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Author(s): Tara M. Harrison, D.V.M., M.P.V.M., Dipl. A.C.Z.M., Dipl. A.C.V.P.M., Dipl. E.C.Z.M. (Zoo Health Management.), and Scott H. Harrison, Ph.D.

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EVALUATION OF HUSBANDRY AND MORTALITY IN LESSER HEDGEHOG TENRECS (*ECHINOPS TELFAIRI*)

Tara M. Harrison, D.V.M., M.P.V.M., Dipl. A.C.Z.M., Dipl. A.C.V.P.M., Dipl. E.C.Z.M. (Zoo Health Management), and Scott H. Harrison, Ph.D.

Abstract: Causes of morbidity and mortality for various species of tenrecs have not been widely published, aside from several reports of neoplasia, and these data are crucial for advancing objectives for preventive medicine, diagnosis, and treatment. A survey on husbandry, morbidity, and mortality of lesser hedgehog tenrecs (*Echinops telfairi*) in Association of Zoos and Aquariums (AZA) institutions was conducted. Out of 32 institutions, 20 responded with data for 98 living and 93 dead animals. The most common causes of mortality among the dead animals were neoplasia (24%), hepatic lipidosis (11%), septicemia (8.6%), pneumonia (8.6%), cardiomyopathy (7.5%), renal disease (6.5%), osteomyelitis (3.2%), and trauma (3.2%). There was no statistically significant correlation between sex and neoplasia. Data about educational usage were specifically provided by survey respondents for 50 of the tenrecs, with only 42% being excluded from educational programming. Tenrecs are common to many AZA institutions as both educational and exhibit animals, and this study provides a helpful reference for expected health problems and highlights the need for future investments into medical diagnosis and treatment for these animals.

Key words: Husbandry, mortality, neoplasia, tenrec, zoo.

INTRODUCTION

Lesser hedgehog tenrecs (*Echinops telfairi*) are small insectivores from the family Tenrecidae and are native to Madagascar.²⁵ Few reports have been published on medical treatments for lesser and greater hedgehog tenrecs (*Setifer setosus*).^{4,13,16} Literature on appropriate clinical and husbandry parameters is lacking in tenrecs, because previously published studies have mainly related to tenrec anatomy, physiology, and evolution.^{1,2,5–9,11,17–20,22,24,28} Our evaluation was carried out to provide essential and up-to-date information on common husbandry practices for lesser hedgehog tenrecs in zoological institutions, their morbidities, and causes of their mortalities.

MATERIALS AND METHODS

Institutions belonging to the Association of Zoos and Aquariums that housed lesser hedgehog tenrecs in 2011 were invited to fill out a survey regarding the care and causes of mortality of their tenrecs.

Thirty-seven questions were asked on the survey. Participants were allowed to skip a

question if it did not pertain to their tenrec(s). Basic background questions involved name and location of the institution and age and sex of the tenrecs. Husbandry questions related to substrate used, lighting offered, diet, diet frequency, diet consumption, use of animal with the public, months of torpor, and group or single housing. Solicited information on mortality included the cause of tenrec death and the age at which death occurred. For instances of neoplasia, participants were surveyed for type of neoplasm, age at diagnosis, occurrence and location of metastases, treatment modalities, and treatment outcomes. Questions in the survey were multiple choice and short answer.

Survey results were collected online through SurveyMonkey (San Mateo, California 94403, USA; <http://www.surveymonkey.com>) and through postal mail. Data were collated in Microsoft Excel, and statistical analyses were performed with IBM SPSS Statistics (version 22, IBM Corp., Armonk, New York 10504, USA) and R (version 3.2.1, The R Foundation for Statistical Computing, Vienna, Austria; <http://www.R-project.org>).

RESULTS

Demographics

Out of 32 zoological institutions holding lesser hedgehog tenrecs, 20 responded to the survey (62.5%). Data were collected for 98 living and 93 deceased tenrecs, with 39 tenrecs not specified as to whether they were alive or not.

From North Carolina State University, College of Veterinary Medicine, Raleigh, North Carolina 27606, USA (T. Harrison), and North Carolina Agricultural and Technical State University, Greensboro, North Carolina 27411, USA (S. Harrison). Correspondence should be directed to Dr. T. Harrison (tara_harrison@ncsu.edu).

Within the overall group of all surveyed tenrecs, 61 (26.5%) were female, 68 (29.6%) were male, and 101 (43.9%) were of unknown sex or not recorded. Of the tenrecs that were alive at the time of this study, 23 were males, 23 were females, and 52 were of unknown sex. Of the tenrecs deceased at the time of the study, 36 were males, 31 were females, and 26 were of unknown sex. All of the tenrecs in the study were sexually intact. The age of all living and deceased tenrecs in the study ranged in age from 0 days to 18 yr old. The mean age of the living tenrecs reported in this study was 4.4 yr old, and the median age was 2 yr old. Data about educational usage were specifically provided by survey respondents for 50 of the tenrecs, with only 42% being excluded from educational programming.

Husbandry

Husbandry was evaluated based on those sets of tenrecs for which specific conditions were reported. The most common substrate used in housing the tenrecs was newspaper (39%). The next two most common substrates were wood shavings (36%) and wood mulch (7.6% each). Other less commonly used substrates included cardboard, hay, sand, and bark.

All tenrecs were housed in indoor exhibits. The temperature range most commonly reported for housing tenrecs was between 21 and 26°C (71%). The temperature range of 27–32°C was reported at a frequency of 11%, and the combination of ranges, 21–26°C and 27–32°C, was reported at a frequency of 18%. The most common humidity level was 30–39% (50%), with the second most common being 60–69% (37.5%), followed by 70–79% humidity (12.5%). Most tenrecs were not provided supplemental lighting (61%). For living arrangements, tenrecs were reported as being housed singly (31%), housed together (38%), or in alternating conditions of housing both singly and together (31%).

Of the 71 animals with reports as to whether or not they went into torpor, 60 (85%) went into some form of torpor. The length of torpor most frequently reported was 2–4 mo (75%), with the next most common length of torpor being 1–2 mo (17%). Furthermore, 8% of tenrecs were in torpor for greater than 4 mo. In general, we did not identify from the surveys any changes in husbandry that would be known to induce torpor.

Tenrec diets were variable, both in the types of food and the variety of food fed to each tenrec. Of the 61 tenrecs for which data on diet

were reported, 13% were fed a single category of diet indicated, 28% were fed two different categories of diet, 44% were fed three different categories of diet, 3.3% were fed four different categories of diet, and 11% were fed five different categories of diet. The most common categories of diet were cat food (fed to 52% of tenrecs) and various worms or insects (fed to 52% of tenrecs). Other dietary sources of food were fruits and vegetables (fed to 36% of tenrecs) and dog food (fed to 31% of tenrecs). Other reported food items were baby food, milk nursed from the mother tenrec by newborn tenrecs, mice, hedgehog diet, and other (<9% each). Animals were predominantly fed once a day (90%). Animals generally consumed 75% of the daily ration (46%), although 29% of respondents reported that their tenrec typically ate only 25% of their daily ration.

Mortality

The mean age of death from all causes was 7.7 yr old, with a standard deviation of 5.3 yr and a median age of death of 8 yr old. The most common age of death was less than 24 hr (14%), such as at birth or shortly thereafter. The mean age of death of sexually mature animals (>6 mo of age) was 9.2 yr old, with a standard deviation of 4.5 yr and median age of 9 yr old. The mean age of death of animals with neoplasia was 11.8 yr old, with a standard deviation of 3.6 yr and median age of 12.5 yr old. The most commonly reported specific cause of death was neoplasia (11%). Other causes of death that were reported were hepatic lipidosis (9.7%), bacterial infection (8.6%), cardiomyopathy (7.5%), and renal disease (6.5%) (Table 1, Fig. 1). Overall, however, the most common cause of death was an unknown or an unlisted disease process or other condition (48.4%), and this was most common in animals that were 0 days old (neonates), although this occurred at all age groups. Non-neoplastic causes of death for sexually mature tenrecs (>6 mo of age) were hepatic lipidosis (14%), cardiomyopathy (11%), sepsis (11%), pneumonia (9.2%), renal disease (9.2%), osteomyelitis (4.6%), trauma (1.5%), and other or unknown causes of death (40%). In terms of ages, for those tenrecs reported as deceased with a nonneoplastic cause of death, 97.4% of tenrecs were less than 5 yr old, 68.2% of tenrecs were 5 yr old and less than 9 yr old, 68.2% of tenrecs were 10 yr old and less than 15 yr old, and 12.5% of tenrecs were 15 yr old or more.

Table 1. Captive lesser hedgehog tenrecs diagnosed with neoplasia compared with the age of the tenrec.

Age range (yr)	No. of animals with neoplasia	% animals with neoplasia	No. of animals treated for neoplasia	Mean time alive posttreatment (mo) ^a
0 to <5	1	0.820	0	N/A
5 to <10	9	27.3	4	3.8
10 to <15	9	25.7	3	8.8
≥15	7	53.8	2	6.9
Unknown	2	7.4	0	N/A

^a N/A indicates not applicable.

Neoplasia

For the 1% of living tenrecs with neoplasia in the surveyed population, none were male, one was female, and one was of unknown sex. This sample size is too small for evaluating statistical significance and survival. For the 26% of deceased tenrecs with neoplasia, 52% were male, 39% were female, and 8.7% were of unknown sex. For all of the animals included in this study that were reported to have a single type of neoplasia (1 living, 19 deceased, and 2 unknown), the most commonly reported type of neoplasia was carcinoma (five tenrecs); however, commonly the specific type of neoplasia was not determined (four tenrecs). Six tenrecs were reported to have multiple neoplasms. The next most commonly reported neoplasia (two tenrecs each) were lymphosarcoma and sarcoma. The following neoplasms were reported in one tenrec each: adenocarcinoma, adenoma, basal cell neoplasia, leiomyoma, leukemia, lipoma, melanoma, multifocal round cell neoplasia, and myeloproliferative neoplasm. Tumors were most commonly located in the liver (18%) and the thyroid (15%), with the next most common location being the abdominal cavity (10%). The shoulder, hind limb, and spleen were reported as the next most common locations (7.7% each). Other reported locations were the adrenal gland, bladder, ear, maxilla or mandible, lungs, tail, testes, thymus, and dermis. The onset of neoplasia was most commonly reported at ages of either 9 or 13 yr old (18% each), with the next most common ages being 8, 10, 12, and 15 yr old (12% each). The least common ages were 4, 6, and 17 yr old (6% each). The mean age of diagnosis of neoplasia was 10.8 yr with a standard deviation of 3.4 yr. Additionally, hematogenous and systemic evidence of metastasis was reported in 53% of neoplasia cases. The most common site of metastasis was the liver and lungs (29% each), followed by the adrenal gland and spleen (12% each). The abdominal body wall and lymph nodes were the least frequent sites of metastasis (5.8% each).

Surgical resection was the most frequent treatment for neoplasia (six tenrecs). The next most common treatment was reported as "other," which included various forms of steroids or nonsteroidal treatments (four tenrecs). Chemotherapy was performed on two tenrecs, and radiation therapy was performed on one tenrec. The survival time of animals after cancer diagnosis averaged 5.7 mo, with a median survival time of 5.8 mo and a range of 0–13 mo. The two animals treated with chemotherapy survived 6 and 12 mo. The one animal treated with radiation survived 9 mo. The six animals treated with surgical resection survived 1 mo (two animals), 2 mo (one), 5 mo (one), 7 mo (one), and 13 mo (one). Of the three animals treated with forms of treatment categorized as "other," one did not survive, one survived 4 mo, and one survived 10 mo.

DISCUSSION

The sex ratio was fairly even in this study with 68 known males versus 61 known females. Based on the reported sex determinations, a greater life expectancy was found for males. However, uncertainties of sex determination could affect the accuracy of sex-based findings, because many

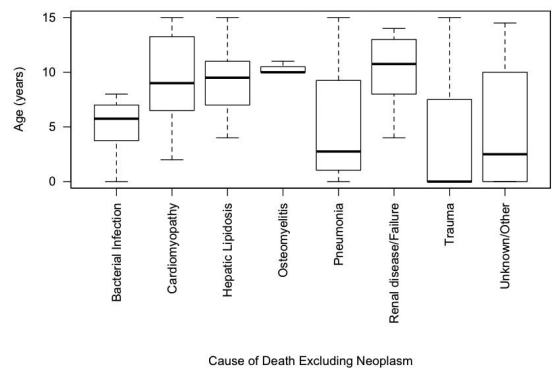


Figure 1. Causes of death in captive lesser hedgehog tenrecs, excluding neoplasia as a cause of death according to the age of the tenrec.

tenrecs in this study (43.9%) did not have a determined sex. The main challenge in determining sex of these animals is that there are no external genitalia present. There are some minor secondary sex characteristics such as periorbital swelling in the males, and in general, males tend to be smaller in size. Additionally, most institutions house tenrecs individually, thus eliminating behavioral clues. Given these factors, there has not been an overall need for surgical sterilization of these animals. Data were not collected on how the sex of these animals was determined (physical examination, postmortem examination, or histopathology) in this survey.

Zoological institutions tended to house tenrecs on a nonnatural substrate, most commonly newspaper. Although the factors behind the choice of substrate were not requested or reported, objectives for such substrates have typically included decreasing the chances of a parasite infection or of impacted material in the spines; both of which could lead to skin infection. All animals in the North American zoological institutions were housed indoors, likely for the purpose of conforming to the climate conditions of Madagascar. This choice may also relate to how tenrecs are commonly part of educational experiences. Temperature was typically held between 21 and 26°C. Madagascar's climate temperature is subtropical and ranges between 9 and 20°C in the winter and 16 and 27°C in the summer (World Weather and Climate Information, <https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine-in-Madagascar>).

The majority of tenrecs went into some form of torpor lasting 2–4 mo. In the wild, lesser hedgehog tenrecs have been found to go into torpor for 2 mo, May and June, and were in torpor for 12–18 hr each day.²¹ In captivity in North America, tenrecs tend to go into torpor in late fall and early winter.

Tenrecs in this study were often fed cat food, which contrasts with the Species Survival Plan recommendation for lesser hedgehog tenrecs to receive primarily an insectivore pelleted diet, as well as insects and produce. Since the time of the survey, however, the Tenrec SSP Advisory reports that there has been an increased use of commercial insectivore diet (e.g., Mazuri Insectivore Diet, Land O'Lakes Purina Feed LLC, Richmond, Indiana 47374, USA). Other options for additional protein sources would be hard-boiled eggs or a canned cat food. In the wild, tenrecs have been previously labeled as insectivores, although they may be more correctly labeled as faunivores,

where they eat a variety of animals other than insects, such as small vertebrates including reptiles, amphibians, birds, and other tenrecs.²⁵

Mortality

Overall, data from our survey indicate that the survival time of tenrecs is longer than that of African pygmy hedgehogs (*Atelerix albiventris*), at 7.7 and 4–6 yr, respectively.¹⁵ Tenrecs have similar causes of death as African pygmy hedgehogs, such as cardiomyopathy, hepatic lipidosis, and bacterial infection.²⁷ African pygmy hedgehogs are reported to have a high rate of cardiomyopathy, where one study reported 38% (16/42) of hedgehogs had cardiomyopathy.^{3,10,26} It was not specified in this survey as to how all causes of death were determined; therefore, some might have been diagnosed without histology, potentially making some of these diagnoses not as finalized. Common causes of neonatal death included trauma, infection, or maternal neglect. We did not have data on births of tenrecs against which the neonatal mortality rates could be compared.

Neoplasia

Our study has found that lesser hedgehog tenrecs develop neoplasia at an older age than African pygmy hedgehogs and greater hedgehog tenrecs.^{14,16} Our study found the earliest reported age for neoplasia in lesser hedgehog tenrecs was 4 yr old, and the most commonly reported ages were 9 and 13 yr old. The earliest reported age for neoplasia in greater tenrecs has been reported as 5.5–6.3 yr old.¹⁶ African pygmy hedgehogs have reports of neoplasia diagnoses ranging between 1 and 3 yr old and an average of 3.5 yr of age.¹⁴ In lesser hedgehog tenrecs, the most common type of neoplasms reported were undifferentiated carcinomas, with the most common site being in the liver or the thyroid gland. This differs from African pygmy hedgehogs, in that the most common types of neoplasia were epithelial in their location and were typically mammary adenocarcinoma, lymphoma, and oral squamous cell carcinoma.¹⁴ Similar to African pygmy hedgehogs, tenrec tumors tend to be malignant.¹⁴ For both species, it is common for metastatic tumors to occur in the liver or in the lungs.

Because of the small size of lesser hedgehog tenrecs, it can be challenging to perform standard medical tests, medical treatments, blood samples, and therapeutic monitoring. All of these challenges make it difficult to diagnose and treat numerous conditions, which may account for the lack of

certain test results and treatments in animals in this survey. Furthermore, tenrecs are not endangered, not typically seen as charismatic, and are not considered a high-profile animal, which may reduce investment in their medical treatments and research. However, necessary medication quantities would be small and, therefore, more affordable because of tenrecs' size. With diagnoses such as liver or thyroid carcinoma, therapies such as piroxicam (Greenstone LLC, Peapack, New Jersey 07977, USA) could be attempted. Piroxicam is readily compounded, which makes it a straightforward method of treatment for these animals.

Our systematic study helps to indicate the range of medical conditions likely needing treatment in lesser hedgehog tenrecs. Before this study, clinical literature on this species has been limited to a single report of treatment of melanoma, along with some reports on a related species, African pygmy hedgehog, being treated for various cancers.^{12,13,23} Similar to African pygmy hedgehogs, our study has found that the most common treatment for cancer in lesser hedgehog tenrecs is surgical resection or treatment with steroidal or nonsteroidal medications.¹⁴ Treatment of neoplasia in the tenrecs was found to be successful for an average of 5–6 mo, with a range of up to 13 mo. With improved diagnostics, increased availability of chemotherapeutics, and increased access to oncologists, it appears likely that future efforts at treatment will lead to an increased length of time for survival.

CONCLUSIONS

This is the first overall review of husbandry, morbidity, and mortality in captive lesser hedgehog tenrecs. Although specific conclusions were not arrived at on husbandry, our review will be a helpful step leading to active discussion and future analysis about differing approaches in the caretaking of tenrecs. Neoplasia was found as a common cause of death in lesser hedgehog tenrecs, but the age and site for which neoplasia develops in lesser hedgehog tenrecs is typically different from African pygmy hedgehogs. The lack of additional diagnostics and histology for some deceased specimens limited our determination of an exact cause of death. In general, increased efforts at data collection and additional research into causes of morbidity, mortality, and neoplasia in lesser hedgehog tenrecs need to be specifically conducted.

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