Evaluation of collars and microchips for visual and permanent identification of pet cats

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Objective—To determine the percentage of pet cats still wearing collars and having functional microchips 6 months after application.

Design—Randomized controlled clinical trial.

Animals—538 client-owned cats.

Procedures—Cats were randomly assigned to wear 1 of 3 types of collars: plastic buckle, breakaway plastic buckle safety, and elastic stretch safety. Each cat was fitted with the assigned collar, and a microchip was inserted SC between the scapulae. Owners completed questionnaires about their experiences and expectations of collars at enrollment and at the conclusion of the study.

Results—391 of the 538 (72.7%) cats successfully wore their collars for the entire 6-month study period. Owners' initial expectations of the cats' tolerance of the collar and the number of times the collar was reapplied on the cats' necks were the most important factors predicting success. Type of collar likely influenced how often collars needed to be reapplied. Eighteen (3.3%) cats caught a forelimb in their collar or caught their collar on an object or in their mouth. Of the 478 microchips that were scanned at the conclusion of the study, 477 (99.8%) were functional.

Conclusions and Clinical Relevance—Most cats successfully wore their collars. Because even house cats can become lost, veterinarians should recommend that all cats wear identification collars since they are the most obvious means of identifying an owned pet. For some cats, collars may frequently come off and become lost; therefore, microchips are an important form of backup identification. Owners should select a collar that their cat will tolerate and should check it often to ensure a proper fit. (*J Am Vet Med Assoc* 2010;237:387–394)

Cats have surpassed dogs numerically as the most popular pet in the United States, with 38.4 million households owning an estimated 88.3 million cats.[1] With this seemingly growing popularity has come a proportional increase in the number of cats entering animal shelters. Although exact estimates do not exist, it is believed that between 3 and 4 million cats enter animal shelters in the United States each year and nearly 75% of them are euthanized.[2] The number of cats entering shelters in Ohio was reportedly 20% higher in 2004 than in 1996.[3]

Of cats entering shelters with an unknown ownership status, < 2% are reunited with their owners, compared with as many as 15% to 19% of lost dogs.[4] One reason for this low reunion rate may be that many owners fail to provide any form of identification for their cats. In 2 studies[5,6] conducted to evaluate methods used by owners to search for lost dogs and cats, only 14% of the cats were wearing any visual identification such as a collar or tag with owner contact information at the time they were lost and only 7% had a microchip, compared with 43% of dogs with visible identification and 8% with a microchip. In Ohio, only 17% of 217 surveyed cat owners reported they use visual means for identifying their cats and only 3% use microchips.[7] Reasons for not providing visual identification included their cats were kept exclusively indoors (51%), their cats did not get lost (24%), and their belief that cats do not tolerate collars or may be hurt by them (11%). Reasons for not providing their cats with a microchip implant were that their cats were kept exclusively indoors (36%), their cats did not get lost (18%), and microchips are too expensive (16%). Other research[6] involving a cohort of lost cats revealed 40% were considered by the owners to be exclusively indoor pets, only demonstrating that being kept indoors does not prevent cats from accidentally escaping and becoming lost.

Despite the growing recognition of the importance of permanent identification of pets, visual identifica-

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tion remains the easiest and fastest way to reunite lost pets with their owners. Particularly with cats, the presence of visual identification helps to distinguish that a particular cat is owned and immediately provides the owner's contact information for anyone that recognizes the cat is lost and is willing to try to locate the owner. In addition, not all animal shelters routinely scan for microchips, particularly when cats are stressed or behave ferally. Presumably, the most reliable long-term method of identification is microchip implantation because microchips cannot be lost or altered. Microchips serve as an important backup form of identification and can be detected by scanners should a lost cat be taken to an animal shelter or veterinary office. The extremely low rate of cats being reunited with their owners through animal shelters coupled with high euthanasia rates for cats in shelters represents a serious welfare concern. Shelters have limited space, and many are only able to keep a select few to offer for adoption; the remainder, if they are not promptly claimed, are often euthanized.

A general dogma apparently exists among cat owners and veterinarians that cats cannot wear collars or will be injured by them. The specific goals of the study reported here were to determine the percentage of cats still wearing a collar 6 months after placement, to compare differences in the percentages among collar types, to document problems (if any) with cats wearing collars, to describe owner perceptions regarding their cats wearing collars, and to determine the percentage of cats with functional microchips 6 months after implantation.

Materials and Methods

Cats—Cat owners were recruited from 4 participating study sites between April 2008 and July 2008. Sites included the Colleges of Veterinary Medicine at The Ohio State University (study site A), University of Florida (study site B), Texas A&M University (study site C), and Cornell University (study site D). Owners were primarily recruited from faculty, staff, and students at the 4 participating institutions through e-mail, Web page, and poster advertisements. Additional owners from among volunteers and staff at local animal shelters were recruited. Owners were allowed to enroll up to 3 cats in the study. Inclusion criteria were the cat had to be > 6 months of age, had to have no known diseases that would prevent completion of the study, had not worn a collar in the previous month, and had no microchip previously implanted. The study protocol was approved by each institution's veterinary hospital board and institutional review board when required by that institution.

Study design—At each institution, enrolled cats were randomly assigned via computer software to 1 of 3 groups representing the 3 types of adjustable nylon collars (plastic buckle collars,[a] breakaway plastic buckle safety collars,[b] and elastic stretch safety collars[c]). These collars were selected because they are commonly commercially available to cat owners. Two of the collars[b,c] had small bells attached to them, and these were removed prior to the start of the study so that no collar in the study had any bells attached.

Identification clinics were held on various days during the 4-month enrollment period. Prior to attending an identification clinic, owners were given a description of the study and an initial questionnaire, which they could complete just prior to or on the day of enrollment. On the day of the identification clinics, owners had the opportunity to ask questions about the study and signed appropriate consent forms. Cats were scanned with a universal microchip scanner to verify the absence of a microchip. When a microchip was detected, the cat was excluded from the study. Microchips[d] were implanted SC between the scapulae during the identification clinic. The function of the microchip was verified by scanning with a universal microchip scanner prior to and immediately after implantation.

The randomly assigned collar with a standard plastic identification tag containing the microchip number as provided by the microchip manufacturer was fitted on each cat's neck such that 2 fingers could comfortably fit between the collar and the neck. Care was taken to ensure the collar was neither too loose nor too tight. In some situations, the size of the cat's neck was too small for the assigned collar type so a different collar type was randomly assigned for the cat. In a few rare instances, cats became too fractious to apply the collar and the owner was instructed to fit the collar on the cat at home.

Owners were asked to make a good faith effort to have the cat wear the collar and were given an observation log to record any type of problems that occurred with their cat after collar application, such as cat scratching or rubbing at the collar, cat getting forelimb or mouth caught in the collar, cat yowling excessively because of the collar, collar falling off necessitating replacement, collar becoming lost permanently, or other problems. If the collar came off of a cat during the study, then the owners were instructed to place the collar back on the cat as soon as they became aware, at their own discretion. Owners were told there were no requirements to keep placing a collar back on the cat and they were completely free at any time to cease participation in the study for any reason. They were asked to record the dates of the adverse events and, if they elected to stop participating because of concerns about the collar, the date and reason for drop out. Finally, owners completed microchip registration forms and received information about the microchip registry and associated customer services. Forms were collected and submitted to the microchip registry by each institution to ensure all cats were registered.

Owners were contacted at the end of the first week and first month of the study and once monthly thereafter to collect information about the cats' progress wearing the collar, including any problems, and to ensure owner compliance with the study protocol. Owners were contacted primarily via e-mail but were also provided with a telephone number for each institution in the event they had immediate concerns and preferred to call. At the end of the 6-month study period, owners were asked to return to the institutions to have their cats scanned to determine whether the microchips were still functional, to verify the location of the microchips, and to evaluate the quality of the collars (good condition or frayed). A microchip was considered to have migrated when it could not be detected by passing the

scanner over the dorsal scapular region but was instead detected at another location. Alternatively, scanners were loaned to owners so they could scan their cats at home and report the results and the condition of the collar. A final study questionnaire and the observation log were collected at this time. For those owners who did not return to have the microchips scanned, these forms were returned via hand delivery, fax, e-mail, or regular mail.

Initial and final questionnaires—Owners were asked a series of written questions at the beginning and end of the study. For the initial questionnaires, owners were asked for contact information; university affiliation (veterinary student, graduate student, undergraduate student, faculty, staff, or other); cat age; cat sex; spay-neuter status; cat breed; whether other animals were in the household (dog, cat, or other); amount of time the cat spent outdoors; whether the cat ever wore a collar prior to the study and, if so, why the cat was no longer wearing it; and expectations for how well the cat would tolerate wearing the collar (very well, moderately well, fairly well, poorly, or not at all). Owners were also asked open-ended questions concerning the reasons they were not currently using a collar on their cat or had a microchip implanted in their cat in the past. Those responses were subsequently categorized.

For the final questionnaire, owners were asked whether their cats were still wearing the collars and, if not, the date of dropping out and the reason (lost the collar, collar continued to come off and owner chose not to place it back on cat, cat scratching or rubbing excessively, cat's forelimb caught in the collar, collar stuck in cat's mouth, or other), number of times the collar came off and was reapplied during study (0, 1 to 5 times, 6 to 10 times, or > 10 times), most common reason the collar came off (cat scratched or kicked it off, cat did not tolerate it well so it was removed to provide relief, not sure [collar was found on the ground], or other), owner's perception of how well cat actually tolerated wearing collar (very well, moderately well, fairly well, poorly, or not at all), owner's feeling toward cat's experience wearing the collar (cat tolerated the collar better than the owner expected, about as well as the owner expected, or worse than the owner expected), and for cats still wearing collar at the study end, whether the owner planned to have the cat continue to wear collar afterward and, if not, the reason. All data were entered into a computer database.[e]

Statistical analysis—Mean ± SD values are reported for normally distributed, continuous data; median and range are reported for nonnormally distributed data; and proportions are reported for responses that consisted of categorical data. Survival analysis with right censoring was used to model the data for time to failure for wearing a collar. A failure was defined as the time a cat was no longer wearing a collar and was measured in days from the initial placement of the collar. Failure could occur for any of the aforementioned reasons that the owner decided to no longer keep the collar applied. Data from cats that were removed early from the study for reasons such as death or loss to follow-up were also censored. Because the random effect of owner needed to be accounted for in the model, traditional Cox proportional hazards modeling could not be used; instead, parametric regression with shared frailty models was used.[f] The Akaike information criterion was used to select the optimal parametric model form.[8] Bivariate parametric survival models with the variable collar type forced in the analyses as the primary covariate of interest were performed to screen variables for subsequent inclusion in multivariate analysis. Variables with values of $P \leq 0.25$ in these bivariate analyses were included in the multivariate analysis. Variables were removed from the full multivariate model on the basis of results of the Wald test. Biologically meaningful interactions between the main effect variables in the model were tested for inclusion in a similar manner. Survival functions for each collar type were plotted by means of Kaplan-Meier curves. Comparisons to assess equality of survivor functions were performed by use of the log-rank test. The χ^2 test was used to compare proportions for categorical variables among the collar types. The Fisher exact test was used to compare proportions when the expected value of a given cell in the comparison was < 5. For all statistical tests, a value of $P \leq 0.05$ was considered significant. Standard statistical software[g] was used for all analyses.

Results

Cats—A total of 538 cats with 338 owners were enrolled at the 4 study sites (158 at site A, 184 at site B, 53 at site C, and 143 at site D). Mean ± SD number of cats enrolled in the study per owner was 1.46 ± 0.65. The median age of enrolled cats was 3.5 years (range, 0.5 to 15 years). Only 30 (5.6%) of the cats were sexually intact, whereas 508 (94.4%) were spayed or neutered. Two hundred eighty (52.0%) cats were male, and 258 (48.0%) were female. Four hundred seven (75.7%) were domestic shorthair cats, 96 (17.8%) were domestic longhair cats, and 35 (6.5%) were purebred cats. Three hundred nine of 534 (57.9%) cats lived with dogs, 455 of 537 (84.7%) lived with other cats, and 116 of 534 (21.7%) lived with other types of pets. Two hundred ten (39.0%) cats had worn collars at some time in the past but not in the month prior to enrolling in the study. Owners classified 396 (73.6%) cats as indoor only, with 142 (26.4%) cats spending at least some time outdoors. No significant differences were evident among collar groups with respect to cat spay-neuter status, age, breed, living with dogs, living with cats, living with other pets, having worn a collar in the past, and spending time outdoors. There was a significant ($P = 0.003$) difference, however, with respect to sex among collar groups; 110 (62.5%) cats with plastic buckle collars were male, compared with only 86 (46.5%) for breakaway plastic buckle safety collars and 84 (47.5%) for elastic stretch safety collars.

The 338 owners were grouped by study site affiliation as follows: veterinary students, 159 (47.0%); graduate students, 16 (4.7%); undergraduate students, 28 (8.3%); faculty, 13 (3.8%); staff, 65 (19.2%); and other, 57 (16.9%). There was no significant association between the distribution of owners in the various affiliations and the distribution of cats with the various collar types.

Analysis of time to collar failure—Random assignments to collar groups were as follows: plastic buckle collar, 176 (32.7%) cats; breakaway plastic buckle safety collar, 185 (34.4%) cats; and elastic stretch safety collar, 177 (32.9%) cats. Of the 538 cats enrolled in the study, 391 (72.7%) wore their collars for the entire 6-month study period and were censored at that time. Data from an additional 32 (5.9%) cats were censored, with 22 cats lost to follow-up, and 10 cats were withdrawn early because of an unrelated competing risk (illness or death). The remaining 115 (21.4%) cats had a failure outcome in that they did not wear the collar for the full 6-month study period (**Figure 1**).

The log-rank test revealed a significant ($P < 0.001$) difference in the duration cats wore each of the 3 collar types. For those cats that had a failure outcome (no longer wore the collar), reasons for failure and percentage of total number of cats in the study included the following: cat lost the collar, 38 (7.1%); cat was scratching or rubbing excessively at the collar, 26 (4.8%); collar continued to come off and owner chose not to replace it, 18 (3.3%); collar was stuck in cat's mouth, 10 (1.9%); cat's forelimb was caught in the collar, 5 (0.9%); collar was caught on other object, 3 (0.6%); and other, 15 (2.8%). Reasons given for the collar coming off and the median times to that event were summarized (**Table 1**). For collars that became caught on a cat's forelimb, that event occurred 3 days after application for 1 breakaway plastic buckle safety collar but 47, 97, 98, and 106 days after application for all others. For the 3 elastic stretch safety collars that became caught on an object, that event occurred 14, 26, and 34 days after application. For collars that became stuck in the cat's mouth, that event occurred 0.5, 5, 15, and 175 days after application for the breakaway plastic buckle safety collar; 3, 4, 10, and 34 days after application for the elastic safety stretch collar; and 1 and 5 days after application for the plastic buckle collar. For the breakaway plastic buckle safety collar that became stuck at 175 days, a similar event occurred for the cat at 0.5 days, but the owner elected to keep her cat in the study until the event occurred the second time. For all circumstances in which a breakaway plastic buckle safety collar became caught on a forelimb, in the mouth, or on an object, the collar did not break away as the design was intended.

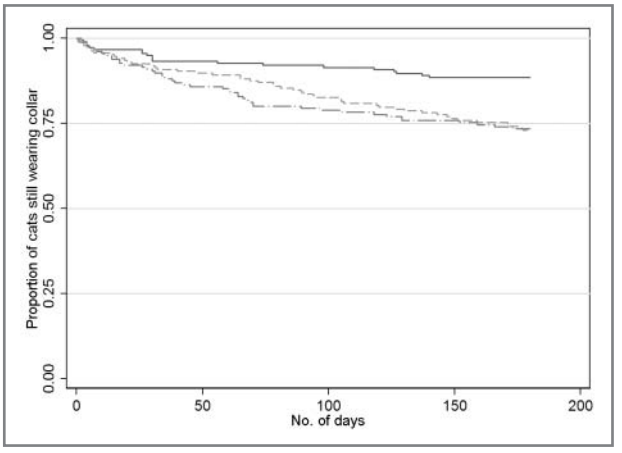

Figure 1—Kaplan-Meier survival curves for interval to failure (collar coming off) for 538 client-owned cats wearing a plastic buckle collar (solid line), a breakaway plastic buckle safety collar (dashed line), or an elastic stretch safety collar (dashed and dotted line).

Other reported problems with collars—For 388 of the cats that completed the study, data were collected on the quality of collars after the 6-month period, indicating 248 (63.9%) collars were in good condition and 140 (36.1%) were frayed. There was a significant ($P < 0.001$) difference in quality among the collar types, with 33 (23.6%) plastic buckle collars, 23 (16.4%) breakaway plastic buckle safety collars, and 84 (60.0%) elastic stretch safety collars reported to have frayed. For 514 cats whose owners reported the information, 333 (64.8%) cats wore their collars without the collars ever coming off during the entire 6-month study period. For 181 cats, their collars did come off and were reapplied by their owners and there was a significant ($P < 0.001$) difference in the number of times this happened among collar types (**Table 2**). The plastic buckle collar never came off during the study for 146 (85.9%) cats wearing it, whereas collars never came off for 109 (60.9%) cats wearing the breakaway buckle collar and 78 (47.3%) cats wearing the elastic stretch safety collar. Reasons owners gave for collars coming off and requiring reapplication also differed significantly ($P = 0.003$) among collar types.

Factors associated with collars coming off—Data for 512 cats grouped by 324 owners were used for the shared frailty parametric survival models to investigate factors associated with collar failure (26/538 cats in the

Table 1—Number (%) of pet cats (n = 115) in which application of 1 of 3 collar types resulted in various problems, necessitating withdrawal from a 6-month study of collar wearing and interval to that withdrawal.

	Plastic buckle collar		Breakaway plastic buckle safety collar		Elastic stretch safety collar	
Reason for withdrawal	No. (%) of cats	Median (range) No. of days	No. (%) of cats	Median (range) No. of days	No. (%) of cats	Median (range) No. of days
Cat lost the collar	2 (10.0)	29 (28–30)	24 (49.0)	99.5 (19–177)	12 (26.1)	92 (4–173)
Collar repeatedly came off (owner stopped replacing)	1 (5.0)	127	5 (10.2)	78 (14–86)	12 (26.1)	43.5 (28–166)
Cat scratching or rubbing excessively at collar	8 (40.0)	28 (4–137)	7 (14.3)	22 (3–148)	11 (23.9)	14 (2–105)
Cat's forelimb caught in collar	1 (5.0)	98	3 (6.1)	47 (3–106)	1 (2.2)	97
Collar caught in cat's mouth	2 (10.0)	3 (1–5)	4 (8.2)	10 (0.5–175)	4 (8.7)	7 (3–34)
Collar caught on object	0 (0)	—	0 (0)	—	3 (6.5)	26 (14–34)
Other	6 (30.0)	96 (1–126)	6 (12.2)	19.5 (0.5–72)	3 (6.5)	89 (69–159)

— = Not applicable.

Table 2—Number (%) of times new collars came off and had to be reapplied during a 6-month period after 1 of 3 collar types was applied to pet cats (n = 514), with reasons given by owners.

Variable	Plastic buckle collar	Breakaway plastic buckle safety collar	Elastic stretch safety collar	*P* value
No. of times collar came off				< 0.001
0	146 (85.9)	109 (60.9)	78 (47.3)	
1–5	22 (12.9)	61 (34.1)	66 (40.0)	
> 5	2 (1.2)	9 (5.0)	21 (12.7)	
Reason collar came off*				0.003
Cat scratched or kicked it off	6 (25.0)	13 (18.6)	27 (31.0)	
Owner removed it to give cat relief	3 (12.5)	5 (7.1)	2 (2.3)	
Not sure (owner found collar on ground)	8 (33.3)	48 (68.6)	45 (51.7)	
Other	7 (29.2)	4 (5.7)	13 (14.9)	

*Reasons given for 181 cats whose collar came off 1 or more times.
A value of $P \leq 0.05$ was considered significant.

Table 3—Results of multivariate parametric shared frailty survival analysis of factors associated with time to failure (collar coming off) over a 6-month period for 512 pet cats wearing a new collar.

Variable	Adjusted HR	95% CI	*P* value
Collar type			
Plastic buckle	1.0	Referent	NA
Breakaway plastic buckle safety	1.9	0.99–3.77	0.052
Elastic stretch safety	1.9	0.95–3.95	0.070
Study site			
A	1.0	Referent	NA
B	0.7	0.28–1.56	0.341
C	4.0	1.24–13.00	0.020
D	2.4	0.99–5.86	0.052
No. of times collar came off and was put back on			
0	1.0	Referent	NA
1–5	1.9	1.06–3.52	0.033
> 5	3.8	1.52–9.60	0.004
Owner expectation of cat's collar tolerance			
Extremely or moderately well	1.0	Referent	NA
Fairly well, poorly, or not at all	1.9	1.06–3.48	0.031

HR = Hazard ratio. NA = Not applicable.
A value of $P < 0.05$ was considered significant. A significant, positive HR value means that collars came off at a greater rate in the indicated group than in the referent group.

study had missing values for one of the covariates and were excluded from the analysis). Factors considered included collar type (forced into the model as the primary variable of interest), study site, university affiliation, cat age, cat breed, cat sex, spay-neuter status, collar color, presence of dogs in the house, presence of other cats in the house, presence of other types of animals in the house, time cat spends outdoors, whether collar was worn in the past, owner expectation of cat tolerating collar (dichotomized into extremely or moderately well; and fairly well, poorly, or not at all), number of times collar came off and was reapplied (grouped as 0, 1 to 5 times, and > 5 times), and collar quality at study end (good or frayed). Only the variables study site, expectation of cat tolerating collar, and number of times collar came off and was reapplied were significant in the final multivariate model, although collar type achieved borderline significance with an adjusted hazard ratio of 1.9 for both the breakaway buckle collar ($P = 0.052$) and elastic stretch safety collar ($P = 0.070$) as compared with the plastic buckle collar (**Table 3**). Final model results indicated cats were significantly more likely to fail to wear a collar for the 6-month study period if their owners did not expect they would accept the collar extremely or moderately well, if their collar came off and had to be put back on, and if the cats were recruited at site C.

Owner perception of their cat's tolerance of a collar—Owners' initial expectations for how well their 538 cats would tolerate a collar were as follows: extremely well, 90 (16.7%); moderately well, 112 (20.8%); fairly well, 200 (37.2%); poorly, 124 (23.0%); and not at all, 10 (1.9%). Overall, owners' expectations were exceeded with 303 (56.3%) stating their cats tolerated the collars better than they expected, 167 (31.0%) as expected, and 43 (8.0%) worse than expected. Of the 391 cats still wearing a collar at the end of the study, owners planned to keep the collars on 352 (90.0%). For the 25 owners who reported reasons they did not plan to continue to use a collar for their cats, the most common reasons were as follows: problems with the collar, 11 (44%); cat was kept indoors only, 5 (20%); and problems with the standard manufacturer's tag bearing the microchip being too big, 3 (12%).

Past use of collars—Overall, 210 (39.0%) cats in the study had worn a collar in the past. There was no significant difference in successfully completing the

study between cats that had worn collars in the past and those that had not. The 3 most common reasons they were no longer wearing a collar were cat removed collar, collar was lost or fell off, and cat was kept indoors only or mostly indoors (**Table 4**). For the 328 (61.0%) cats that had never worn a collar in the past, the most common reasons were that the cat was kept indoors all or most of the time, the owner believed collars are dangerous, the collar was not needed or necessary, and the owner just never thought of it or tried a collar (**Table 5**).

Table 4—Reasons cats (n = 210) with a history of wearing a collar were no longer wearing the collar.

Reason*	No. (%) of cats
Cat removed collar	46 (21.9)
Collar became lost or fell off	43 (20.5)
Cat kept indoors all or most of time	29 (13.8)
Other	22 (10.5)
Cat didn't like collar	18 (8.6)
Owner elected to remove collar (no specific reason)	12 (5.7)
Cat didn't like bell	11 (5.2)
Collar was old or worn out	10 (4.8)
Collar broke	9 (4.3)
Collar provoked scratching or skin irritation	9 (4.3)
Cat outgrew collar	7 (3.3)
Cat caught collar on jaw, mouth, or tongue	5 (2.4)
Collar used only when traveling	5 (2.4)
Collar caught on objects	4 (1.9)
Collar perceived as dangerous	3 (1.4)

*Owners were allowed to indicate > 1 reason.

Table 5—Reasons owners (n = 208) never applied collars on their cats in the past.

Reason*	No. (%) of owners
Cat kept indoors all or most of time	113 (54.3)
Collar perceived as dangerous	25 (12.0)
Didn't need it or not necessary	24 (11.5)
Never thought of it or never tried it	24 (11.5)
Cat was recently adopted	13 (6.3)
Other	12 (5.8)
Previous owner experience with other cats	10 (4.8)
Didn't think cat would tolerate it	9 (4.3)
No specific reason	8 (3.8)
Cat didn't like collar	8 (3.8)
Cat wears harness outside	4 (1.9)
Cat removed collar	2 (1.0)
Collar became lost or fell off	2 (1.0)

*Owners were allowed to indicate > 1 reason.

Table 6—Reasons owners (n = 338) never had their cats implanted with a microchip in the past.

Reason*	No. (%) of owners
Expense of microchip implantation	113 (33.4)
Cat kept indoors all or most of time	96 (28.4)
Planned to but never followed through	63 (18.6)
Aware of the option but never considered it	26 (7.7)
Microchip implanting not offered or available	26 (7.7)
No specific reason	25 (7.4)
Other	23 (6.8)
Recently adopted	16 (4.7)
Didn't need it or not necessary	14 (4.1)
Wanted to have it done with cat anesthetized	9 (2.7)
Unaware of or unfamiliar with microchip implantation	7 (2.1)
Concern for reliability of microchip	6 (1.8)
Thought procedure might be stressful or painful	6 (1.8)
Thought cat already had a microchip	4 (1.2)
Live in area where cats aren't scanned	2 (0.6)

*Owners were allowed to indicate > 1 reason.

Success of microchips—None of the cats enrolled in the study had been implanted with a microchip before enrollment. The most common reasons for never having had their cats identified in that manner were the associated expense, the cat was kept indoors all or most of the time, and the owner had planned to have the implantation performed but never followed through (**Table 6**). Of the 478 cats that were scanned for microchip detection at the end of the study, only 3 (0.6%) had microchips that had migrated and were located outside the implanted region. One cat had a microchip that was not functional at the end of the study (ie, could not be read by a scanner). That cat underwent radiography, which revealed the microchip was still present. A second microchip was consequently implanted on the basis of manufacturer recommendations.

Discussion

Results of the study reported here suggested that approximately three-fourths of cats could successfully wear a collar. Although a significant difference was not found, plastic buckle collars may have stayed on better than the other collar types in the study cats. However, owner willingness to replace a collar repeatedly if it did come off as well as owner expectations for success were even more important than collar type. This means that any collar type could be selected, but careful fitting and monitoring as well as patience in replacing the collar during the cats' adjustment period are key. It may be that the owners' perceptions of their cats were based on prior knowledge of their cats' ability to wear a collar or that owners with a belief that their cats would not tolerate the collars well had lower tolerances for adverse events such as the cat scratching at the collar. Regardless, many cats tolerated their collars better than owner expectations, with 59.1% of owners stating their cats tolerated the collar better than they expected and only 8.4% stating their cats tolerated it worse than they expected. In addition, most owners planned to keep the collar on their cat after the study was completed.

Owners were asked to provide reasons their cats had never worn a collar in the past, and some of these reasons were consistent with those expressed in other research as well as with our belief about the dogma related to cats not wearing collars. In another study,[7] Ohioans were asked the reason their cats were not currently wearing a collar and tag and the 2 most common reasons given were that the cat was kept entirely indoors (51.4%) and the cat did not get lost (24.0%). In the present study, the most common reason given by owners for their cat never wearing a collar was the cat was kept indoors all or most of the time; however, indoor-only cats can become lost too.[6] An additional challenge with cats is the feeding of free-roaming cats. Surveys of residents in various geographic regions of

the United States have shown that between 8% and 26% of households feed free-roaming cats.[7,9] If a cat that is owned becomes lost and does not have visual identification in the form of a collar and tag, people may start to feed the cat, increasing the likelihood that the cat will take up residence in the new location. The presence of a collar and tag would alert people the cat is owned, hopefully increasing their willingness to try and find the rightful owner. Veterinarians and their staff can play an important role in overcoming these barriers by having discussions with their clients about the importance of providing visual identification for their cats, providing collars and tags for purchase, and instructing owners on proper collar application, beginning at the kitten stage whenever possible.

An additional barrier to owners never having placed a collar on their cats was the perception that collars were dangerous. In our study, although uncommon, collars did pose some degree of danger in that 3.3% of cats got their collars caught on an object, in their mouths, or on their own forelimbs. These reasons were also reported with similar frequencies for cats that had worn a collar in the past, prior to the study. The median interval to a collar getting caught in a cat's mouth was only 5 days, which suggested cats should be watched closely for the first few days after collar application to ensure they are tolerating the collar. For the 1 cat that got its collar caught in its mouth and was withdrawn from the study at 175 days after application, the collar actually became caught in the mouth on the first day of the study but the owner elected to continue. Given the serious nature of this event, if it occurs, owners need to consider trying a different collar type, refitting the collar, or not using a collar for their cat. All 3 cats that got their collar caught on an object had worn the elastic stretch safety collar. We found during the study that these collars stretch and become loose, making them easier to become caught. With any collar type, it is important to teach owners the importance of checking the collar periodically to ensure it does not need to be adjusted.

We also found that a little more than a third of cats were able to get their collars off during the study, requiring owners to reapply them. The plastic buckle collar stayed on the best, compared with the 2 types of safety collars. In addition, 38 collars were lost during the study (2 plastic buckle, 24 breakaway plastic buckle safety, and 12 elastic stretch safety), and 140 (36.1%) collars of cats that completed the study were frayed. For cats in the study who had worn a collar in the past, the 2 most common problems reported by owners were that their cat removed the collars and the collars fell off or were lost. It is likely that the head and neck conformation (and relative circumference) of a cat influence the ease with which it can remove a collar. We did not measure these variables in the present study, but such measurements would be important to assess in future research. Our findings supported the idea that keeping a collar on a cat may require some effort by the owner and may require periodic reapplication. As mentioned previously, periodic checking of collar fit may reduce the frequency of cats removing their collars, but it may also help reduce false expectations of owners if veterinarians and their staff can educate owners that collars require some effort to keep on certain cats. The fact that collar loss can be common and frequent in some situations underscores the importance of microchip implantation as a backup form of identification.

Owners in our study were also asked reasons they had never had their cats implanted with a microchip in the past, with the most common reasons being the expense of the implant and their cat was kept indoors all or most of the time. These were also 2 of the 3 main reasons given in a previous study,[6] although expense was given as a reason by a higher proportion of participants in the present study. The discrepancy in findings may be attributable to the high proportion of veterinary student owners in our study, for whom expense may be a greater concern than for other owners. To this end, veterinarians and staff can also help to educate cat owners about the importance of microchip implantation as a means of permanent identification, even for indoor-only cats. Only 3 (0.6%) of the microchips implanted in our study had migrated from their original implantation sites, and 1 microchip could not be read by the scanner. This proportion is less than the 1.6% reported for microchip migration in dogs and cats entering animal shelters.[10] Even though the chance of microchip migration or reading failure is low, scanning an animal for the presence of a readable microchip during a yearly wellness examination is an opportunity to ensure the microchip is still functional, to ensure it has not migrated considerably, and to remind owners to keep their information up-to-date in the microchip registry. For these reasons, we strongly recommend that routine chip checkups be performed as part of every wellness examination for cats and dogs.

The finding that study site C had a higher adjusted hazard ratio than the other sites requires addressing. Given that > 1 site was in the southern United States, this phenomenon does not appear to be associated with geographic location but, rather, was most likely attributable to other, unmeasured confounders such as owner characteristics or other unknown factors.

The present study had several limitations. First, the population of owners from which the study sample was obtained may not be representative of the general cat-owning populace, since owners were associated with colleges of veterinary medicine or animal shelters in limited geographic areas. Nonetheless, important issues surrounding identification of pet cats were highlighted by our findings, including the lack of identification provided for cats by many owners. Given that the cohort of owners in the study might be presumed to be more educated than the general public, the lack of identification is particularly alarming. Furthermore, even among this cohort, a considerable number found it difficult to keep the collars on their cats.

A second limitation is that a few cats could not be randomly assigned to collar groups because of the size of their necks and inability to wear the plastic buckle collar. This might have introduced bias in the success of collar types. Third, owners of cats that had previously worn collars possibly had different expectations about collar tolerance, although the fact that a cat wore a collar in the past was not a significant factor in the analysis. Finally, it is possible that cats that already had

a microchip implant and that were ineligible for study participation may have been different from eligible cats in terms of their ability to wear a collar.

Regardless of the study limitations, our results indicated that many owners, even well-educated people, did not even think to put a collar on their cats but were willing to do so once educated. In addition, findings suggested that making microchips widely available and affordable may increase compliance. In our experience, implanting microchips is quick, easy, and minimally stressful in cats and does not require use of excessive restraint or sedation. We believe that both visual and permanent identification are essential components of a comprehensive preventive medical plan for cats and that the potential benefits far exceed any potential adverse effects. This holds true even for indoor cats; owners do not plan to lose their pets, and veterinarians can play a life-saving role in increasing recovery through education and implementation of wellness protocols that include visual and permanent identification of cats. Additional research is needed to determine whether problems associated with collars coming off can be reduced through collar design, placement of collars on kittens to acclimate them to the collars, and education of owners on proper collar fitting and maintenance.

a. Aspen Pet Small Adjustable Collar (3/8" single-ply nylon with plastic buckle, adjusts from 8" to 14"), Aspen Pet Products Inc, Denver, Colo.
b. Aspen Pet Safety Collar (3/8" single-ply nylon with breakaway plastic buckle, adjusts from 8" to 12"), Aspen Pet Products Inc, Denver, Colo.
c. Licorice Strip Safety Stretch (3/8" single-ply elasticized nylon with stainless buckle, fully adjustable 10" collar), Coastal Pet Products Inc, Alliance, Ohio.
d. HomeAgain microchip (unencrypted 125 kHz), Digital Angel Inc, distributed by Schering-Plough HomeAgain LLC, Kenilworth, NJ.
e. Microsoft Office Access 2003, Microsoft Corp, Redmond, Wash.
f. STREG, StataCorp, College Station, Tex.
g. Stata, version 10.1, StataCorp, College Station, Tex.

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10. Lord LK, Ingwersen W, Gray JL, et al. Characterization of animals with a microchip entering animal shelters. *J Am Vet Med Assoc* 2008;235:160–167.