

# Effects of environmental enrichment on the behavior of shelter dogs

Meghan E. Herron, DVM; Taylor M. Kirby-Madden, BA; Linda K. Lord, DVM, PhD

**Objective**—To determine the effect of food-toy enrichment combined with cage-behavior training on desirable behaviors in shelter dogs and adoption rates.

**Design**—Randomized controlled clinical trial.

**Animals**—107 dogs.

**Procedures**—Dogs placed up for adoption in a municipal shelter were randomly assigned to either an experimental group (n = 48) or control group (59). Experimental group subjects were exposed to an environmental enrichment and training protocol consisting of twice-daily cage-behavior training and daily provision of a food-filled toy. Cage-behavior training included operant conditioning via positive reinforcement of desirable behaviors, including approaching the front of the cage, sitting or lying, and remaining quiet when approached. Behavioral observations were performed by a blinded observer in a scan-sampling technique on day 0 (first day on adoption floor) and again on day 3 for experimental (n = 26) and control (32) dogs. Body posture, location in cage, and other behavioral parameters were recorded. Adoption information and behavioral observation data were compared between groups.

**Results**—Compared with the control group, the experimental group had a significantly greater percentage of dogs with an increase in desirable behaviors of sitting or lying down (17/26 [65%] vs 7/32 [22%]) and being quiet (9/26 [35%] vs 4/32 [13%]) and a significantly greater percentage of dogs with a decrease in the undesirable behavior of jumping (15/26 [57%] vs 3/32 [9%]). Location in cage, fearfulness, and eye contact were not significantly different between groups. Survival analysis revealed no significant difference in adoption rates between groups.

**Conclusions and Clinical Relevance**—Results suggested that enrichment programs improve desirable behaviors and decrease undesirable behavior in shelter dogs, which may enhance welfare. (*J Am Vet Med Assoc* 2014;244:687–692)

Canine behavior is a critical facet of shelter housing and management and plays a major role in determining an animal's adoptability and welfare. Most municipal shelters rely on single-dog housing where kennel size may be restricted. Previous studies<sup>1,2</sup> suggest that singly housed dogs may be predisposed to stereotypic behaviors, such as circling, digging, floor licking, and frequent changes from one state of locomotion to another (ie, changing from walking to jumping, from standing to spinning, and from sitting to pacing). Such behaviors have been correlated with chronic stress and may be indicators of poor welfare.<sup>2–4</sup> Adding to this concern, dogs that are chronically restricted from social exposure have increased physiological stress responses (eg, increased urine cortisol-to-creatinine concentration ratios), hormonal and immunologic changes (eg, neutrophilia), and behaviors associated with fear and distress (low posture, autogrooming, paw lifting, and

From the Departments of Veterinary Clinical Sciences (Herron, Kirby-Madden) and Veterinary Preventive Medicine (Lord), College of Veterinary Medicine, The Ohio State University, Columbus, OH 43210. Presented in part at the American College of Veterinary Behaviorists Annual Veterinary Behavior Symposium, Chicago, July 2013. The authors thank Margaret O'Brien, Abby Obenour, Kayla Whitfield-Bradley, Petrina Patete, Jonathan Tenenzapf, Kelsey Bryant, Gina Han, Emma Smith, and Brittany Vichosky for technical assistance. Address correspondence to Dr. Herron (meghan.herron@cvm.osu.edu).

## ABBREVIATION

RLR Real-life rooms

vocalization).<sup>2,3</sup> Because behavioral and associated physiologic changes pose substantial welfare concerns in dogs,<sup>4–6</sup> shelters strive to increase calm, affiliative behaviors as best possible.

Environmental enrichment may be a way to mitigate the effects of the stress associated with the shelter environment. A review of enrichment for kennel dogs suggests that a variety of animate and inanimate enrichment increases the complexity of dog behavior and helps prevent undesirable behavior,<sup>7,8</sup> allowing for improved animal welfare in the shelter environment. Animate enrichment with human social contact has been shown to increase affiliative behavior in shelter dogs, both toward dogs and people.<sup>9,10</sup> Furthermore, inanimate enrichment in the form of food-filled toys also promotes desirable behaviors in shelter dogs.<sup>11</sup> The provision of such toys also seems to enhance adoptability and public preference for shelter dogs.<sup>12,13</sup> Enrichment programs that incorporate behavior training (obedience) have also been shown to improve adoptability.<sup>12</sup> This is essential in shelter environments because lengthy shelter stays have been correlated with a worsening of behavior and the potential for poor welfare.<sup>14</sup>

Although previous studies have examined the effects of specific enrichment procedures on the behavior of kennel dogs, none have assessed the overall effects on behaviors in response to a complex enrichment program that involves both animate and inanimate forms of enrichment and behavior training. The purpose of the study reported here was to determine the effect of food-toy enrichment combined with cage-behavior training on desirable behaviors in shelter dogs and adoption rates. We hypothesized that shelter dogs receiving a complex program of environmental enrichment would have improved behavior, compared with those not receiving it. Specifically, we hypothesized that this enrichment program would lead to an increase in desirable behaviors (sitting, being quiet, making eye contact, and approaching the front of the kennel) and a decrease in undesirable behaviors (jumping, vocalizing, and remaining in the back of the kennel). Given that past studies<sup>12</sup> have linked some of these desirable behaviors (alertness and position at the front of the cage) with increased adoption rates, we also hypothesized that a complex enrichment program would increase the adoption rates for dogs enrolled.

## Materials and Methods

**Animals and housing**—The study was conducted at the Franklin County Dog Shelter in Columbus, Ohio, for 4 weeks between July and August 2012. This municipal shelter houses all stray dogs in Franklin county, a metropolitan area with a population of > 1 million people. Unclaimed stray and owner-surrendered dogs must pass a medical examination and behavioral assessment to be eligible for adoption. Dogs are vaccinated and neutered prior to going up for adoption, and each dog is housed singly. Typically, the shelter places 5 to 15 dogs up for adoption each day. Dog are housed in a holding ward for 3 days prior to being processed for neutering and next-day adoption. Owner-surrendered dogs that were already neutered were placed up for adoption the following day.

This study and the animal handling protocol were approved by The Ohio State University Institutional Animal Care and Use Committee. Consent for the use of the dogs in this study was obtained by the Franklin County Dog Shelter administration and county commissioners.

The shelter has 2 identical, kennel-style adoption wards (A and B) that hold 20 to 25 dogs, which were used to house study subjects. Each ward has 1 row each of double-sided kennels, and each individual kennel is divided in half by a guillotine door. One side holds water bowls affixed to a door, and the other side typically has bedding and toys as well as kennel cards with each dog's information for potential adopters. There are walkways on both sides of the kennels, making the kennels an island in the middle of the room. A typical kennel size is 113 × 267 cm (width by length), with a metal wall 123 cm high on 2 sides. The kennel doors (1 on each side of the guillotine divider) are made of metal bars. Dogs in wards A and B are not able to see other dogs unless they are large enough to stand and look over the edge of their

kennel (123 cm). Individual kennels are cleaned every morning before the shelter opens, and dogs are fed a commercial brand dry kibble twice a day at 7 AM and 7 PM. The shelter also has 45 cinderblock and glass-enclosed RLRs. These rooms are positioned at the entry to the adoption areas, and potential adopters must pass by them before reaching the adoption wards. The variability in the shapes, sizes, and locations of the RLRs was prohibitive of a consistent enrichment and training program (ie, solid doors that do not allow for consistent front-of-kennel body position training). In addition, adoption rates for dogs housed in RLRs are high and most dogs are adopted within 24 to 48 hours. For both of these reasons, dogs housed in RLRs were excluded from the study. Only dogs housed in wards A and B were included in the study.

The evening prior to placing dogs on the adoption floor, dogs 6 months of age and older were randomly assigned for placement into either the experimental group (ward A) or the control group (ward B), according to a block randomization with a block size of 6.<sup>15</sup> Randomization for group assignment was performed with the aid of a computerized random number generator. Puppies < 6 months of age and dogs transferred into the adoption wards from the isolation ward were excluded from the study (puppies are typically adopted more quickly than juveniles and adults, and dogs coming from isolation were exposed to the shelter environment for longer periods than dogs going up for adoption from the holding wards). After 6 dogs were randomly assigned to either ward A or ward B, staff filled the RLRs with the remaining dogs ready to be placed up for adoption. Dogs in RLRs were not a part of the study. If the RLRs were all occupied, then the remaining dogs that were ready to move up to the adoption floor were randomly assigned to either ward A or B, according to the block randomization. This process of ward assignment–RLR assignment–ward assignment was done to prevent bias selection for the RLRs versus the wards, to ensure at least 6 dogs were enrolled in the study per day, and to keep the RLRs occupied, as were the wishes of the shelter management.

Dogs enrolled in both the control and experimental groups were available for adoption at any time, and volunteers were allowed to walk dogs from either group for elimination purposes; the frequency and length of walks were not altered by the study for either group. For the duration of the study, no dogs in either group were allowed to have any food treats while in their kennel or undergo any behavior training, nor could they have any food toys outside what was provided via the enrichment program.

**Experimental procedure**—Dogs were observed on day 0 (their first morning on the adoption floor and prior to any enrichment) and again on day 3 (their fourth morning on the adoption floor and after 3 days of enrichment or no enrichment). In-cage behavior was observed each morning between 9:30 AM and 11:00 AM by the same observer, who was blind to dog grouping and therefore unaware of enrichment status, for all 28 days. The behavior of each dog was recorded over a 90-minute period by means of a scan-sampling technique. At 15-minute intervals, the observer approached the front of each dog's kennel, stood quietly for 3 seconds, and

then looked up and recorded behaviors occurring at that moment, allowing for collection of 6 observations/dog/d. Five behavioral parameters were recorded: position in cage (front, middle, or back), eye contact (yes or no), body posture (sitting, lying down, standing, walking, or jumping), vocalization (quiet [no vocalization], whining, barking, or growling), and fear (yes or no; defined as at least 2 signs of a fear response<sup>4,5</sup> as follows: tucked tail, pinned ears, stiff body posture with a side stare [whale eye], cowering, trembling, lip licking, or yawning). Dogs absent from their cage for > 2 of the 6 observations on either day 0 or 3 ( $n = 2$ ) were excluded from the study because < 4 observations may not be representative of their cage behavior.

The study's enrichment program was modeled after an elective course offered at The Ohio State University College of Veterinary Medicine where preclinical veterinary students attend weekly shifts on-site at the shelter as well as didactic lectures on current literature. An enrichment delivery team, comprised of 9 volunteers (3 veterinary students, 5 undergraduate students, and 1 law student), administered the daily enrichment protocol for the dogs in the experimental ward. Team members were trained, observed, and approved by the principal investigator prior to the start of the study to maintain consistency. For each of the 28 study days, there were 2 afternoon shifts with each shift filled by 1 volunteer. In both shifts, the volunteer completed 2 rounds of cage-behavior training through positive reinforcement training, using liver-flavored training treats<sup>a</sup> to reward desirable behavior. Volunteers were instructed to reward any desirable behavior with the marker word "yes," immediately followed by a piece of food. Desirable behavior was defined as follows: making eye contact, being quiet, sitting or lying down when approached, or approaching the front of the kennel. To reward quiet behavior, the volunteers would not reward any dog that was vocalizing, even if other behaviors were desirable, such as following a sit or down command. Instead, if a dog were vocalizing, the volunteer moved to the next kennel and waited for the dog to stop vocalizing. After the dog was quiet for at least 6 seconds, the volunteer would then revisit that dog's kennel, say "yes," and provide a treat. Likewise, volunteers ignored jumping, barking, whining, or growling. Enrichment group dogs also received a frozen food-filled toy<sup>b</sup> stuffed with puppy kibble and canned dog food every afternoon, prior to the evening meal. Enrichment team members removed the toys from the kennels in the late afternoon for cleaning, refilling, and freezing. To ensure that the study protocol was designed appropriately for implementation at this shelter, a 4-day pilot study was undertaken 3 weeks prior to the beginning of the official study. Enrichment team members were observed for consistency during cage-behavior training, and the shelter veterinary staff implemented a sample block randomization for all dogs placed up for adoption. The pilot confirmed that the study design was well suited for implementation at the site, and that shelter staff were able to incorporate block randomization into their normal move-up protocol without issue.

Individual adoption outcomes were recorded as either adopted (with the day of adoption recorded as 0 through 7) or available (if not adopted by day 7). Each

dog's adoption status was tracked for 7 days, after which point the dog was no longer considered enrolled in the study. Seven days was chosen both because it coincided with the shelter's previously reported duration of stay and because the shelter requested the ability to move dogs to the RLRs after 1 week, as needed, to increase exposure to potential adopters and reduce noise-associated stressors. Adoption outcome data were retrieved from the shelter's software program.<sup>c</sup>

To measure for any changes in desirable or undesirable behaviors, the number of times a dog performed each behavior on day 0 was compared with the number of times a dog performed each behavior on day 3. Dogs were then classified (yes vs no) as having an increase in desirable behaviors or no increase in the behavior or as having a decrease in undesirable behaviors or no decrease in the behavior. A similar classification was done to classify whether dogs had any increase in undesirable behaviors.

**Statistical analysis**—Comparisons between experimental and control groups for increases or decreases in behaviors were then made for each behavior by means of a  $\chi^2$  test. The Fisher exact test was used for categorical variables when the expected value of a given cell in the comparison was < 5. Values of  $P \leq 0.05$  were considered significant. Standard statistical software<sup>d</sup> was used. Desirable behaviors were defined for each of the 5 behavioral parameters as follows: body posture (sitting or lying down), position in cage (front), eye contact (yes), fearfulness (no), and vocalization (quiet). Undesirable behaviors were defined for each of the 5 behavioral parameters as follows: body posture (jumping), position in cage (back), eye contact (no), fearfulness (yes), and vocalization (whining, barking, or growling). A percentage increase or decrease in behavior was chosen to model the data because this allowed for analysis of individual dog improvement. Each dog served as its own control at day 0, thereby allowing for dogs with various baselines to improve or worsen.

To account for any confounding effects between the experimental and control groups, comparisons were made between groups for sex, age, body weight, breed (mixed or purebred), and source by means of  $\chi^2$  analysis. Comparisons were also made between experimental and control groups for age (in years) and body weight (in kg) by means of a Student *t* test. Finally, to obtain descriptive data, the total number of behavioral observations for each day by treatment group was summed categorically for location in cage, eye contact, and fearfulness, and the percentage of desirable behaviors was calculated for each by day and group. These particular categories were reported as summations because dogs in this shelter population were prescreened for sociability, and the population was expected to have uniformly high values for these 3 categories. To measure the effect of treatment on time to adoption, survival analysis (time to event comparisons) with right censoring was used to model the data.

## Results

**Adoption rate**—A total of 119 dogs were initially enrolled in the study, with 57 dogs assigned to the

experimental group and 62 dogs to the control group. Twelve dogs were removed for illness ( $n = 4$ ), wearing an Elizabethan collar (which would interfere with enrichment; 3), do-not-feed designation as a result of recent dental procedures (2), deafness (1), shy dog program participant (additional enrichment provided by shelter staff; 1), and having been returned to shelter (1), leaving 107 dogs for adoption rate analysis.

Median age, body weight, sex, breed (mixed vs purebred), and source (stray, owner-surrender, or impounded) were not significantly different between the experimental and control groups (Table 1). There was no significant difference in the mean duration of stay until adoption between the dogs in the experimental and control groups. The mean duration of stay for dogs in the experimental group was 4 days, compared with the control group at 3.75 days. Thirty-nine of 59 (66%) control dogs and 34 of 48 (71%) treatment dogs were adopted by day 7; survival analysis revealed no significant difference in adoption rates between groups.

**Behavioral observations**—Sixty dogs were enrolled in the study long enough to have behavioral observations recorded at day 3, including 26 dogs in the experimental group and 32 dogs in the control group. Of the 2 dogs remaining, one was missing from its cage for  $> 4$  of 6 behavioral observations and another was missing day 3 observation data. Both dogs were therefore excluded from analysis, leaving 58 dogs for behavioral observation analysis. Remaining experimental and control subjects had no significant difference in group composition (age, body weight, sex, breed, or source; Table 2).

The increase from day 0 to 3 in the percentage of dogs with various desirable behaviors was significantly greater for dogs in the group that received the enrichment protocol, compared with dogs that did not receive the enrichment protocol. From day 0 to 3, dogs in the experimental group had a significantly ( $P = 0.001$ ) greater increase in either sitting or lying down body postures (as opposed to standing, walking, or jumping), compared with dogs in the control group (17/26 [65%] vs 7/32 [22%], respectively). Similarly, dogs in the experimental group had a significantly ( $P = 0.045$ ) greater increase in quiet behavior, compared with control dogs (9/26 [35%] vs 4/32 [13%], respectively). No significant change in the percentage of dogs with the desirable behaviors of a front-of-cage position, reduced fearfulness, or making eye contact was found between experimental dogs and control dogs, yet these desirable behaviors were uniformly high in both groups on both days (Table 3).

The decrease in the percentage of dogs with the undesirable behavior of jumping from day 0 to 3 was significantly ( $P < 0.001$ ) greater for dogs in the group that received the enrichment protocol, compared with dogs that did not receive the enrichment protocol (15/26 [58%] vs 3/32 [9%], respectively). No other significant difference in the decrease of undesirable behaviors was found between groups.

However, an increase in the undesirable behavior of jumping was significantly ( $P < 0.014$ ) greater in the control group (13/32 [41%]) versus the treatment group (3/26 [12%]) from day 0 to 3. Similarly, control group

Table 1—Signalment of dogs placed up for adoption in a municipal shelter that were exposed to an environmental enrichment and training protocol consisting of twice-daily cage-behavior training and daily provision of a food-filled toy (experimental group) or that received no enrichment (control group).

Signalment	Experimental (n = 48)	Control (n = 59)
Age (y)	1.4 (0.5–6)	2 (0.5–6)
Sex		
Male	23 (48)	35 (59)
Female	25 (52)	24 (41)
Body weight (kg)	15 (2.5–39)	12.3 (2–36)
Breed		
Purebred	23	24
Mixed	25	35
Source		
Impound	20	21
Stray	10	14
Owner surrender	18	24

Data are median (range) or number (percentage).  
All males were castrated and all females ovariohysterectomized prior to being placed up for adoption.

Table 2—Signalment of dogs in the control and experimental groups in Table 1 that were available for behavioral observations after 3 days.

Signalment	Experimental (n = 26)	Control (n = 32)
Age (y)	2.2 (0.5–6)	2.3 (0.5–6)
Sex		
Male	17 (65)	20 (63)
Female	9 (35)	12 (37)
Body weight (kg)	17 (3–35)	15 (3–32)
Breed		
Purebred	12	12
Mixed	14	20
Source		
Impound	11	14
Stray	5	5
Owner surrender	10	13

Table 3—Total number (%) of selected desirable behaviors with uniformly high prevalence across group and time. The number of times the behavior was observed is reported as a percentage of total number of observations.

Variable	No. of trials	Front of cage	Eye contact	Not fearful
Control				
Day 0	192	183 (95)	177 (92)	143 (74)
Day 3	190	190 (100)	177 (93)	164 (85)
Experimental				
Day 0	154	147 (95)	140 (91)	122 (79)
Day 3	150	147 (98)	144 (96)	139 (93)

Data are number (percentage).

dogs had a significantly ( $P < 0.020$ ) greater increase in barking, whining, or growling, compared with the treatment group (17/32 [53%] vs 6/26 [23%], respectively). No other significant difference in increases in undesirable behaviors was found between the groups.

## Discussion

The findings of this study demonstrate that shelters indeed have the ability to improve the behavior of kennel dogs. Dogs exposed to a complex enrichment protocol had calmer body postures, were quieter when



people approached their cages, and were less likely to jump up for a cage greeting. All of these behavioral differences are widely accepted as being associated with lower stress levels and better welfare.<sup>16</sup> Decreasing vocalization is not only beneficial for the individual dog that is quieter, but is also beneficial for nearby canine residents and creates a more pleasant experience for the visiting public. In fact, previous studies<sup>13</sup> have noted that potential adopters prefer dogs that are not barking. Future studies might examine and compare overall noise levels associated with the entire ward that is exposed to an enrichment protocol to determine whether all dogs within an enrichment ward are quieter and not just those in the cage being approached.

Notably, enrichment appears to have a protective effect against the development of undesirable behaviors in shelter dogs. In this study, the combination of animate and inanimate enrichment not only improved behavior, but also prevented certain behaviors from getting worse. This is demonstrated by the fact that dogs in the control group had increases in jumping and barking behaviors, both of which may indicate stress and are unappealing to potential adopters.<sup>2,7,14</sup> Vocalization in particular has been directly correlated with a manifestation of chronic stress.<sup>2,6</sup> This protective effect is profound, particularly considering that new dogs, each with unique behavioral histories and experience, were enrolled and introduced into both study wards on a daily basis. A limitation in the study could be that we dichotomized change within dog to determine whether it occurred, rather than evaluating the magnitude of change within dog. Finally, this study only measured behavioral changes over 4 days; we suspect continued enrichment would further improve behaviors and protect against the development of undesirable behaviors. Further study to assess the long-term effects of enrichment is indicated.

We hypothesized that dogs exposed to a complex enrichment program would have an increase in front-of-cage body position as well as making eye contact, yet no difference was detected between the groups for either behavior. This is likely due to the fact that these behaviors were uniformly high in both groups, even on the first day. Previous studies<sup>14</sup> have shown that dogs in a rescue shelter for < 1 month spend significantly more time in the front-of-cage position than dogs with longer shelter stays. Considering that all dogs in the present study were within their first week of their shelter stay, this may have been the biggest influence. Alternatively, other studies<sup>17</sup> have found a higher incidence of back-of-cage position overall, even in enrichment conditions. These subjects were reportedly strays and did not undergo a temperament evaluation. Whether the early front-of-cage behavior in the study population is a result of curiosity in a novel environment or a result of this shelter's selection for highly social behavior during temperament evaluation for adoption remains unknown.

Other studies<sup>10</sup> have shown that training specifically targeted toward glance duration is an effective means of getting shelter dogs to make and hold direct eye contact with potential adopters. The behavior training in the present study was perhaps not as well targeted toward prolonged eye contact as in the previous study.<sup>10</sup> Regardless, the high prevalence of making eye contact

and front-of-cage positioning indicates that this shelter has been successful in choosing dogs that perform affiliative behaviors.

Although a significant decrease in fearfulness was not detected in either group, the incidence of fearful behavior was lower for both groups on day 3, compared with the first day on the adoption floor. Other studies<sup>18</sup> have found decreases in cortisol levels associated with longer stays, and it may be that fear decreases as dogs habituate to the kennel environment in general, regardless of enrichment. Overall, fearful behavior was not highly prevalent in either group, which may again speak to this shelter's selection process during temperament evaluation prior to being placed on the adoption floor.

Contrary to our initial hypothesis, enrichment did not affect the duration of stay for the dogs in this shelter. This differs from the findings of Luescher and Medlock,<sup>12</sup> who found that trained dogs had higher adoption rates. Most likely, our findings are due to the fact that the majority of the dogs in this study (68%) were adopted within a week and adoption rates could be measured accurately for comparison for only 7 days. In the previous study,<sup>12</sup> adoption information was followed for up to a year following enrichment and training. Per shelter requirements, the enrichment program could not maintain standardization beyond 7 days and we were unable to measure adoption rates beyond that time frame. Perhaps in a shelter where an enrichment program could be maintained without moving dogs to separate, individual housing areas, the effects of enrichment on the adoption rate of dogs housed in a shelter > 7 days could be measured. Furthermore, a myriad of variables affect whether an individual animal is adopted quickly, many of which are beyond a shelter's control. Despite the fact that this study did not reveal a difference in adoption rates between the enrichment and control groups, it does not preclude the possibility that an individual dog's behavior plays a role in how quickly it is adopted. Size, age, and breed are immutable characteristics and often influence which dogs are adopted most quickly.<sup>10,19</sup>

Maintaining behavioral health in the animals they house should be a primary goal for every shelter. The findings of this study show that a complex enrichment program can help achieve that goal. This enrichment program, modeled after the elective course at The Ohio State University College of Veterinary Medicine, was effective in increasing as well as preventing the deterioration of desirable behaviors in shelter dogs. Implementation of similarly designed programs could bolster the partnerships between municipal shelters and veterinary educational institutions across the country. This educational program could be duplicated in other institutions so that veterinary students can gain hands-on experience with managing the behavior and welfare of a diverse population of dogs as well as provide community outreach to shelter dogs, staff, volunteers, and the general public on training, enrichment, and behavioral welfare.

- 
- a. Freeze Dried Liver Training Treats, Bil-Jac, Medina, Ohio.
  - b. Kong Co, Golden, Colo.
  - c. Shelter Buddy, Centennial, Colo.
  - d. Stata, version 9.1, StataCorp, College Station, Tex.
-

## References

- Hubrecht RC, Serpell JA, Poole TB. Correlates of pen size and housing conditions on the behaviour of kennelled dogs. *Appl Anim Behav Sci* 1992;34:365–383.
- Beerda B, Schilder MBH, van Hoof JARAM, et al. Chronic stress in dogs subjected to social and spatial restriction. I: behavioral responses. *Physiol Behav* 1999;66:233–242.
- Beerda B, Schilder MBH, Bernadina W, et al. Chronic stress in dogs subjected to social and spatial restriction. II: hormonal and immunological responses. *Physiol Behav* 1999;66:243–254.
- Beerda B, Schilder MBH, van Hoof JARAM, et al. Manifestations of chronic and acute stress in dogs. *Appl Anim Behav Sci* 1997;52:307–319.
- Sheppard G, Mills DS. Evaluation of dog-appeasing pheromone as a potential treatment for dogs fearful of fireworks. *Vet Rec* 2003;152:432–436.
- Beerda B, Schilder MBH, van Hoof JARAM, et al. Behavioral, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Appl Anim Behav Sci* 1998;58:365–381.
- Hubrecht RC. A comparison of social and environmental enrichment methods for laboratory housed dogs. *Appl Anim Behav Sci* 1993;37:345–361.
- Wells DL. A review of environmental enrichment for kennelled dogs, *Canis familiaris*. *Appl Anim Behav Sci* 2004;85:307–317.
- Normando S, Corain L, Salvadoretti M, et al. Effects of an enhanced human interaction program on shelter dogs' behavior analysed using a novel nonparametric test. *Appl Anim Behav Sci* 2008;116:211–219.
- Protopopova A, Gilmour AJ, Weiss RH, et al. The effects for social training and other factors on adoption success of shelter dogs. *Appl Anim Behav Sci* 2012;142:61–68.
- Schipper LL, Vinke CM, Schilder MBH, et al. The effect of feeding enrichment toys on the behaviour of kennelled dogs (*Canis familiaris*). *Appl Anim Behav Sci* 2008;114:182–195.
- Luescher AU, Medlock RT. The effects of training and environmental alterations on adoption success of shelter dogs. *Appl Anim Behav Sci* 2009;117:63–68.
- Wells DL, Hepper PG. The behaviour of dogs in a rescue shelter. *Anim Welf* 1992;1:171–186.
- Wells DL, Graham L, Hepper PG. The influence of length of time in a rescue shelter on the behaviour of kennelled dogs. *Anim Welf* 2002;11:317–325.
- Friedman LM, Furberg CD, DeMets DL. *Fundamentals of clinical trials*. 3rd ed. New York: Springer-Verlag Inc, 1998.
- Coppola CL, Enns RM, Grandin T. Noise in the animal shelter environment: building design and the effects of daily noise exposure. *J Appl Anim Welf Sci* 2006;9:1–7.
- Wells DL, Hepper PG. The influence of environmental change on the behaviour of shelter dogs. *Appl Anim Behav Sci* 2000;68:151–162.
- Hennessy MB, Voith VL, Mazzei SJ, et al. Behavior and cortisol levels of dogs in a public animal shelter, and an exploration of the ability of these measures to predict problem behavior after adoption. *Appl Anim Behav Sci* 2001;73:217–233.
- Brown WP, Davidson JP, Zuefle ME. Effects of phenotypic characteristics on the length of stay of dogs at two no kill animal shelters. *J Appl Anim Welf Sci* 2013;16:2–18.



### From this month's AJVR

## Effect of body position on intra-abdominal pressures and abdominal perfusion pressures measured at three sites in horses anesthetized with short-term total intravenous anesthesia

Victoria H. Scott et al

**Objective**—To assess effects of body position on direct measurements of intra-abdominal pressure (IAP) and abdominal perfusion pressure (APP) in horses anesthetized with total intravenous anesthesia (TIVA).

**Animals**—9 healthy adult horses.

**Procedures**—Instrumentation in unsedated standing horses involved insertion of an arterial catheter for blood pressure measurements and 3 intraperitoneal cannulas (left flank, right flank, and ventral abdomen) for IAP measurements. Baseline values were measured for heart rate, respiratory rate, systolic arterial pressure, mean arterial blood pressure (MAP), diastolic arterial blood pressure, and IAP. Horses were medicated with xylazine, and pressures were measured again. Anesthesia was induced with ketamine-diazepam and maintained with a ketamine-guaifenesin infusion. Horses were positioned twice into left lateral recumbency, right lateral recumbency, or dorsal recumbency. Hemodynamic pressures and accessible abdominal pressures were measured for each recumbency position. The APP was calculated as MAP – IAP. Differences in IAP, MAP, APP, and sedation (standing horses) or body position (anesthetized horses) were compared with repeated-measures ANOVA or paired *t* tests.

**Results**—Baseline hemodynamic and IAPs were not different after xylazine administration. Ventral abdomen IAP and MAP were lower for horses in dorsal recumbency than in right or left lateral recumbency. Ventral abdomen APP remained unchanged. For lateral recumbencies, flank IAP was lower and APP was higher than pressure measurements at the same sites during dorsal recumbency.

**Conclusions and Clinical Relevance**—Body position affected IAP and APP in healthy anesthetized horses. These effects should be considered when developing IAP acquisition methods for use in horses with abdominal disease. (*Am J Vet Res* 2014;75:301–308)



See the midmonth issues of *JAVMA* for the expanded table of contents for the *AJVR* or log on to [avmajournals.avma.org](http://avmajournals.avma.org) for access to all the abstracts.