A Model for Teaching Raptor Medicine in the Veterinary Curriculum

Laurel A. Degernes ■ Julie A. Nettifee Osborne

ABSTRACT

Injured or sick wild avian species, especially raptors (birds of prey, including hawks, owls, falcons, and eagles), can present different challenges to veterinary students and veterinarians who are trained in companion avian medicine (e.g., parrot medicine). Proper capture and restraint, feeding, housing, and certain diagnostic and treatment techniques involving raptors require different skills, knowledge, and resources than working with parrots. We developed an innovative raptor medicine program that enables students to acquire proficiency in safe capture, restraint, and examination techniques and in common diagnostic and treatment procedures. A self-assessment survey was developed to determine students' confidence and proficiency in 10 procedures taught in the lab. Groups were compared by class status (Year 1 vs. Year 2 and 3) and level of prior raptor experience (non-experienced or experienced). In surveys conducted before and after teaching two sets of raptor training labs, students rated themselves significantly more proficient in all 10 diagnostic and treatment procedures after completing the two raptor laboratories. The greatest improvements were observed in technical skill procedures such as fluid administration, intramuscular injections, cloacal swabs, venipuncture, and bandaging. Our approach to incorporating elective wildlife learning experiences into the veterinary curriculum may be replicable in other veterinary schools, with or without a wildlife rehabilitation program.

INTRODUCTION

Common approaches to teaching critical diagnostic and treatment skills in the management of injured or sick wild avian species, particularly raptors, have limitations. Lectures, textbooks, and videotapes do not provide hands-on, practical experience.[1–4] In a typical laboratory situation, a single demonstration of a technique is given and then students practice on raptors (e.g., wild raptors undergoing rehabilitation before release or non-releasable raptors). This approach can potentially lead to injury of the patient and/or the veterinary student. To address these limitations, we developed two elective raptor medicine courses at North Carolina State University College of Veterinary Medicine (NCSU-CVM), in collaboration with a raptor rehabilitation center. The elective raptor medicine courses are aimed at students in years 1 through 3 who are interested in learning more about wild bird medicine. One of the courses (Raptor Medicine and Rehabilitation) is taught during a one-week elective period. The other course (Topics in Wild Bird Medicine) is taught during fall and spring semesters and includes one Saturday laboratory each semester. Many of the technical skills acquired in these courses are applicable to other wild and companion avian patients.

RAPTOR MEDICINE AND REHABILITATION ELECTIVE COURSE

Raptor Medicine and Rehabilitation is a one-week elective course that has been taught since 2000 at the end of fall semester. Between 2000 and 2003, 24 students have enrolled in the course (maximum six per class). All students participating in this elective had participated in at least one of the raptor laboratories described in the next section. On the first day of the course, students use raptor cadavers to learn the fundamentals of handling, physical examination, bandaging, fluid therapy, anatomy, and necropsy. During the afternoon of day 1, the students observe hunting by trained falconry birds owned by members of the North Carolina Falconers Guild. For days 2 through 5, the students put what they have learned into practice at the Carolina Raptor Center (CRC), a non-profit raptor rehabilitation facility located three hours from Raleigh in Charlotte, North Carolina. Students and two faculty instructors are housed locally. December is an ideal time for this course because of the large influx of newly admitted injured raptors during fall migration. The students are divided into groups of two to three and participate in all daily activities in the rehabilitation center, including capture and handling, new patient admissions, physical examination, physical therapy, treatments, bandaging, venipuncture, radiographs, ophthalmic examinations, anesthesia and surgeries, beak and talon trimming, feeding, necropsies, pre-release assessments, and evaluation of the education raptors. The students admit up to 15 new patients during the week, in addition to working with another 40 to 50 birds undergoing rehabilitation. The staff and volunteers at CRC also assist NCSU faculty with student training.

TOPICS IN WILD AVIAN MEDICINE ELECTIVE COURSE

In the Topics in Wild Avian Medicine course, students participate in two raptor teaching laboratories (''raptor labs''); attend five avian seminars offered at NCSU-CVM or at local, state, or national conferences; and individually complete three Web-based learning modules developed by the course coordinator (LAD). The three Web-based learning

modules are included in the course Web site and covered captive management issues in raptors and other wild birds, raptor handling, physical examination and anatomy, and lead poisoning in waterfowl. Many students attend avian seminars that are part of an NCSU-CVM seminar course, Advanced Topics in Avian and Reptile Medicine. Students document their participation in the live and Web-based seminars by submitting a summary of key points from each seminar.

Organization of Laboratories

Raptor labs are taught each semester to groups of 16–24 students (morning and afternoon sessions), using approximately 10–15 live, non-releasable raptors in each lab. Although this course has been offered as a credit course since 2003, raptor labs were taught as an extracurricular weekend activity beginning in 1990. The raptor labs are conducted in a large teaching laboratory facility with ample space, lighting, and tables. Students work in groups of two or three to promote cooperative learning and to allow for a rotational setting to practice both handling skills and diagnostic and therapeutic techniques, thereby maximizing their learning opportunities. Students are encouraged to rotate and practice techniques using a variety of raptor species. The Institutional Animal Care and Use Committee approves all laboratory procedures and birds used in these labs.

Fall Semester Lab

This lab introduces students to common native raptor species (identification, natural history, etc.), safe capture and handling techniques with a variety of raptor species (hawks, owls, and vultures, as available), external anatomy and terminology, and physical examination techniques. Safety is emphasized, for students as well as patients. The students learn to minimize patient stress as much as possible (keeping the handling time short, covering the head except during head exams, minimizing extraneous noise and commotion, etc.). All students are required to wear safety glasses and protective leather gloves (welders' gloves) during capture and handling.

Spring Semester Lab

This lab introduces students to diagnostic and therapeutic techniques commonly used in raptor rehabilitation. Raptor capture and handling and physical examination are included in this lab to reinforce and provide additional experience with these techniques. Once the birds are restrained, they are anesthetized with a combination of intramuscular ketamine and xylazine and redosed as needed to keep them under a medium plane of anesthesia for the duration of the lab.[1] We use this combination of injectable drugs because of their relatively wide margin of safety for most species of birds used in the labs and to allow more birds to be used in the lab simultaneously than would be otherwise possible with limited access to anesthesia machines in the teaching laboratory. Anesthetizing the birds during this lab minimizes the level of stress for both patients and students and allows the students to learn new techniques without the extra challenge of struggling patients and concern for serious injury by talons and beaks. Techniques taught in this lab include venipuncture; cloacal swab; ophthalmic examination; administration of subcutaneous fluids and intramuscular injections; passage of a crop feeding tube; and application of a figure-of-eight wing bandage, wing-body wrap, and ball bandage. The students are encouraged to practice each of the procedures until they have successfully accomplished each task. Two faculty instructors rotate through the groups to assist and critique the students as they perform the lab procedures.

Types and Sources of Birds

Native North Carolina raptors commonly represented in the labs include red-tailed hawks (*Buteo jamaicensis*), red-shouldered hawks (*Buteo lineatus*), broad-winged hawks (*Buteo platypterus*), Cooper's hawks (*Accipiter cooperii*), barred owls (*Strix varia*), great-horned owls (*Bubo virginianus*), eastern screech owls (*Otus asio*), barn owls (*Tyto alba*), turkey vultures (*Cathartes aura*), and black vultures (*Coragyps atratus*). All raptors are supplied by the Carolina Raptor Center and have permanent injuries that make them unsuitable for release to the wild or for transfer to another facility for educational purposes. Typical injuries include ophthalmic injuries; mal-union or non-union fractures of the wings or legs; joint luxations; neurological trauma; loss of function of the wing, leg, or foot; and any other problem that prevents the birds from full return to function in the wild.[1–3] The advantage of using non-releasable wild raptors for the teaching labs is that we avoid the liability of damaging feathers or causing physical harm to client-owned (e.g., falconer's) or potentially releasable wild birds. It is important to prevent bending or breaking feathers when handling falconry or rehabilitation birds because of the potential for flight impairment.[1]

The raptors are housed in a small facility with flight cages at NCSU for several days to two weeks prior to the labs. A group of four to six student volunteers who have participated in one or more previous raptor labs and have received extra training from faculty instructors assist with initial physical examinations and daily monitoring, feeding, watering, and flight-cage cleaning. During the labs, the volunteers help set up the labs and assist two faculty instructors with teaching.

The birds supplied by CRC would have been euthanized previously had they not been saved for our teaching labs. At the completion of each set of raptor labs, the birds are euthanized and frozen for later teaching opportunities. These cadavers are used for many different teaching purposes, including avian anatomy labs, second-year elective surgery projects, the Raptor Medicine and Rehabilitation elective course, and senior clinical rotations (critical care procedures, including placement of intraosseous catheters and air sac breathing tubes, and surgeries, such as liver biopsies, ingluviotomies, and orthopedic surgeries).

Assessment of Spring Raptor Lab

Assessment of experiential learning is challenging, particularly when students have varied backgrounds and experience in the subject matter. To give us some measure of the effectiveness of our laboratory training, we conducted an outcome assessment survey before and after the spring-semester raptor labs in 2003 and 2004. If students in 2004 had participated in the 2003 spring raptor lab, they were asked not to complete a second survey. Included in the pre-lab survey was a set of six background questions related to

Table 1: Spring raptor laboratory background questions

1. What DVM class are you in? Freshman, Sophomore, Junior
2. Have you participated in the Raptor Medicine & Rehabilitation elective course? Yes No
3. Have you participated in previous Raptor Labs?

   Yes No

   If yes, what semester/year (s)? _____
4. Do you have other raptor experiences (e.g., from working with a rehabilitation program or other facility with raptors)? Yes No (If Yes, briefly list your experiences)
5. Are you currently registered in Topics in Wild Avian Medicine this spring? Yes No
6. If you answered ''Yes'' in question 5, what were your reasons for registering for this course? (check all that apply)

   ____ I wanted hands-on experience specifically with raptors

   ____ I wanted more avian experience to apply to pet birds and other birds

   ____ I wanted this experience for future veterinary practice

   ____ I wanted this course on my transcript for getting externships as a senior student

   ____ I wanted this course on my transcript to use for job hunting/marketing

   ____ I wanted this course on my transcript to use for applying for internships

the student's class level, previous raptor experience and courses, and reasons for registration in the Topics in Wild Avian Medicine elective course (Table 1). In addition, students completed a pre-lab self-assessment questionnaire rating their proficiency in performing each of 10 procedures that are primary learning objectives for the laboratory (Table 2). The students were asked to rate their general familiarity with and confidence in performing various procedures in raptors, based on a scale of 1 (no familiarity/confidence, or not done) to 6 (very confident in their ability to complete the procedure without complications). If students had never done a particular procedure before the lab, they were instructed to circle ND, as well as to indicate a numerical response from 1 to 6 based on their assessment of their level of confidence that they could perform the procedure. A cutoff of 4.5/6 was arbitrarily selected as the definition of proficiency. Faculty instructors did not score individual student performances during the lab.

The students' level of experience was assessed on the basis of the number of previous raptor labs they had participated in and/or participation in the Raptor Medicine and Rehabilitation elective. *Non-experienced* students were classified as those who had participated in one raptor lab or none at all; *experienced* students were those who had participated in two or more raptor labs and/or the Raptor Medicine and Rehabilitation elective.

Students were divided into two sets of groups: freshman students in Year 1 ($N = 30$) and combined sophomore and junior students in Year 2–3 ($N = 24$). Students in the second and third years of DVM training had had a variety of required and elective courses in which to gain basic clinical veterinary skills. We presumed that these students came into the training lab with more veterinary experience and confidence, resulting in smaller, less significant differences in their self-assessment in the 10 technical skills. These students were also divided into non-experienced ($N = 41$) and experienced ($N = 13$) groups. There was only one Year 1 student in the experienced group, which precluded subdividing Year 1 students by experience levels.

Statistical analysis was done on five groups of students: Year 1, Year 2–3, non-experienced, experienced, and all students combined. The differences between mean values on the pre-lab and post-lab questions for each of 10 procedures were tested for significance using a paired *t*-test if the data were normally distributed and a Wilcoxon Signed Rank test for non-normally distributed data.[a] Mean differences in pre-lab and post-lab scores were compared between students in Year 1 and those in Year 2–3, as well as between non-experienced and experienced students, using the *t*-test for normally distributed data or the Mann-Whitney Rank-Sum test for non-normally distributed data. We were also interested in determining which of the 10 procedures would be most difficult for the students to learn and which the students felt most familiar with before the lab. Multiple pairwise comparison procedures (Tukey test or, for comparisons with unequal group sizes, Dunn's method) were used to determine differences within each group of students in post-lab versus pre-lab scores for the 10 procedures. Level of statistical significance was set at $p < 0.05$.

RESULTS

A total of 61 students took part in the training laboratories (see Table 3), 35 in 2003 and 26 in 2004. Completed surveys (both pre-lab and post-lab) were collected from 54 students (32 in 2003, 22 in 2004), for an 89% return rate; of these students, 30 (55%) were in year 1, nine (17%) in year 2, and 15 (28%) in year 3. There were 13 experienced students (24% of respondents, including one year 1, three year 2, and nine year 3 students) and 41 non-experienced students

Table 2: Spring raptor laboratory pre-lab survey*

Imagine that you are a small animal practitioner in a rural community without a wildlife rehabilitation program within 100 miles . . . One afternoon, your favorite client presents a critically injured red-tailed hawk requiring emergency stabilization to save its life. You are the only doctor in the clinic, and have one technician available to assist you.

Please rate your general familiarity and confidence at performing the following procedures in raptors by circling the number that most closely fits you. 1 = no familiarity/confidence; 6 = I am very confident in my ability to do this without complications. If you have never done this procedure, circle ND, as well as a numerical response (in other words, I've never actually done this but feel xxxx level of confidence that I could). Assume that you have all equipment and supplies necessary to do these procedures.

1. Raptor capture and handling, with emphasis on safety for the hawk and personnel
2. Perform a thorough physical examination, including assessment of musculoskeletal and neurologic systems
3. Collect a blood sample from the jugular or wing (basilic) vein
4. Collect a cloacal swab
5. Perform an ophthalmic examination
6. Administer subcutaneous fluids
7. Administer an intramuscular injection
8. Apply a figure-of-8 bandage
9. Apply a wing-body wrap
10. Apply a ball bandage

*The post-lab survey questions were identical, except for the prelude paragraph, which asked the students to rate themselves after completion of the lab.

Table 3: Summarized results of background questions from the spring raptor lab

1. DVM students by class
   - Freshman 55% ($n = 30$)
   - Sophomore 17% ($n = 9$)
   - Junior 28% ($n = 15$)
2. Previous enrollment in the Raptor Medicine and Rehabilitation elective

   Yes: 13% ($n = 7$) No: 87% ($n = 47$)
3. Previous participation in one or more previous NCSU-CVM raptor labs

   Yes: 85% ($n = 46$) No: 15% ($n = 8$)
4. Other raptor experiences (e.g., wildlife rehabilitation centers)

   Yes: 41% ($n = 22$) No: 59% ($n = 32$)
5. Current registration in Topics in Wild Avian Medicine elective

   Yes: 61% ($n = 33$) No: 39% ($n = 21$)
6. Reasons for registering for Topics in Wild Avian Medicine (includes responses only from students registered in course)
   - Wanted hands-on experience with raptors: 94% ($n = 31$)
   - Wanted more avian experience to apply to pet birds/others: 88% ($n = 29$)
   - Wanted this experience for future veterinary practice: 94% ($n = 31$)
   - Wanted this course on their transcript for getting externships as a senior: 33% ($n = 11$)
   - Wanted this course for job hunting/marketing: 39% ($n = 13$)
   - Wanted the course for applying for internships: 33% ($n = 11$)

(76%, including 29 year 1, six year 2, and six year 3 students). Seven experienced students had previously participated in the one-week Raptor Medicine and Rehabilitation elective (13% of respondents, including one in each of year 1 and year 2 and five in year 3). More than 68% of the students ($n = 37$) had participated in one previous NCSU-CVM raptor lab, and 17% had participated in two ($n = 4$) or three ($n = 5$) previous raptor labs. Five year 1 students and three students in years 2–3 had not previously participated in a raptor lab, although two year 1 students had some previous raptor zoo or rehabilitation program experience. Forty-one percent of students ($n = 22$) had some previous raptor or other wild avian experience through a wildlife rehabilitation program, zoo, or veterinary clinic.

Although students were allowed to participate in the raptor lab without concurrent registration in the credit course, Topics in Wild Avian Medicine, 61% ($n = 33$) of lab participants were registered in the course. When these students were asked their reasons for registering in this course, the three most commonly listed reasons were wanting hands-on experience specifically with raptors (94%, $n = 31$ of 33 registered in course); wanting this experience for future veterinary practice (94%, $n = 31$); and wanting more avian experience to apply to pet birds and other birds (88%, $n = 29$). Other reasons for registering in the course included wanting this course listed on their transcript for future job-hunting purposes (39%, $n = 13$), for applying for internships (33%, $n = 11$), and for applying for senior-year externships (33%, $n = 11$).

The pre-lab and post-lab survey assessment demonstrated that students felt they had improved their technical diagnostic and treatment skills with respect to raptors (Table 4). When pre-lab and post-lab data were compared, there was a significant increase in scores for all 10 procedures for students in Year 1, Year 2–3, in the non-experienced group, and all students combined ($p \leq 0.01$).

Students in the Year 1 group had significantly larger mean increases in their post-lab scores for all procedures than students in the Year 2–3 group ($p \leq 0.02$), except for raptor handling, physical examination, and ophthalmic exam procedures. Non-experienced students had significantly larger mean differences between pre-lab and post-lab scores than experienced students for all 10 procedures ($p \leq 0.02$). There was a 1.6- to 3.3-point difference range in post-lab versus pre-lab scores for students in year 1 and for non-experienced students for all procedures except for the physical exam (point difference range 1.4 and 1.3, respectively). Students in the Year 2–3 group had their greatest point difference ranges (1.6–2.0) for the ophthalmic exam, the wing-body wrap, and the ball bandage (all other point differences ≤ 1.4). Bandaging procedures accounted for the greatest increase in post-lab versus pre-lab scores for all groups. In contrast, handling was associated with the lowest score difference for Year 1 and Non-experienced groups, while cloacal swab was associated with the lowest score difference in the Year 2–3 and Experienced groups. Using a self-assessment score of 4.5 to define proficiency, students in all groups achieved or exceeded proficiency for all procedures except for the physical exam and ophthalmic exam (see Table 4). Average post-lab scores for physical exam and ophthalmic exam procedures ranged from 4.0 to 4.3 for students in the Year 1 and Non-experienced groups and for all students combined. Students in Year 2–3 and Experienced groups rated themselves as proficient in all 10 procedures after the lab. Furthermore, these students rated themselves as proficient on their pre-lab self-assessments for three procedures: cloacal swab, subcutaneous fluids, and IM injection. Experienced students also had mean pre-lab scores of 4.7 and 4.6 for handling and venipuncture procedures.

The experienced group included seven students who had previously taken the Raptor Medicine and Rehabilitation course and six who had participated in two or three previous raptor labs. Pre-lab and post-lab scores for these groups were found not to be statistically different, so they were combined into one group. Students in the Experienced group had presumably done all of these procedures at least once prior to the lab. None of these students had a point difference greater than 1.4, and the lowest point difference was 0.3, for the cloacal swab. In the pre-lab survey, the experienced students considered themselves proficient in handling and venipuncture procedures. They felt least confident (pre-lab scores ranging from 3.9 to 4.1) in the physical exam, the ophthalmic exam, and the three bandaging procedures. After the lab, they indicated a significant increase in proficiency in all procedures ($p \leq 0.02$) except for the cloacal swab, subcutaneous fluid administration, and IM injection (they rated themselves at 5.0–5.5 on the pre-lab assessment for these procedures, the highest pre-lab ratings of any group).

Multiple pairwise comparisons were done between pre-lab and post-lab scores for each procedure within each group to determine which procedures were easiest and which were most difficult for the students to learn, as well as to determine which procedures the students had some familiarity with prior to the raptor lab (see Table 4). When all students were combined, the ball bandage procedure had the greatest increase in median score compared to handling, physical exam, venipuncture, cloacal swab, subcutaneous fluids, and IM injection. For year 1 students, the median score difference was greater for the ball bandage than for handling, the physical exam, and subcutaneous fluids ($p < 0.05$). For year 2–3 students, the median score difference was greater for the ball bandage than for the cloacal swab, subcutaneous fluids, and IM injection ($p < 0.05$). For non-experienced students, the median score difference was greater for the ball bandage than for handling, physical exam, venipuncture, cloacal swab, ophthalmic exam, subcutaneous fluids, and IM injection ($p < 0.05$). These students also had significantly higher median score differences for the wing-body wrap and the figure-of-8 bandage than for handling ($p < 0.05$). There were no significant differences between median post-lab and pre-lab scores for experienced students for any of the pairwise comparisons for the 10 procedures completed in the lab.

DISCUSSION

Based on survey results, all students increased their level of confidence in their ability to perform 10 diagnostic and treatment procedures after a half-day raptor lab. None of the year 1 or non-experienced students rated themselves as proficient before the lab with any procedure, but after the

Table 4: Summary of results of pre-lab and post-lab survey questions (see Table 2) for 10 procedures (mean and standard deviation reported)*

Procedure	Year 1 Pre-/Post-lab[a, b] ($n=30$)	Year 2–3 Pre-/Post-lab[a, b] ($n=24$)	Non-experienced Pre-/Post-lab[a, c] ($n=41$)	Experienced Pre-/Post-lab[a, c] ($n=13$)	All students Pre-/Post-lab[a] ($n=54$)
Raptor handling	1.4 ± 1.3	0.9 ± 0.8	1.3 ± 1.2	0.6 ± 0.7	1.2 ± 1.1
	3.5/4.9	4.1/5.0	3.6/4.9	4.7/5.3	3.8/5.0
Physical exam	1.6 ± 0.9	1.2 ± 0.7	1.6 ± 0.9	0.9 ± 0.5	1.4 ± 0.9
	2.4/4.0	3.5/4.7	2.5/4.1	3.9/4.8	2.9/4.3
Venipuncture	2.1 ± 1.4	0.9 ± 1.2	1.8 ± 1.5	0.8 ± 0.7	1.5 ± 1.4
	2.7/4.8	4.4/5.3	3.1/4.9	4.6/5.4	3.5/5.0
Cloacal swab	2.3 ± 1.6	0.7 ± 1.1	1.9 ± 1.6	0.3 ± 0.5	1.5 ± 1.4
	3.0/5.3	4.9/5.6	3.4/5.3	5.5/5.8[a, **]	4.0/5.5
Ophthalmic exam	1.9 ± 1.2	1.7 ± 1.5	2.0 ± 1.4	1.0 ± 1.0	1.7 ± 1.2
	2.1/4.0	3.2/4.7	2.1/4.1	4.1/5.1	2.6/4.3
Subcutaneous fluids	2.0 ± 1.5	0.8 ± 1.2	1.8 ± 1.6	0.5 ± 0.8	1.5 ± 1.5
	3.1/5.1	4.5/5.3	3.2/5.0	5.0/5.5[a, **]	3.7/5.2
IM injection	2.2 ± 1.4	1.0 ± 1.4	2.0 ± 1.5	0.6 ± 1.1	1.6 ± 1.5
	3.4/5.6	4.7/5.7	3.7/5.7	5.0/5.6[a, **]	4.0/5.6
Figure-of-8 bandage	2.7 ± 1.6	1.4 ± 1.1	2.5 ± 1.5[d]	1.0 ± 0.9	2.1 ± 1.5
	2.2/4.9	3.3/4.7	2.2/4.7	4.1/5.1	2.7/4.8
Wing-body wrap	2.6 ± 1.6	1.6 ± 1.0	2.5 ± 1.3[e]	1.1 ± 1.0	2.1 ± 1.4
	2.1/4.7	3.3/4.9	2.2/4.7	4.1/5.2	2.7/4.8
Ball bandage	3.3 ± 1.5[f]	2.0 ± 1.3[g]	3.1 ± 1.3[h]	1.4 ± 1.2[i]	2.6 ± 1.5[j]
	1.5/4.8	3.0/5.0	1.6/4.7	4.0/5.4	2.3/4.9

*Data reported include mean differences (±SD) between post-lab and pre-lab scores (top line in each cell) and mean pre-lab and post-lab scores (bottom line in each cell). Respondents rated their ability to perform each procedure on a scale of 1 (no familiarity/confidence) to 6 (very confident in ability to perform procedure without complications). Level of proficiency was arbitrarily established at 4.5 or higher.

a There were significant increases in mean post-lab versus pre-lab scores within all groups examined, except as noted with a double asterisk for three procedures in the Experienced group.

b Students in the Year 1 group had significantly larger mean differences between pre-lab and post-lab scores than students in the Year 2–3 group, except for raptor handling, physical examination, and ophthalmic exam procedures.

c Compared to experienced students, non-experienced students had significantly larger mean differences between pre-lab and post-lab scores for all 10 procedures.

d There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for figure-of-8 bandage and equivalent scores for handling (Non-experienced group).

e There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for wing-body wrap and equivalent scores for handling (Non-experienced group).

f There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for ball bandage and equivalent scores for handling, physical exam, and subcutaneous fluids (Year 1 group).

g There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for ball bandage and equivalent scores for cloacal swab, subcutaneous fluids, and IM injection (Year 2–3 group).

h There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for ball bandage and equivalent scores for handling, physical exam, venipuncture, cloacal swab, ophthalmic exam, subcutaneous fluids, and IM injection (Non-experienced group).

i There were no significant differences ($p<0.05$) between median post-lab and pre-lab scores for any of the pairwise comparisons for the 10 procedures (Experienced group).

j There was a significant difference ($p<0.05$) between median post-lab and pre-lab scores for ball bandage and equivalent scores for handling, physical exam, venipuncture, cloacal swab, subcutaneous fluids, and IM injection (all students combined).

lab, both groups rated themselves as proficient in eight of 10 procedures.

Year 1 students constituted just over half of the students but made up 71% of the Non-experienced group. The overlap between these groups likely accounts for the similarity of results between the two. Overall, these students showed the greatest increase in post-lab over pre-lab scores. These findings are not unexpected, considering their minimal level of veterinary training. Since 90% of year 1 students had participated in a previous raptor lab that emphasized handling and physical examination procedures, it was not surprising that there was less difference between post-lab and pre-lab scores for handling. However, these students felt less confident in their physical exam skills.

In contrast, 92% of students in the experienced group were in year 2 or year 3, and experienced students represented 54% of the Year 2–3 group, probably accounting for the partial overlap in results. These groups, while still demonstrating improvement in scores, showed smaller changes than less experienced groups. Students in the Year 2–3 and Experienced groups felt most confident in those technical skills that they had practiced on pigeons in avian labs in the required curriculum, including the cloacal swab, subcutaneous fluids, and IM injections. Students in all groups had the lowest mean pre-lab scores and the greatest increase in scores for the ball bandage procedure. None of the non-experienced students had gained any prior experience with, or knowledge of this procedure in any elective or required avian or other companion-animal laboratory. Experienced students had done the procedure at least once before but still did not feel proficient in this or the two other bandaging procedures before the lab, probably reflecting the necessity of practice and repetition to learn these technical procedures.

Predominantly, scores increased to the greatest extent in application of skills that were more technical in nature, such as the ability to administer intramuscular injections and subcutaneous fluids, collect blood and cloacal swabs, and apply different bandaging techniques. Less improvement was seen in areas such as physical exams and ophthalmic exams, which require multiple cognitive and psychomotor skills. Repeated opportunities to practice technical and cognitive skills and to relate these experiences and knowledge to other areas of veterinary medicine are necessary to develop clinical competence, whether with raptors, pet birds, or companion animals.[5, 6]

One shortcoming of this study was that teaching faculty did not score students' actual proficiency; faculty assessment of student proficiency might have resulted in lower post-lab scores. It would have been interesting to survey students before and after the one-week Raptor Medicine and Rehabilitation course and to compare the students' self-assessment scores to a faculty assessment of proficiency. The smaller class size of that course ($N = 6$) would have made faculty assessment more feasible.

The two elective raptor medicine courses provide numerous opportunities for veterinary students in years 1 through 3 to develop skills essential for managing injured and sick raptors. Many of these diagnostic and treatment skills are directly applicable for use with companion birds, but some (e.g., passage of crop feeding tube and ball bandaging techniques) require some modifications because of anatomic differences between parrots and raptors. While most of our students are planning to enter traditional companion-animal practice, many want to pursue veterinary training with non-traditional species in preparation for private practice that may include companion and wild avian patients. A small percentage of students in each class is interested in pursuing careers in zoological or wildlife medicine. Elective courses, externships, research projects, and related opportunities are absolutely essential to help these students prepare for alternative careers in veterinary medicine.[7]

We developed a model to teach raptor medicine and rehabilitation in a veterinary school without an on-site wildlife rehabilitation program. In today's climate of budgetary cutbacks, developing innovative teaching programs using community resources is likely to become more common. The essential ingredients for the success of this model included experienced and interested faculty or adjunct faculty to develop training opportunities and a wildlife rehabilitation center willing to participate in the teaching mission of the institution.

ACKNOWLEDGMENTS

We could not provide a teaching program in raptor medicine without the cooperation of the Carolina Raptor Center (CRC). This center is committed to helping us create new models to teach raptor medicine and rehabilitation in our curricula, and they recognize that training future veterinarians is beneficial to raising the quality of veterinary care for wildlife everywhere. We also thank Dr. Elizabeth Stone and three anonymous reviewers for their helpful comments.

NOTE

a The software used was Sigma Stat Statistical Software, version 2.0, SPSS Inc, Chicago, IL <www.spss.com>.

REFERENCES

1 Redig PT. *Medical Management of Birds of Prey*, 3rd ed. St. Paul, MN: Raptor Center at the University of Minnesota, 1993.

2 Heidenreich M. *Birds of Prey: Medicine and Management*. Malden, MA: Blackwell Science, 1997.

3 Cooper JE, ed. *Birds of Prey: Health and Disease*, 3rd ed. Malden, MA: Blackwell Science, 2002.

4 Lumeij JT, Remple JD, Redig PT, Lierz M, Cooper JE, eds. *Raptor Biomedicine III*. Lake Worth, FL: Zoological Education Network, 2000.

5 Kincaid SA. In retrospect: teaching is ''dribbling and passing.'' *J Vet Med Educ* 30:81–87, 2003.

6 Moore DA, Leamon MH, Cox PD, Servis ME. Teaching implications of different educational theories and approaches. *J Vet Med Educ* 29:117–123, 2002.

7 Sherman DM, Pokras M, English AW. Preparing veterinarians for meaningful participation in wildlife conservation. *J Vet Med Educ* 26:26–29, 1999.

AUTHOR INFORMATION

Laurel A. Degernes, DVM, Dipl. ABVP (Avian Practice), is an Associate Professor of Companion and Wild Avian Medicine in the Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606 USA.
E-mail: laurel_degernes@ncsu.edu. Her primary research interests include critical care management of companion and wild avian patients.

Julie A. Nettifee Osborne, BS, RVMT, is a Avian Research Technician in the Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606 USA.