

Analgesia—Nearly all of the participants (361 [98.4%] responses) responded affirmatively when asked whether they believed reptiles can feel pain. There were no negative responses to this question.

Participants reported varying degrees of client concern regarding analgesia of their patients (Table 1). Similar to the responses regarding client concerns about anesthesia, the majority of participants (262 [71.4%]) described less than half their clients as being concerned about the provision of analgesia to their reptile patients.

When asked if they emphasize the importance of pain management to clients, 222 participants (60.5%) answered yes and 124 (33.8%) answered no. Most respondents did not consider their knowledge of analgesia in reptiles to be adequate; only 75 (20.4%) answered yes to this question, whereas 282 (76.8%) answered no.

Following the categorization of Dohoo and Dohoo,[3] participants were described as being an analgesic user or non-user on the basis of their responses to the percentage of patients that routinely receive analgesics as part of their surgical management. If respondents reported using analgesics in ≥ 50% of their patients, they were considered to be users, and if < 50% of patients typically received analgesics, the respondents were considered non-users. On the basis of this categorization, 145 (39.5%) respondents were users and 66 (18.0%) were non-users.

Of the 321 participants who reportedly include chelonian species in their practice, only 133 responded to the question of when analgesics are administered. Only 139 of 350 respondents who practice on lizards, 125 of 323 who practice on snakes, and 26 of 63 who practice on crocodilians answered this question.

Participants were surveyed about the timing of their routine use of analgesics in different types of reptiles (**Table 6**). They were asked to identify whether analgesic drugs were typically used before a potentially painful procedure, after the procedure, or both. Most respondents indicated that analgesics were given to reptile patients both before and after a procedure.

To better describe the use of analgesic agents in reptile practice, participants were asked about the criteria that they use to decide whether an analgesic is required. Two hundred seventy-seven (75.5%) respondents reported using the anticipated degree of pain, based on extrapolation from a similar procedure in other species, in their decision-making. Two hundred forty (65.4%) respondents reported using behavioral changes (attitude, appetite, posture, and vocalizing); 209 (56.9%) reported using the anticipated degree of pain, based on prior experience with the procedure in reptiles; and 116 (31.6%) used physical changes (heart rate and respiratory rate) in their decision-making.

One hundred eighty-eight (51.2%) participants did not routinely use **nonsteroidal anti-inflammatory drugs (NSAIDs)** in their reptile patients, whereas 165 (45.0%) did use this class of analgesic routinely.

When asked about potential sources of information on which participants based their use of analgesics in reptiles, 297 (80.9%) reported using reptile textbooks, 293 (78.9%) reported using information from continuing education meetings, 256 (69.8%) reported using personal experience, 241 (65.7%) reported using original pain-related research published in refereed journals, 238 (64.9%) extrapolated drug use and doses from domestic species, and 207 (56.4%) reported using information obtained from internet discussion forums.

Participants were asked to suggest their own ideas

Table 5—Results of a survey (No. [%] of veterinarians) on the types of anesthesia-related complications in reptiles

Complication	Veterinarians
Respiratory depression or apnea	186 (50.7)
Difficulty with monitoring and maintaining constant depth of anesthesia	173 (47.1)
Prolonged recovery period	159 (43.3)
Hypothermia	109 (29.7)
Death	47 (12.8)
Prolonged induction period	26 (7.1)
Bradycardia	25 (6.8)
Difficulty using monitoring equipment	21 (5.7)
Inability to assess pain and provide analgesia	14 (3.8)
Unpredictable response to drug or dose	14 (3.8)
Difficulty with intubation or endotracheal tube becoming obstructed	8 (2.2)
Hypoxemia	8 (2.2)
Hypotension	5 (1.4)
Provision of patient support (eg, fluids)	4 (1.1)
Postoperative anorexia	4 (1.1)

Table 6—Results of a survey (No. [%] of veterinarians) on when analgesic drugs are administered to reptiles in relation to surgery

Group	Timing of analgesia	Usage
Chelonians	Before	20 (15.0)
	After	28 (21.1)
	Both	85 (63.9)
Lizards	Before	20 (14.4)
	After	29 (20.9)
	Both	90 (64.7)
Snakes	Before	18 (14.4)
	After	28 (22.4)
	Both	79 (63.2)
Crocodilians	Before	2 (7.7)
	After	10 (38.5)
	Both	14 (53.8)

for original research in areas that they felt were deficient in information on which to base their clinical practice. Many respondents (110/276 [39.9%]) suggested pharmacokinetic research to establish correct doses, dosing intervals, incidence of adverse effects, and overall safety of different analgesics in different reptile species. Seventy-two (26.1%) respondents suggested investigating comparative efficacies of different drugs in different species and determining clinical responses to the administration of analgesics (ie, minimum alveolar concentration reduction studies with inhalant anesthetics). Thirty-seven (13.4%) participants recommended establishing indicators to permit subjective and objective assessment of pain in research models. Suggested areas for investigation included behavioral changes and physiologic indicators (cortisol or catecholamines) of pain that could be used in studies to test drug efficacies. Twenty-two (8.0%) respondents suggested basic pain physiology studies to better describe pain transmission pathways and identify the presence and distribution of opioid and other pain-modifying receptors in different reptile species. Another 8.0% suggested specifically investigating nonsteroidal anti-inflammatory analgesics in reptiles in terms of drug kinetics, safety, and efficacy. Nine (3.3%) participants suggested conducting large-scale, multicenter clinical trials to assess efficacy of different analgesic drugs in reptiles treated for a variety of problems, and 4 (1.4%) suggested research to investigate the use of orally administered analgesics that could be sent with clients for long-term use in reptiles at home.

Discussion

The membership of the Association of Reptile and Amphibian Veterinarians was targeted for this questionnaire to collect information from a population of veterinarians with a professional interest in reptile medicine. The overall return rate of 367 (33.6%) completed surveys for a single mailing was considered to be good and revealed the interest in anesthesia and analgesia that reptile practitioners in North America have. The 367 responses reported here were comparable to other large-scale surveys of anesthesia and analgesia practice in North America that have had 90,[4] 275,[3] and 333[5] responses upon which to base their conclusions. This high level of interest is a positive factor and suggests that continued research into the areas of reptile anesthesia and analgesia will be well received by veterinarians involved in reptile practice.

Reptiles are generally considered to be more challenging to anesthetize than most species that veterinarians routinely deal with because they have many unique anatomic and physiologic characteristics.[1] Depending on species, size, and disposition, even routine procedures such as physical examination, blood collection, and diagnostic imaging may necessitate chemical restraint or general anesthesia.[1,6]

As with any anesthetic episode, an attempt at ensuring patient well-being begins in the preoperative period. Several authors have stressed the importance of completing a minimum database that includes a complete history, thorough physical examination, and determination of PCV and total solids.[1,7] These recommendations appear to have become the standard in practice because nearly all respondents in the study reported here required a history and physical examination prior to anesthesia. Additional testing should be based on this initial assessment and may include CBC, serum biochemical analyses, and diagnostic imaging. The requirement for preoperative blood analysis was more variable, with only half of all respondents requiring a CBC or serum biochemical analyses and < 25% requiring measurement of PCV.

The most commonly recommended method for maintaining general anesthesia in reptiles is by use of inhalational agents.[1,8-11] Results of this survey concurred with this assumption. Nearly all respondents used inhalational techniques to maintain anesthesia in their reptile patients. In addition to the benefits of providing better control over anesthetic depth and more rapid recovery times, inhalational anesthesia also requires the use of oxygen as a carrier gas and, in most instances, tracheal intubation.[8-11] As a result of the supplemental oxygen, reptiles are less likely to become hypoxemic and, if intubated, can be ventilated if required. Supplemental oxygen and intubation are also recommended because the respiratory depressant effects of anesthesia are common in these species.[7,11-14]

The anesthetic agents used in practice appear to reflect those that have been used in the most recent research in reptiles and are also those that are most commonly used in general practice on domestic species. The 5 most commonly used agents reported here were isoflurane, ketamine, butorphanol, propofol, and local anesthetics. Isoflurane has been recommended for several years over halothane for use in reptiles.[1] Isoflurane administration results in faster induction and recovery and provides better control of the depth of anesthesia, most likely because it has lower blood-to-gas solubility; this characteristic is also responsible for recent reports[9,11] on the use of sevoflurane in reptiles. Sevoflurane administration results in even more rapid induction and recovery in most reptiles. Presently, isoflurane appears to be the standard in practice, but with the increasing number of investigations into the efficacy and safety of sevoflurane in reptiles, the latter may become increasingly more common. Historically, ketamine has been the most commonly used injectable agent for most reptile species, primarily because of its reliability in inducing some degree of immobilization and its administration by the IM route. Disadvantages of its use include the necessity for high doses that result in rapid induction but often extremely prolonged recovery, respiratory depression, apnea, and unpredictable depth of anesthesia among individuals and species at a given dose.[15-17] For these reasons, several recent studies[6,8,9,12,14,18,19] have investigated the concurrent use of reversible α_2 adrenergic agonists (such as medetomidine) in an attempt to lower the overall required dose of ketamine and the use of IV or intraosseous propofol administration to induce short-term anesthesia. Propofol reliably induces anesthesia and short-term immobilization in a number of reptile species, and the time required until the patient is completely recovered is much shorter than when other injectable agents are used. With nearly half the respondents in the study reported here already using propofol routinely in practice, it is likely that the popularity of this agent will continue to grow in the

future as more practitioners become familiar with its advantages and uses. Butorphanol was the most commonly cited analgesic agent, even though the only published reptile study[20] that investigated the potential for its analgesic effects during isoflurane anesthesia found it to have none. There are no other reported studies investigating the use of butorphanol for sedation or pain control in reptiles. It is, however, one of the most commonly used analgesics in domestic species, and the high degree of use reported in this study likely reflects practitioners' comfort level with its use in their other patients.[3,5]

The methods used to monitor and support reptile patients during anesthesia were quite varied. Most respondents intubated reptiles and maintained anesthesia with inhalation agents. Nearly 75% of those surveyed also used a dedicated anesthetist. Unfortunately, the use of vital parameter monitors was found to be uncommon, with fewer than 50% of respondents reporting use of these monitors. This is similar to a survey of anesthetic techniques in private practices in which < 40% of respondents reported use of continuous monitors.[5] Pulse oximetry and ultrasonic Doppler flow detectors were the most commonly reported monitors used in the study reported here. Both of these monitors are very useful in that they both provide continuous, real-time data about the patient's pulse rate, rhythm, and peripheral perfusion status. Doppler monitors are versatile and can be used in a variety of species and for this reason have been recommended for cardiopulmonary studies in reptiles.[10,12] Pulse oximeters have been found to be variably useful in different reptile species.[8,10,18] It is often difficult to place them appropriately to obtain a strong signal, and the information provided for oxyhemoglobin saturation is based on the human oxyhemoglobin dissociation curve and has not been verified in reptiles. In most studies that compared oxyhemoglobin saturation measured by pulse oximetry with that measured via blood gas values, the pulse oximeter values suggested hypoxemia and were not accurate.[8,18] Although electrocardiography has been found to be useful in several studies,[6,9,18] its use in practice appears to be uncommon.

Difficulty with monitoring anesthetic depth and maintaining a constant level of anesthesia is common. In this study, the toe-pinch (pedal) reflex was most commonly used to judge anesthetic depth, followed by the righting, tail-pinch, palpebral, corneal, and tongue withdrawal reflexes. Several studies[6,8,16,18] have investigated the usefulness of various reflexes in various species. In most reports,[8,16,18] the righting reflex is the first to be lost with the onset of anesthesia and the last to return during recovery The other reflexes are lost at variable times depending on the drugs used and the species and are therefore less reliable for predicting depth of anesthesia. At a surgical plane of anesthesia, the corneal reflex should be maintained, and if it is lost, the reptile should be considered to be at a deep plane of anesthesia.[8] It may be more effective to use the righting reflex to monitor anesthetic depth instead of the toe-pinch reflex that most practitioners are more commonly using now.

Complications are commonly encountered during anesthesia of reptiles. In this study, the most frequently reported complications were respiratory depression or apnea, difficulty monitoring and maintaining a constant depth of anesthesia, prolonged recovery after anesthesia, and hypothermia. Considering the large number of respondents who reported respiratory depression and apnea as complications during reptile anesthesia, surprisingly few reported using a ventilator during anesthesia, and an even smaller group used capnography to monitor the adequacy of ventilation. Many studies[6-8,12,14,15,18,19] have reported breath-holding as common occurrences during reptile anesthesia, and with certain species such as chelonians, it can be extremely difficult to observe inspiration and expiration. Apnea is especially common during anesthetic induction via inhalation in aquatic species that are able to breath-hold for extended periods in response to the noxious smell of some anesthetics or the placement of a mask over their snout or head (the so-called dive reflex). Intraoperative apnea during inhalation anesthesia may also contribute to the anesthesia becoming too light and may cause rapid awakening during painful stimuli. Several investigators recommend the use of intubation and assisted ventilation to maintain normal exchange of oxygen and carbon dioxide and adequate concentration of anesthetic.[1,11-14] Prolonged recovery after anesthesia has long been reported as a complication of reptile anesthesia.[13,17,21] With the increasing use of isoflurane, sevoflurane, propofol, and lower doses of ketamine when used with medetomidine (the effects of which can be reversed by use of antagonists), recovery times are generally shorter than in the past.

The capacity to feel pain is generally assumed to be related to phylogenetic position, with mammals and birds being placed higher than reptiles, amphibians, and fish.[22] Pain is not easily defined or quantified, even in humans. Until recently, the lack of information has resulted in the common misconception that pain in nonmammalian species is unimportant. However, as 1 author points out, "the inability to accurately quantitate pain does not negate its existence."[23]

The basic anatomic, physiologic, and biochemical components of pain perception that exist in mammals also exist in nonmammalian species.[24-27] These findings suggest that nonmammalian species have the capacity to feel pain by having the appropriate neurologic components to evoke action potentials in response to painful stimuli, endogenous antinociceptive mechanisms to modulate pain, and observable modulation of pain pathways and behavioral responses with known analgesic agents.[22,24-27] Unfortunately, few studies have evaluated the recognition, assessment, and treatment of pain in reptiles in a clinical setting, and as a result, there is a paucity of information on which to base clinical decisions involving pain management.

This survey found that there is an overwhelming interest in pain management by practitioners. Nearly all the respondents believed that their reptile patients had the capacity to feel pain, and most respondents emphasized the importance of pain management to their clients. However, more than 75% of respondents described their knowledge of analgesia in reptiles as inadequate. Interestingly, when asked to quantify the percentage of reptiles that are given analgesic agents, < 40% of respondents used analgesics in > 50% of their reptile patients. This is in stark contrast to the 98.4%

who believed that reptiles can feel pain. Clearly, this area of reptile medicine must be addressed in the immediate future because many veterinarians consider themselves unable to make educated pain management decisions despite believing that reptiles feel pain.

This study revealed that analgesics are typically administered to reptiles both before and after a surgical procedure. Among lizards, snakes, and chelonians, nearly two-thirds were administered an analgesic agent preemptively, followed by an additional dose after a painful procedure. This is consistent with the currently held theory in humans and domestic species that pain is better treated prior to the painful stimulus and that the postoperative dose will be more effective.[28] Interestingly, a much smaller proportion of crocodilian species, compared with other species, received preemptive analgesia; the reason is unclear, but the limited ability to handle many crocodilians prior to immobilization and anesthesia may be a contributing factor.

Likely reflecting the lack of species-specific research in reptile pain management, most respondents used the anticipated degree of pain, based on extrapolation from a similar procedure in other species, when determining the requirement for providing analgesia to reptiles. This is reasonable because "current knowledge suggests that it is appropriate and preferable to consider procedures known to be painful when applied to human subjects to be painful when applied to other animals."[23] Fewer participants used behavioral changes or their past experience with the procedure in reptiles, and even fewer used physical changes such as heart rate in their decision-making.

Nonsteroidal anti-inflammatory drugs were used by half the respondents during pain management. To date, there have been no studies to evaluate the efficacy, safety, or use of NSAIDs as analgesics in reptiles, and the doses reported by participants in this study were generally similar to those reported anecdotally as being extrapolated from domestic species (most commonly from doses used in dogs).[7] The use of NSAIDs in reptiles represents a large area of research that needs to be explored.

When asked to suggest areas of research that would be useful in advancing our knowledge of pain management in reptiles, most respondents focused on a database of information analogous to that of domestic species and humans. Basic research into the pharmacokinetics of different analgesic agents in different reptile species to determine appropriate doses, dosing intervals, and safety was the most common response. When asked to describe the doses and dosing intervals of the analgesics used in their practices, respondents had extremely varied responses. For example, the dose of butorphanol varied from 0.02 mg/kg (0.009 mg/lb) to 25 mg/kg (11.4 mg/lb), with dosing intervals from 4 to 48 hours. Considering that this opioid has recently been shown to not have analgesic (isoflurane-sparing) effects[20] and the limited investigations of using other opioids in reptiles,[24] this wide variance clearly indicates that directed research must be conducted to determine the appropriate use of this and other analgesics.

[a]Available from the author on request.
[b]Microsoft Access, Microsoft Corp, Redmond, Wash.

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