Clinical features, treatment, and outcomes of cutaneous and oral squamous cell carcinoma in avian species

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OBJECTIVE
To determine the clinical features, treatment, and outcomes of treatment for oral and cutaneous squamous cell carcinoma (SCC) in avian species.

DESIGN
Retrospective case series with nested cohort study.

ANIMALS
87 client-owned birds of various species with histologically confirmed SCC of the skin or oral cavity.

PROCEDURES
Clinicians entered case information through an online survey tool. Data were collected regarding patient signalment, concurrent conditions, treatments, adverse effects, and clinical outcomes. Relationships were examined between complete excision and partial or complete response. Survival analysis was performed to compare outcomes among groupings of therapeutic approaches.

RESULTS
Only 7 of 64 (11%) birds for which full outcome data were available had complete remission of SCC; 53 (83%) had progressive disease, were euthanized, or died of the disease. The unadjusted OR for partial or complete response following complete tumor excision (vs other treatment approaches) was 6.9 (95% confidence interval [CI], 1.8 to 25.8). Risk of death was 62% lower (hazard ratio, 0.38; 95% CI, 0.19 to 0.77) for birds that underwent complete excision versus conservative treatment. Median survival time from initial evaluation for birds receiving complete excision was 628 days (95% CI, 210 to 1,008 days), compared with 171 days (95% CI, 89 to 286 days) for birds receiving monitoring with or without conservative treatment. Birds receiving any other additional treatment had a median survival time of 357 days (95% CI, 143 to 562 days).

CONCLUSIONS AND CLINICAL RELEVANCE
For birds with SCC, complete excision was the only treatment approach significantly associated with complete or partial response and increased survival time. (*J Am Vet Med Assoc* 2018;252:309–315)

Oral and cutaneous SCCs are common in avian species[1] but are poorly studied in terms of treatment outcomes and survival expectancy. As in other species, these tumors are composed of moderately to poorly differentiated keratinocytes, which may contain cores of compressed keratin. Squamous cell carcinoma is locally invasive and rarely metastasizes. Common sites of tumor development include the skin, uropygial gland, and upper gastrointestinal tract, including the oral cavity. The disease is commonly observed in cockatiels (*Nymphicus hollandicus*), Amazon parrots (*Amazona* spp), and budgerigars (*Melopsittacus undulatus*)[1,2] but has been reported for several avian species.[3–23] Poor outcomes have been reported for birds with tumors unamenable to excision, suggesting that these tumors may be relatively resistant to nonsurgical treatments such as external beam radiation, strontium radiation, and systemic or local chemotherapy.[2,23]

A connection between certain risk factors (hypovitaminosis A, chronic wounds, or infections) and the development of SCCs in birds has been hypothesized but has not been investigated in a large number of patients.[24] However, since the mid 1980s, researchers have explored the link between vitamin A deficiency and epithelial disorders, including SCC, in humans.[25–29] Additionally, the link between chronic inflammation and cancer development is well described in the human and veterinary medical literature.[30–33] Given that the suspected causes of and risk factors for SCC appear to be similar in human and avian patients, understanding more about the causes and responses to treatment in avian species may guide treatment for birds as well as research for treatment of SCC in humans.

Large-scale case series are rarely reported in avian medicine because of the difficulty accumulating

ABBREVIATIONS

CI	Confidence interval
SCC	Squamous cell carcinoma

sufficient numbers of cases. The purpose of the study reported here was to assess concurrent conditions, therapeutic responses, and outcomes in a cohort of avian species treated for SCC at multiple institutions as well as to provide information on species predilections and concurrent diseases.

Materials and Methods

Case selection

Case information on birds with SCC was provided from the University of California-Davis School of Veterinary Medicine, Cornell University College of Veterinary Medicine, and Colorado State University College of Veterinary Medicine as well as from self-defined primary care private veterinary hospitals and private specialty practices in 11 states (New York, South Carolina, North Carolina, Florida, Illinois, Missouri, Texas, New Mexico, California, Washington, and Utah) by means of an online survey created with a clinical informatics tool.[34,a] Birds of any avian species were included in the study if they had histologically confirmed SCC anywhere on the skin (including the beak) or within the oral cavity, regardless of treatment received or lack thereof. The survey was promoted at the Association of Avian Veterinarians conference in 2012 and 2013, through the Association's website, through the online Veterinary Information Network, directly to avian specialists, and through local veterinary medical associations.

Data collection

The online survey allowed clinicians to enter data on patient signalment, concurrent illnesses, diagnostic tests, treatments, and adverse effects. Specifically, clinicians were asked to include information on the species, age, and sex of birds as well as on concurrent infections (bacterial, viral, mycotic, or parasitic) and noninfectious diseases (renal disease, hepatic disease, or feather-damaging behavior) as well as types of diagnostic techniques used to stage disease (eg, diagnostic imaging, CBC, serum biochemical analysis, fine needle aspiration, and biopsy).

Detailed clinical information was requested regarding the different types of approaches to SCC treatment. Veterinary providers could select from the following categories: conservative treatment, NSAIDs, complete excision, debulking excision, radiation therapy (strontium), radiation therapy (external beam), chemotherapy (systemic), chemotherapy (intralesional), cryotherapy, photodynamic therapy, topical treatment, nutraceuticals, alternative, euthanasia (at diagnosis), no treatment, and other. For complete excision, information was obtained on whether margins were examined and identified as clean. For intralesional and systemic chemotherapy, information was obtained regarding the type of agent or agents used, dose and number of doses given, administration interval, and whether body surface area or body weight was used in dose calculations. For radiation therapy, information was obtained regarding the type of radiation used, dose (Gy) delivered, treatment interval, and number of treatments provided. For cryotherapy and photodynamic therapy, information was obtained regarding the treatment interval and number of treatments provided. For NSAIDs, the type of agent used as well as information on the dose and administration interval were obtained. Information was also obtained on whether (yes or no) acupuncture was provided and the nature of any herbal treatments used.

Information was obtained on patient outcomes (complete response, partial response, stable disease, progressive disease, euthanasia without treatment, euthanasia due to disease progression, and death due to disease progression) as well as the development of metastases. Survival times from initial evaluation were calculated by use of reported death or last follow-up dates. Outcomes were defined for survey participants on the basis of the human Response Evaluation Criteria in Solid Tumors criteria for tumor response.[35] Complete response was defined as no evidence of clinical disease, partial response was defined as at least a 30% decrease in the sum of neoplastic lesions, stable disease was defined as neither sufficient shrinkage to qualify for partial response nor sufficient increase to qualify for progressive disease, and progressive disease was defined as at least a 20% increase in the sum of neoplastic lesions or the appearance of new lesions.

An adverse effects monitoring consensus document[36] from the Veterinary Cooperative Oncology Group was modified for use in avian species and incorporated into the survey instrument to allow quantification of adverse effects.[37] Adverse effects were assessed for each of the listed treatments and were graded on a scale from 1 to 5, with 1 representing subclinical disease and 5 representing death resulting from treatment.

Statistical analysis

Statistical[b] and graphic[c] software were used for all analyses. Values of $P < 0.05$ were used to identify significant interactions in all models. Putative protective and risk factors were investigated for associations with survival time from initial evaluation. These variables included treatment approach, lesion location, concurrent diseases, and signalment. Distributions of the outcome variable partial or complete response within each of these variables was examined, and a χ^2 test was used to test for associations with outcome. The Fisher exact test was used to determine whether the most prevalent lesion location in each of the 3 most common species or species groups differed significantly from the prevalences of the other lesion locations in that particular species or species groups.

Logistic regression was used to perform a bivariate analysis of the relationship between complete excision (vs any of the other possible treatment choices from which respondents could select) and partial or complete response (vs any of the other 5 possible

outcome choices). This dichotomization of primary exposure and outcome variables was performed to allow for larger sample sizes and increased power to detect significant differences.

For survival analysis, birds were categorized into 3 groups on the basis of treatment approach used: complete excision, other treatment (excluding complete excision and including any other treatment approach used except NSAIDs alone), or conservative treatment (no treatment other than surgical debulking [ie, partial excision] of the tumor, NSAIDs, supportive care [including nutritional support, antimicrobial or antifungal treatments for concurrent disease, or other medical treatments not related to cancer treatments], or euthanasia). Birds with < 6 months of documented follow-up information available or with unknown survival status were excluded from this analysis, as were birds that received a diagnosis after death or that died or were euthanized within 5 days after initial evaluation. The Kaplan-Meier product-limit method of survival function estimation was used to evaluate associations of treatment categories with survival time. The Mantel-Cox log rank test was used for 2-way comparisons of survival time between treatment categories. Log rank hazard ratios were calculated for birds that received complete excision versus conservative treatment and other treatment. The survival time for each bird was calculated as the number of days from initial evaluation to death.

Results

Animals

Survey responses were received from across the United States and Australia, representing avian patients treated for SCC between July 1998 and July 2014. Of the 153 surveys that were submitted or initialized through the online platform, 63 (41%) lacked full completion or key case information. Two additional cases involved SCC in anatomic locations not considered for inclusion in this study, and 1 case was not SCC or squamous adenocarcinoma. Overall, 87 birds fulfilled the criteria for inclusion in the study.

Of included birds, 9 (10%) had been examined and treated by veterinarians from general private practice, 63 (72%) by veterinarians from specialty or referral practice, and 15 (17%) by veterinarians from academic practice. Mean age at the time of initial evaluation was 20.1 years (range, 4 to 45 years). Twelve (15%) birds were < 10 years of age, 45 (58%) were between 10 and 25 years of age, and 21 (27%) were > 25 years of age. Of birds for which sex was known (n = 62 [71%]), 35 (56%) were female, and 27 (44%) were male.

The 3 most common species or species groups represented were cockatiel (n = 31 [36%]; age range, 9 to 31 years), Amazon parrot (17 [20%]; age range, 13 to 45 years), and conure (*Pyrrhura* spp or *Aratinga* spp; 10 [11%]; age range, 7 to 26 years). Other represented groups included budgerigar (6 [7%]; age range, 4 to 8 years), cockatoo (5 [6%]; age range, 17 to 45 years), African gray parrot (*Psittacus erithacus* or *Psittacus timneh*; 4 [5%]; age range, 7 to 26 years), macaw (4 [5%]; age range, 11 to 39 years), lovebird (4 [5%]; age range, 9 to 15 years), *Brotogeris* spp (1 [1%]; no age provided), Indian ringneck parakeet (*Psittacula krameri*; 1 [1%]; 14 years), Quaker parrot (*Myiopsitta monachus*; 1 [1%]; 17 years), unspecified Psittaciforme (1 [1%]; 13 years), domestic chicken (1 [1%]; no age provided), and Muscovy duck (*Cairina moschata*; 1 [1%]; 11 years).

Disease

The mean interval between initial evaluation and diagnosis of SCC was 53 days. Signs at initial evaluation included a mass or skin lesion (n = 50 [57%]), respiratory distress (11 [13%]), feather-picking or self-damaging behavior (9 [10%]), oral lesion (6 [7%]), general signs of weakness or lethargy (5 [6%]), regurgitation or dysphagia (3 [3%]), chronic or nonhealing infection (3 [3%]), beak abnormality (2 [2%]), or other signs (1 [1%]), with several birds having multiple signs. Reported concurrent diseases and conditions for all 87 birds included hypovitaminosis A (24 [28%]), bacterial infection (19 [22%]), and feather-damaging behavior (19 [22%]). Locations of SCC varied and included single dermal sites (27 [31%]), oral cavity excluding the choana (22 [25%]), uropygial gland (17 [20%]), multiple dermal sites (5 [6%]), choana (5 [6%]), beak (3 [3%]), digit (1 [1%]), and other sites (6 [7%]). For 1 bird, no primary location was specified.

For the 3 most common avian species or species groups, sufficient numbers of birds were represented to determine whether the prevalence of the most common lesion location for each of these differed significantly from the prevalences of the other lesion locations for that particular species or species group. For cockatiels, the skin was the most common location ($P = 0.04$). For Amazon parrots, lesions within the oral cavity were strikingly more common than in other locations ($P < 0.001$). For conures, lesions in the oral cavity or on the beak were more common than in other locations ($P = 0.006$).

Treatment

Various types of treatments were provided, often in combination, including surgical debulking (29/87 [33%]), NSAIDs (22 [25%]), complete excision with clean margins (20 [23%]), conservative treatment or monitoring (16 [18%]), cryotherapy (9 [10%]), systemic chemotherapy (8 [9%]), strontium radiation (7 [8%]), no treatment (6 [7%]), external beam radiation therapy (5 [6%]), topical treatment (4 [5%]), euthanasia (4 [5%]), nutraceuticals (4 [5%]), intralesional chemotherapy (2 [2%]), alternative therapy (2 [2%]), and other treatments (15 [17%]). Other treatments consisted primarily of concurrent antimicrobial administration. No birds received phototherapy.

The most common NSAID provided was meloxicam (n = 18; mean dose, 0.45 mg/kg [0.20 mg/lb];

dose range, 0.1 to 1.0 mg/kg [0.05 to 0.45 mg/lb]). Other NSAIDs included piroxicam (1; 0.45 mg/kg) and ibuprofen (3; dose in 1 patient, 6 mg/kg [2.7 mg/lb]). Carboplatin was the only systemic chemotherapeutic agent used, administered to 8 birds at a mean dose of 13.0 mg/kg (5.9 mg/lb; range, 5 to 28 mg/kg [2.3 to 12.7 mg/lb]). Three of these birds received doses calculated on the basis of body surface area ([K × body weight$^{2/3}$]/10^4), where K, the shape constant for a given species, was defined as 10.1. Intralesional chemotherapy involved carboplatin (3 mg/kg [1.4 mg/lb]) in one bird and cisplatin (50 mg/kg [22.7 mg/lb]) in another. Nutraceuticals were used for 4 birds, including a product containing minerals, vitamins, and proteins in a blend of live *Saccharomyces cerevisiae*[d] (n = 3); an herbal supplement containing pau d'arco, red clover, golden seal, comfy root, nettles, and aloe vera (1); and omega-3 fatty acids (1).

Adverse effects of all treatments examined were reported for only 8 of 87 (9%) birds. These included musculoskeletal effects (n = 3), lethargy (2), heteropenia (2), dermatologic lesions (2), metabolic or laboratory value changes (2), anorexia (1), skin ulceration (1), and bradyarrhythmia (1), for a total of 14 events. Reported musculoskeletal effects included wound dehiscence and subcutaneous emphysema due to debulking and glottal swelling due to cryotherapy. Lethargy was attributed to carboplatin and imiquimod administration. The heteropenia was attributed to carboplatin administration in both affected birds, and the severity was grade 2 or 3. Metabolic or laboratory value changes included high serum aspartate aminotransferase activity and bile acids concentration associated with strontium administration in 1 bird. Skin ulceration was noted secondary to cryotherapy. The bradyarrhythmia (grade 5) occurred in another bird during carboplatin administration. Grade 2 anorexia was attributed to carboplatin administration. One bird had a grade 3 skin ulceration at the excision site that was treated with silver sulfadiazine application.

Outcome

The follow-up period for study birds ranged from 8 to 1,780 days after initial evaluation. For outcome analysis, only birds with at least 180 days of follow-up data were considered. Ten (11%) birds had no date recorded for the initial evaluation, last follow-up examination, or survival time. Thirteen (15%) birds had < 180 days of follow-up data and were excluded from outcome analysis, leaving 64 (74%) birds for outcome evaluation. Only 7 of 64 (11%) birds for which full outcome data were available had complete remission of SCC; 53 (83%) had progressive disease, were euthanized, or died of the disease.

Four of 8 birds that underwent complete excision alone had complete remission, 2 had stable disease, and 2 had progressive disease. Four birds underwent complete excision with some other combination of treatments. Two of these 4 birds also received topical or nutraceutical treatment, and one had progressive disease and the other a complete response. One of the 4 birds underwent complete excision and external beam radiation, and it had progressive disease. The final bird underwent complete excision and systemic chemotherapy, and it had a complete response.

Overall, 1 of the 19 (5%) birds that received treatment (other than complete excision) had complete remission of SCC, 5 (26%) had partial remission, 1 (5%) had stable disease, 6 (32%) had progressive disease, and 6 (32%) were euthanized or died owing to disease progression **(Table 1)**. Insufficient numbers of birds with any particular adjunctive treatment or treatment combination were available to be able to determine whether any treatment was associated with greater odds of a complete or partial response relative to other treatments.

Seven (11%) birds received only debulking surgery and no adjunctive treatment. Five of these birds had progressive disease, 1 had a partial response, and 1 was euthanized. Twenty-two (34%) birds received no treatment, conservative treatment, NSAIDs only, or other treatment, which primarily consisted of

Table 1—Number of birds with histologically confirmed SCC that had various clinical outcomes following treatment other than complete surgical excision or conservative treatment. (n = 19).

			Outcomes				
Treatment 1	**Treatment 2**	**Total No. of birds**	**Complete remission**	**Partial remission**	**Stable**	**Progressive disease**	**Euthanized or died**
Systemic chemotherapy	—	2	0	0	0	1	1
Systemic chemotherapy	Cryotherapy	3	0	1	0	2	0
Systemic chemotherapy	Strontium radiation	1	0	0	0	0	1
Intralesional chemotherapy	—	1	0	1	0	0	0
Intralesional chemotherapy	Cryotherapy	1	0	1	0	0	0
External beam radiation	Cryotherapy	1	0	1	0	0	0
Cryotherapy	—	3	0	0	1	2	0
Strontium radiation	—	5	1	1	0	0	3
Topical medication or nutraceutical	—	2	0	0	0	1	1
Total		**19**	**1**	**5**	**1**	**6**	**6**

— = Not done.

antimicrobial or antifungal treatment for concurrent infections (n = 12 [55%]) or wound care (4 [18%]). Two of these 22 (9%) birds were reported as having stable disease, whereas the remaining birds either had progressive disease or were euthanized or died owing to disease progression. Four (6%) birds had euthanasia listed as a treatment.

Table 2—Unadjusted ORs and 95% CIs for associations between various factors and partial or complete response to complete or partial excision in birds with histologically confirmed SCC and available outcome data (n = 64).

Characteristic	OR	95% CI
Concurrent disease*		
Feather-damaging behavior (n = 22)	2.6	0.9–7.4
Hypovitaminosis A (n = 19)	1.2	0.4–3.5
Chronic skin or bacterial infection (n = 16)	0.6	0.2–2.2
None (n = 21)	1.0	Referent
Treatment†		
Complete excision (n = 12)	6.9	1.8–25.8
Other (n = 18)	1.0	Referent
Lesion location†		
Skin (n = 24)	1.0	Referent
Uropygial gland (n = 6)	1.2	0.35–4.16

*Many birds had multiple concurrent diseases, so numbers total > 64. †Reported for patients with dermal and uropygial gland lesions only

Odds ratios can be interpreted as the odds of an outcome in one group relative to the odds in another (referent) group and are considered significant when the respective 95% CI excludes 1.

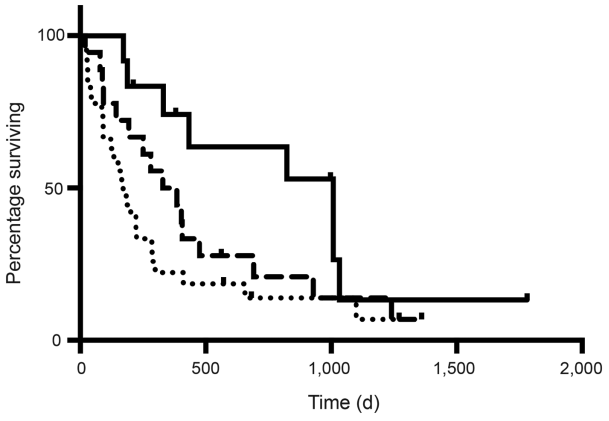

Figure 1—Kaplan-Meier curves of survival time from initial evaluation for birds with SCC treated by complete excision (solid line; n = 12), conservative treatment (dotted line; 27; no treatment other than surgical debulking [ie, partial excision] of the tumor; NSAIDs; supportive care including nutritional support, antimicrobials, antifungals, or other medical treatments not related to cancer treatments; or euthanasia), or any other treatment approach (dashed line; 18; excluding complete excision and including any other treatment approach used except NSAIDs alone). Birds with < 6 months of documented follow-up information available or with unknown survival status were excluded from this analysis, as were birds that received a diagnosis after death or that died or were euthanized within 5 days after initial evaluation. Compared with birds with SCC that received conservative treatment, birds that underwent complete excision of the tumor had a 62% lower risk of death (hazard ratio, 0.38; 95% CI, 0.19 to 0.77; $P = 0.01$).

Unadjusted ORs for associations between putative protective or risk factors and partial or complete response to SCC treatment were summarized **(Table 2)**. No significant association with outcome was identified for various types of concurrent (vs no concurrent) disease. The odds of complete or partial remission was almost 7 times as great for birds undergoing complete excision as for birds treated with other approaches. No association was identified between lesion location (uropygial gland vs skin) and outcome.

For survival analysis, birds that were either euthanized or died within 5 days after initial evaluation were excluded, as were those that received a diagnosis after death (n = 7), leaving a total of 57 birds. At the conclusion of the study, 9 of these 57 (16%) birds remained alive. Compared with birds that received conservative treatment, birds that underwent complete tumor excision had a 62% lower risk of death (hazard ratio, 0.38; 95% CI, 0.19 to 0.77; $P = 0.01$; **Figure 1**). Median (95% CI) survival time from initial evaluation for birds with > 6 months of documented follow-up information available and known survival status (excluding birds that received a diagnosis after death or that died or were euthanized within 5 days after initial evaluation) was 628 days (210 to 1,008 days) for birds undergoing complete excision, 357 days (143 to 562 days) for birds receiving any other additional treatment, and 171 days (89 to 286 days) for birds receiving monitoring with or without conservative treatment. The overall median survival time for all 3 treatment categories combined was 280 days (95% CI, 183 to 403 days; mean, 418 days).

Discussion

The present study provided estimates of the survival expectancy of avian species with histologically confirmed SCC. A literature review performed by the authors revealed 17 birds with SCC in 12 primary reports.[3–10,13,14,17–22] Of these 17 birds, 4 had a complete response to treatment (although 1 bird had only a 93-day follow-up period) and 6 were euthanized at diagnosis. The median survival time for the remaining 7 birds was 70 days (mean, 122.7 days). This is lower than the overall median survival time for all 3 treatment categories combined in the present study. Treatment approaches reported in the cited literature include excision (complete and debulking; n = 7), radiation therapy (3), chemotherapy (3), and photodynamic therapy (2). The present study captured all of these treatment approaches except photodynamic therapy.

Statistical evaluation of associations of various treatment combinations with outcome could not be performed in the present study because of the low number of birds represented by each. The relevant data were therefore reported descriptively here to add to the literature on SCC in birds. Because the study relied on clinician assessment of outcomes, it is unclear whether these outcomes had been appropriately selected on the basis of the Response Evaluation Criteria in Solid Tumors criteria provided.

In the present study, bacterial infections, feather-damaging behavior, and hypovitaminosis A were observed in 22% to 28% of included birds. It was not possible to determine whether the prevalence of these conditions was higher in birds with SCC than in other birds because no control group was included, but this information should provide a benchmark for future studies in which the co-occurrence of these conditions with SCC is investigated.

Whether chronic bacterial infections predispose birds to SCC or the SCC predisposes some birds to infection remains unclear. Hypovitaminosis A causes squamous metaplasia in multiple animal species, including humans.[26,29] Squamous metaplasia, which has various etiologies, can progress to SCC if the underlying cause for the metaplastic change is not addressed.[38] Psittacines are commonly fed seed-based diets that are known to be deficient in vitamin A.[2] Avian practitioners should therefore obtain a full diet history and make appropriate recommendations to owners for improving the vitamin A content of the diet.

Practitioners should also be aware of the appearance of early metaplastic lesions (ie, blunting of the choanal papillae) and the increased likelihood that these lesions may become infected. Secondary infections can mask an underlying metaplastic or neoplastic lesion, and repeated biopsies may be necessary for a diagnosis. In the present study, the mean interval from initial evaluation to diagnosis was 53 days, highlighting the need for practitioners to perform biopsy early in the course of disease and repeat biopsies if results of histologic specimen examination are inconclusive or inconsistent with the clinical signs. Because of difficulties obtaining a definitive diagnosis with this neoplasia, we report survival time here from the date of initial evaluation and acknowledge that this may have biased the findings toward longer survival times than if calculated from the date of diagnosis instead.

An original intention of the study reported here was to report types of adverse effects of treatment and proportions of birds affected to allow an examination of the association of adverse effects with particular treatments. An extensive list of possible adverse effects was included in the survey for treating practitioners to complete. However, very few adverse effects were reported, either owing to an actual low number of adverse effects or to underreporting. Given the extent of reported adverse effects of radiation therapy and chemotherapy in other species,[36] we suspect that underreporting may have occurred. To understand this critical aspect of patient care, improved monitoring and quantification of adverse effects are important for the advancement of avian oncology practice. The adverse effects document used for our study has been published[37] to help avian practitioners monitor their patients' treatment-related adverse effects.

The limitations of the present study include those inherent to any retrospective study with a small sample size. Treatments and outcomes needed to be grouped to achieve sufficient sample sizes and distributions for analysis. Birds with complete and partial responses were combined into 1 group, and treatment approaches were collapsed from 17 to 3 categories. As a result, there was a mixing of effects among these groups and an understanding of distinct outcomes and their associations with distinct treatment approaches was lost. An additional limitation was the possible bias introduced by differences in durations of patient follow-up. Not all birds were followed until the time of death. The follow-up period for those still alive at the time of analysis varied between 2 and 59 months. Short follow-up periods may have led to the exclusion of adverse outcome reporting in some circumstances, thereby resulting in biased estimates of treatment response and survival time.

The data provided by the present study regarding concurrent diseases, treatment approaches, adverse effects, and outcomes in birds with SCC can be useful in conversations with owners of affected birds, particularly given that it has been difficult to define the natural course of disease for birds with owners who decline treatment. The findings could help practitioners counsel owners on the best course of action for their birds. The study methods involving use of the clinical informatics tool for data collection also provided a proof of concept for how adverse event and outcome monitoring might be incorporated into similar studies for other cancers in other exotic or nondomestic species.

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Footnotes

a. REDCap, Vanderbilt University, Nashville, Tenn.
b. STATA, version 10 for Windows, StataCorp LP, College Station, Tex.
c. Prism7 for Mac OS X, version 7.0a, GraphPad Software Inc, La Jolla, Calif.
d. Healthzyme, Harrisons' Pet Products, West South Beach, Fla.

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