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Effects of Animal-assisted Activities on Biobehavioral Stress Responses in Hospitalized Children: A Randomized Controlled Study

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ABSTRACT

Purpose: This study assessed the effectiveness of animal-assisted activities (AAA) on biobehavioral stress responses (anxiety, positive and negative affect, and salivary cortisol and C-reactive protein [CRP] levels) in hospitalized children.
Design and Methods: This was a randomized, controlled study.
Method: Forty-eight participants were randomly assigned to receive a 10-minute AAA ($n = 24$) or a control condition ($n = 24$). Anxiety, positive and negative affect, and levels of salivary biomarkers were assessed before and after the intervention.
Results: Although increases in positive affect and decreases in negative affect were larger in the AAA condition, pre- and post-intervention differences between the AAA and control conditions were not significant. In addition, pre- and post-intervention differences between the conditions in salivary cortisol and CRP were not statistically significant. Baseline levels of anxiety, cortisol, and CRP had a significant and large correlation to the corresponding post-intervention measures. Scores on the Pet Attitude Scale were high but were not associated with changes in anxiety, positive affect, negative affect, or stress biomarkers.
Conclusions: Although changes were in the expected direction, the magnitude of the effect was small. Future randomized controlled trials with larger recruitment are needed to determine the effectiveness of AAAs in reducing biobehavioral stress responses in hospitalized children.
Practice Implications: Nurses are positioned to recommend AAA as a beneficial and safe experience for hospitalized children.

Hospitalized children face significant anxiety and negative emotions related to serious health problems and unfamiliar hospital settings (Bossert, 1994; Tiedeman & Clatworthy, 1990). During times of stress, levels of neuroendocrine biomarkers such as cortisol are elevated and can negatively affect immune function and recovery by down-regulating inflammatory responses (Schneiderman, Ironson, & Siegel, 2005; Steptoe, Hamer, & Chida, 2007). Animal-assisted activities (AAAs) are endorsed by healthcare providers as a cost-effective intervention in various healthcare settings that provide motivational, educational, recreational, and therapeutic benefits to patients (AVMA, 2017; SCAS, 2013). The aim of the current study was to test the effectiveness of AAA in reducing biobehavioral stress responses in hospitalized children.

Several studies have shown that AAAs improve positive mood/affect in hospitalized children (Bouchard, Landry, Belles-Isles, & Gagnon, 2004; Kaminski, Pellino, & Wish, 2002; Stoffel & Braun, 2006; Wu, Niedra, Pendergrast, & McCrindle, 2002), but determining AAA effectiveness and generalizing findings are hampered by a variety of methodologies used, with variable rigor. One group reported hospitalized children had a higher level of positive affect after a brief AAA than after playing with people (Kaminski et al., 2002); however, the study used non-random sampling, which can introduce selection bias. Other researchers reported that AAAs improved hospitalized children's general positive feelings, but the absence of a control group limited the validity of the findings (Bouchard et al., 2004; Wu et al., 2002). As noted by Chur-Hansen, McArthur, Winefield, Hanieh, and Hazel (2014), the authors of one qualitative study among hospitalized children reported AAA promoted calmness and positive mood, but the absence of triangulation limited the validity of the findings (Stoffel & Braun, 2006).

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Tsai, Friedmann, and Thomas (2010) investigated the effects of an AAA on anxiety in hospitalized children and reported no significant differences in anxiety responses after the AAA; however, the study was limited by its post-test-only design, the small sample size ($N = 15$), and absence of a control group. Moreover, a post-hoc power analysis indicated a larger sample size ($N = 40$) would have been required to detect changes between the two conditions. More recently, using a more rigorous design with a randomized group assignment and a control group, Barker, Knisely, Schubert, Green, and Ameringer (2015) investigated the effects of AAA on anxiety responses in 40 hospitalized children who were randomly assigned to a 10-minute AAA or an active control condition (jigsaw puzzles). Anxiety was measured before and after the assigned condition. Although children in the AAA condition reported significantly lower post-intervention anxiety scores than those in the control condition, there were no significant differences within or between groups in pre- and post-intervention anxiety scores. The authors suggested an alternative explanation for their results was based on the low level of anxiety of hospitalized children at baseline.

AAAs have been shown to optimize immune responses in adult populations, but this has not been reported in hospitalized children. Several studies have reported significant decreases in cortisol, suggestive of stress attenuation, in adults interacting with therapy dogs (Barker & Dawson, 1998; Barker, Knisely, McCain, & Best, 2005; Barker, Knisely, McCain, Schubert, & Pandurangi, 2010; Cole, Gawlinski, Steers, & Kotlerman, 2007; Orlandi et al., 2007). Other researchers investigating adults who were asked to pet a dog reported significant increases in positive immune responses (e.g., salivary immunoglobulin A) among participants (Charnetski, Riggers, & Brennan, 2004).

Although some researchers have explored the psychological effects of AAAs in hospitalized children using self-report instruments, few researchers have used a biobehavioral approach with biological parameters to corroborate self-reports (Nepps, Stewart, & Bruckno, 2014). Kaminski et al. (2002) used a biobehavioral approach that investigated behavioral affect and salivary cortisol responses to AAA in hospitalized children. The authors reported that children in the AAA condition had a higher level of positive behavioral affect and decreased level of salivary cortisol, when compared with a play group condition, but there were no significant differences between the groups, however the study used non-random sampling. Although other stress biomarkers such as cortisol have been tested in prior studies, to our knowledge, no studies have investigated the biobehavioral effects of AAAs on psychosocial and stress-related inflammatory responses in children.

The methodological weaknesses of previous studies result in a gap in rigorous evidence to promote the use of AAAs in hospital settings. Owing to the mixed results of the few studies using a variety of patient populations and methods, the effectiveness of AAAs to reduce stress, anxiety, and improve mood and physiological stress responses in hospitalized children is unclear. Thus, in the current study, we sought to use a rigorous randomized controlled trial to measure biological stress parameters to corroborate self-report data on the impact of AAAs to improve biobehavioral stress responses in hospitalized children.

The conceptual model for the current study was derived from an expanded biobehavioral model (Kang, Rice, Park, Turner-Henson, & Downs, 2010) that integrates a physiological model of stress (Selye, 1974); the cognitive appraisal model of stress and coping theory (Lazarus & Folkman, 1984); and the stress, allostasis, and allostatic load model (McEwen, 2003). The adapted biobehavioral model posits that children respond to illness and hospitalization with anxiety, negative mood, and increased levels of the stress biomarkers cortisol and C-reactive protein (CRP). The focus of our study was the individual, environmental, psychosocial, and biological domains in the adapted model (Fig. 1).

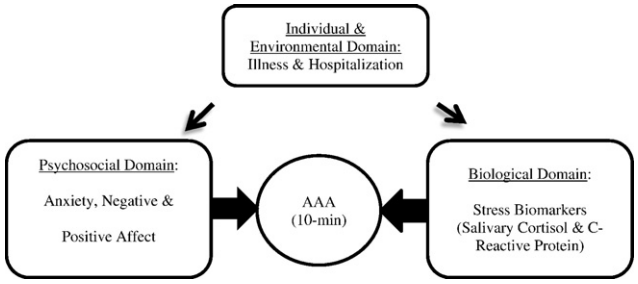

Fig. 1. Expanded biobehavioral model (adapted from Kang et al., 2010).

Method

Subjects and Setting

Power analysis was computed with G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) for a repeated measures design with two measurements per subject and two groups of subjects. Setting $\alpha = 0.05$ and with an estimated Cohen's $f = 0.46$ effect size (Cohen, 1988) for the interaction between time and group, and power = 80%, the estimated sample size was $N = 40$. The effect size was estimated from a previous data on inflammatory responses to AAA (Branson, Baun, Bergstrom, Kang, & Barker, 2014) using a similar inflammatory biomarker, Interluekin-1β. Anticipating missing data from a 15% attrition rate, we enrolled 48 subjects.

Patients were recruited from a medical-surgical unit in a large urban teaching hospital that had an established AAA program. Each therapy dog met obedience, temperament, and health standards required by the AAA program and the hospital and was deemed appropriate for therapy dog visitation. The animal handlers were volunteers, and no administrative costs were associated with delivering the program. Per hospital policy, the dogs were bathed before visitation, and each patient was required to wash his or her hands before and after the AAA. The therapy dogs included a standard poodle, English mastiff, Yorkshire terrier, shih tzu, schnauzer, pug, golden retriever, and two shelties. All except one animal handler was female. The study was conducted during the regularly scheduled AAA, which occurred twice per month between 10 a.m. and 1 p.m.; data were collected over 10 months.

Participants were included if they were 7–17 years old, understood English, alert, oriented (to person, place, and time), able to complete the study instruments, able to provide saliva specimens, had consent from their parent/legal guardian, and gave their own assent. Individuals were excluded if they were currently taking hormone replacement or steroidal anti-inflammatory medications, were in contact isolation, had been diagnosed with Addison's or Cushing's disease, or had fears or phobias of dogs or were allergic to dogs.

Study Design

We tested the effectiveness of a 10-minute AAA on biobehavioral stress responses (anxiety, mood/affect, and salivary cortisol and CRP) in hospitalized children using a randomized controlled trial with an existing AAA program in a pediatric hospital. The central hypothesis was that children who received the AAA would have larger decreases in anxiety, negative affect, cortisol, and CRP and larger improvements in positive affect than children in the non-AAA control condition.

We used a 2-arm randomized, controlled design, whereby participants were randomly assigned to either a 10-min AAA or a 10-min non-AAA control condition. The control condition (Fig. 2) was a plush stuffed dog (no person or live dog). Demographic data were collected at baseline verbally and via chart review. Outcome measures were collected twice, pre- and post-intervention, and included self-reported anxiety and mood (negative and positive affect) with well-established psychometric instruments, and saliva for the noninvasive biological

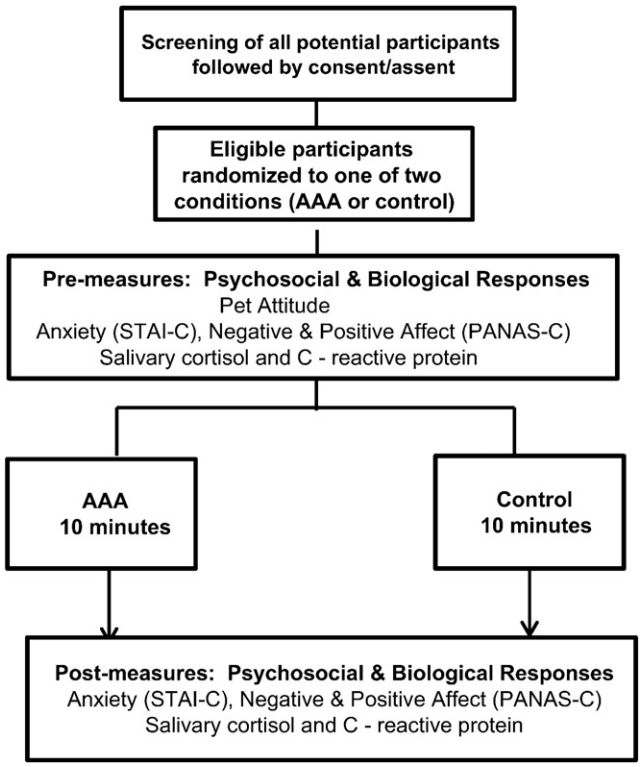

Fig. 2. Randomized control design.

measures of stress (cortisol) and inflammatory (C-reactive protein) responses. The study was approved by the university's Institutional Review Board and was exempt from review by the university's Institutional Animal Care and Use Committee.

Participants

The CONSORT flow diagram (Fig. 3) illustrates the number of patients who were assessed for eligibility and approached, the number who were randomly assigned to a condition, and the number analyzed. Many patients ($N = 135$) were excluded from the study or declined to participate primarily owing to a language barrier or illness-related factors. Initially, 28 participants were allocated to the AAA condition, and of those, four withdrew owing to concerns about confidentiality, physical therapy interference, concurrent bedside procedure, or temporal proximity to a surgical procedure. Twenty-five participants were initially allocated to the control condition, and of those, one withdrew because of agitation related to the inability to provide the saliva specimen. The final sample comprised 48 participants (AAA = 24; control = 24). None of the 48 participants were lost to follow-up. Missing data included three positive and negative affect scores (AAA), one state anxiety score (control), and one subject's saliva sample (AAA), which had insufficient volume to analyze. The remaining subjects' data were included in the statistical analysis.

All patients who were admitted to the clinical unit on the day of the regularly scheduled AAA were screened for eligibility. The staff nurses were asked whether the patients potentially met the eligibility criteria, and their medical records were subsequently reviewed. Research staff approached each potentially eligible child and his/her parent or custodial guardian in the patient's room, explained the study, and invited the child to participate. Before enrollment, written consent was received from the parent or legal guardian, and written assent was received from the child. Blinding was not possible, but research staff and participants were blinded to the study condition allocation before enrollment, and the participant did not know the condition to which he/she would be randomly assigned. After enrollment and before the intervention began, random assignment was by concealed envelopes that allocated each participant to one of the study conditions. The concealed envelopes were provided by a statistician and were opened after enrollment. To reduce the effects of resentful demoralization, children who were randomized to the control condition were offered an AAA later in the day, which was not part of the research project. All study conditions occurred in the patient's private room.

Procedures

The AAA intervention consisted of a one-time 10-minute AAA with a dog and handler, both of whom interacted with the patient. The AAA was casual and did not restrict the handler from conversing, which is standard AAA practice. Children washed their hands before and after the AAA. The therapy dog was leashed and controlled by the dog handler at all times. If the participant wanted the dog to be placed on the bed, a clean sheet was placed on the bed between the dog and patient. Otherwise, the dog was at the patient's bedside and within easy reach. Tactile and visual contact with the dog was promoted by the handler. The parent or guardian was given no specific instructions except to remain at the bedside. There were no limitations on whom the child could interact with, which replicated standard AAA practice. Participants assigned to the control condition received a new plush stuffed dog for the same 10-minute timeframe without any structured activity or person. At the end of the control condition session, the plush stuffed dog was offered for the child to keep. The parent or guardian was given the same instructions as in the AAA condition. Medical staff in our hospital were familiar with the established AAA program and the medical team often rounded during both study conditions, and if needed, nurses would administer intravenous medications for the patient during the study conditions. However, patients were withdrawn from the study if a medical intervention occurred during the study that was physically or emotionally stressful, such as physical therapy procedure ($n = 1$) or another bedside procedure that included a cast removal ($n = 1$). Data were collected immediately before and after the AAA and control condition. Psychosocial data were collected using standardized instruments, and saliva was collected via passive drool. Participants were not allowed to brush their teeth, drink, or eat a large meal 1 h before data collection. Participants rinsed their mouths with water and waited 10 min before providing a specimen. Saliva specimens were collected between 10 a.m. and 1 p.m. to control for circadian rhythmicity.

Measures

Anxiety

State anxiety was measured using the State Anxiety Inventory for Children (STAI-C), an instrument developed to measure current emotions (e.g. nervous, upset) in upper elementary or junior high school-aged children (Spielberger, Gorsuch, & Lushene, 1970). The instrument comprises 20 statements that ask about how one feels at a particular moment in time with three responses from “very” to “not.” Scores range from 20 to 80, and higher scores indicate a higher state of anxiety. Internal consistency has been demonstrated; researchers have reported acceptable reliability coefficients in children 13–18 years old experiencing episodic illness related symptoms with Cronbach's α of 0.86 for the pre-intervention STAI-C scores (Tarbell, Millar, Laudenslager, Palmer, & Fortunato, 2017). Cronbach's alpha for the pre-intervention STAI-C scores in this study was 0.71.

Mood/Affect

Positive and negative affect were measured using the 10-item Positive and Negative Affect Schedule for Children (10 PANAS-C) (Ebesutani et al., 2012). The 10 PANAS-C is a 10-item self-report measure that asks children and adolescents to rate adjectives of varying mood states (5 positive and 5 negative affect adjectives) according to how often they feel *joyful*, *cheerful*, *happy*, *lively*, *proud*, *miserable*, *mad*, *afraid*, *scared*,

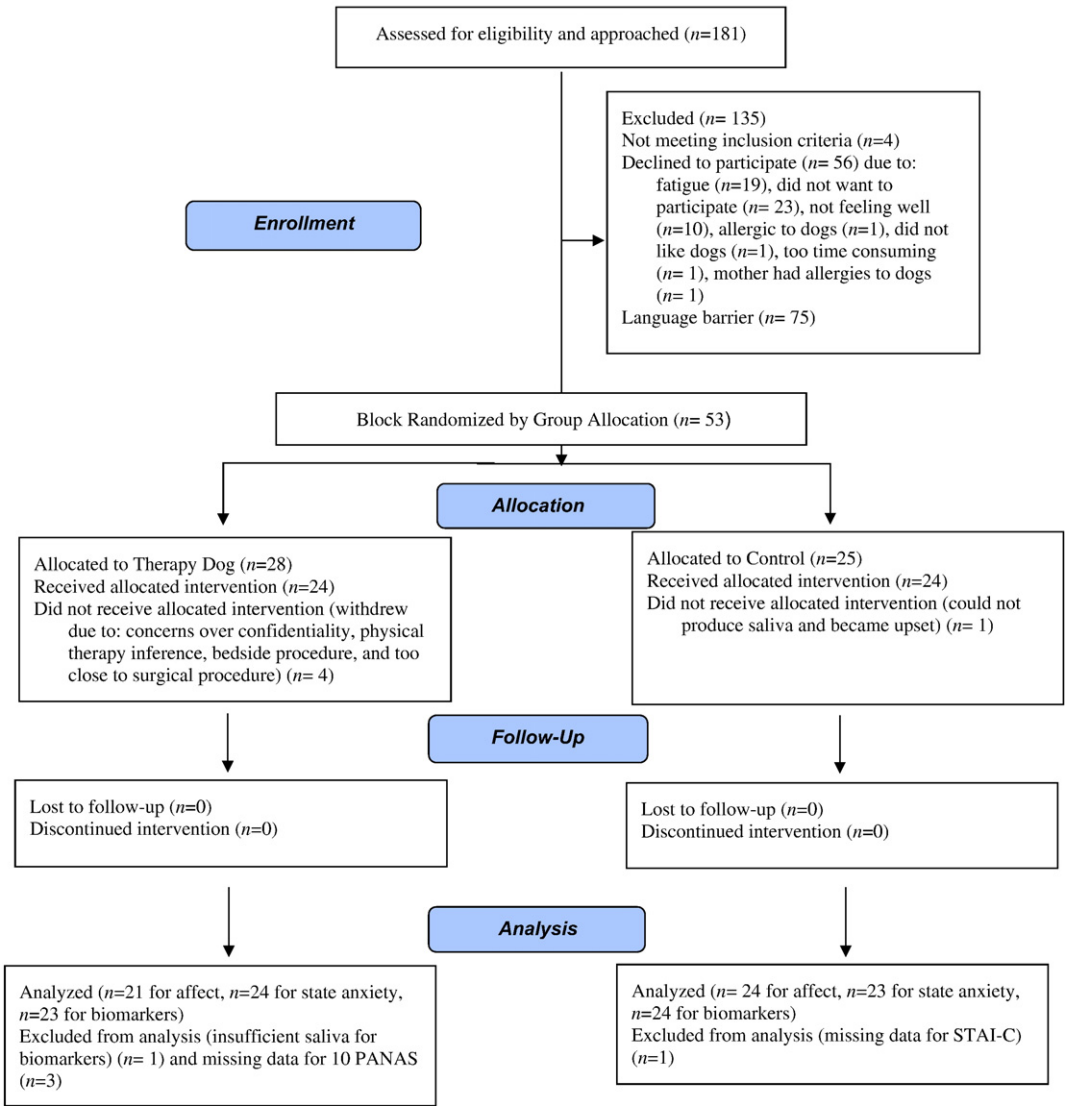

Fig. 3. CONSORT flow diagram of randomized controlled trial.

and *sad*. The item responses use a 5-point Likert scale ranging from 1 ("very slightly or none at all") to 5 ("extremely"). Total scores for the positive and negative affect subscales range from 5 to 25, with higher scores indicating either higher positive or higher negative affect. The PANAS-C has demonstrated acceptable validity and internal consistency estimates when compared to the full-length 27-item PANAS-C scale with alpha of 0.86 for the positive scale and 0.82 for the negative scale (Ebesutani et al., 2012). Cronbach's alpha for the pre-intervention 10 PANAS-C scores in this study was 0.74.

Pet Attitude

Participants' attitude toward pets were measured using the Pet Attitude Scale (PAS) (Templer, Salter, Dickey, Baldwin, & Veleber, 1981). The PAS is an 18-item paper and pencil instrument with 7 Likert scale response statements that measure the favorableness of attitudes toward pets. Scores range from 18 to 126, and higher scores indicate more positive attitudes toward pets. Evidence of the internal consistency of the PAS has been demonstrated in university students ages 19 to 34 years with a Cronbach's alpha of 0.94 (Morovati, Steinberg, Taylor, & Lee, 2008). Other researchers have modified the PAS using a 5-point Likert scale in elementary school aged students with Cronbach's alpha of 0.86 (Daly & Morton, 2006). Cronbach's alpha using the original 7-point PAS in this study was 0.78.

Human-Animal Interaction

A newly developed instrument, the Human-Animal Interaction Scale (HAIS) (Fournier, Berry, Letson, & Chanen, 2016) was piloted among 25% ($n = 6$) of the AAA participants to quantify and describe the behavioral interactions between the participants and the therapy dog. The HAIS is a 24-item self-report questionnaire with a 5-point Likert scale that asks participants to rank the frequency of human and animal behaviors when engaging with an animal, i.e. therapy dog. The HAIS includes two subscales; the human subscale includes 14 items that identify the frequency of positive and negative human behaviors (e.g., hugged the animal and behaved aggressively with the animal, respectively), and the animal subscale includes 10 items that identify positive and negative animal behaviors (e.g., initiating friendly interaction and making unfriendly sounds, respectively). To calculate each subscale score, undesirable behaviors are subtracted from desirable behaviors. The total score ranges from −24 to 72, with higher scores indicating a higher frequency of positive human-animal interaction. To our knowledge, the HAIS has not been tested in children; however, the HAIS has been tested among adults interacting with an animal and demonstrated construct and convergent validity and reliability with a Cronbach's

alpha of 0.82 (Fournier et al., 2016). The HAIS also demonstrated acceptable internal consistency reliability in our pilot sample with Cronbach's alpha 0.77.

In the current study, two additional questions using the same 5-point Likert scale were included from the original longer 28-item HAIS: "Did you enjoy interacting with the animal(s) today?" and "Did you make an emotional connection with the animal(s)?" These last two items were not included when calculating the total score; rather, they were used to further describe enjoyment and emotional connection with the animal (A. Fournier, personal communication, April 22, 2016).

Salivary Biomarkers

Salivary cortisol is a widely used and reliable biomarker of the hypothalamic-pituitary-adrenal axis stress response and has been shown to be highly correlated ($r = 0.90$; $p < 0.0001$) with serum measures (Daniel et al., 2006; Eatough, Shirtcliff, Hanson, & Pollak, 2009). CRP is a stress-responsive salivary protein that is a widely-used biomarker of systemic inflammation (Cheng, Zhang, Lu, & Wang, 2012; Hamer et al., 2006; Steptoe et al., 2007). Salivary CRP has been shown to correlate with serum measures ($r = 0.72$, $p < 0.001$) (Ouellet-Morin, Danese, Williams, & Arseneault, 2011).

Saliva specimens were placed in a biohazard bag in a cooler with ice and immediately transported to the Biosciences Laboratory at the University. Saliva specimens were stored at −80 °C and then batch assayed using a Salimetrics enzyme immunoassay procedure. Coefficients of variation (CVs) were calculated to determine the precision of the assays and were acceptable in the current study. For cortisol, the intra-assay CV using controls was 3.93%, and the inter-assay CV using controls was 10.17%. For CRP, the intra-assay CV using controls was 6.49%, and the inter-assay CV using controls was 13.12%.

Data Analysis

Descriptive statistics were computed for demographic variables and compared by condition. Biological variables were log-transformed (base 10) owing to non-normal distribution patterns. Analysis of covariance (ANCOVA) was used for the outcome variables to test the equality of group means in the post-intervention measure while controlling for baseline (pre-intervention) variability of each measure. When the assumption of homogeneity of slopes was not met for ANCOVA, independent samples *t*-tests were conducted to test the equality of group means of differences (post- and pre-intervention). Pearson correlation coefficients were computed to determine the relationship of pet attitude levels with the pre- and post-intervention outcome values in the AAA condition. Data were analyzed using IBM SPSS (version 22) and *p*-values ≤ 0.05 were considered statistically significant.

Results

Participant Characteristics

No significant differences were found between the AAA and control conditions in demographic variables (Table 1). Participants' ages ranged from 7 to 17 years (*Mean* [*M*] = 13.2, standard deviation [*SD*] = 2.8). Most participants were Hispanic (35%) or White (33%). Nearly three-fourths (71%) of the participants reported owning a dog, and participants in both conditions rated their pet attitude (PAS) as high ($M = 100.73$, $SD = 11.05$). The average duration of hospitalization was 1.9 days. The most common diagnoses were trauma (27%), gastrointestinal (25%), and musculoskeletal (23%) disorders, and 31% were post-surgery.

Effectiveness of AAA on Affect, Anxiety and Salivary Biomarkers of Stress

Scores for children in the AAA and control condition at baseline indicated a moderate level of positive affect ($M = 17.39$, $SD = 4.90$ and $M = 16.63$, $SD = 5.22$, respectively), whereas the level of negative affect scores for the AAA and control condition indicated a mild degree of negative affect ($M = 10.36$, $SD = 3.87$ and $M = 9.25$, $SD = 3.34$, respectively).

Baseline anxiety levels for children in the AAA and control condition ($M = 32.00$, $SD = 6.69$ and $M = 31.38$, $SD = 5.62$, respectively) were similar to those reported in hospitalized children (Jalalodini, Nourian, Saatchi, Kavousi, & Ghaljeh, 2016; Kiliś-Pstrusińskaa et al., 2013), but lower than those reported in hospitalized children during the pre-operative period (Aytekin, Doru, & Kucukoglu, 2016). Baseline levels of salivary cortisol for the AAA and control condition ($M = 0.29$ μg/dL, $SD = 0.27$ and $M = 0.42$ μg/dL, $SD = 1.09$, respectively) were within the normal range expected of children ages 12–18 years (0.021–0.883 μg/dL) (Salimetrics, 2016). Salivary CRP levels for the AAA and control condition (*Md* = 8241, IQR = 29,759 pg/mL.85 and *Md* = 10,295, IQR = 21,6597 pg/mL, respectively) were higher than those reported in children and adolescents who were not hospitalized (Byrne et al., 2013; Byrne et al., 2016; Goodson et al., 2014), but within the range of values

Table 1
Characteristics of the sample ($N = 48$).

	AAA $N = 24$ (50%) *N* (%) *M* (*SD*)	Control $N = 24$ (50%) *N* (%) *M* (*SD*)	*p*
Age (years)	13.43 (0.59)	12.83 (0.58)	0.364[a]
Diagnosis			
Respiratory	0 (0)	1 (4)	0.31[b]
Neurological	5 (21)	2 (8)	0.22[b]
Psychiatric	0 (0)	2 (8)	0.15[b]
Hematological	0 (0)	2 (8)	0.15[b]
Gastrointestinal	5 (21)	7 (29)	0.50[b]
Liver	1 (4)	1 (4)	1.00[b]
Endocrine	2 (8)	1 (4)	0.55[b]
Musculoskeletal	6 (25)	5 (21)	0.73[b]
Immunological	0 (0)	1 (4)	0.31[b]
Other	3 (13)	1 (4)	0.29[b]
Trauma	8 (33)	5 (21)	0.33[b]
Surgical procedure	6 (25)	9 (38%)	0.35[b]
Gender			0.56[b]
Female	11 (48)	13 (54)	
Male	13 (54)	11 (48)	
Lives with			0.56[b]
One parent	14 (58)	12 (50)	
Both parents	10 (42)	12 (50)	
Dog ownership (current)			0.34[b]
Yes	15 (63)	19 (79)	
No	9 (38)	5 (21)	
Length of hospital stay			0.21[b]
1–2 days	7 (29)	14 (58)	
3–4 days	8 (33)	6 (25)	
5–6 days	6 (25)	2 (8)	
>7 days	3 (13)	2 (8)	
Ethnicity			0.76[b]
Asian and other	1 (4)	3 (13)	
African American	6 (25)	5 (21)	
Hispanic	8 (33)	9 (38)	
White	9 (38)	7 (29)	
Education (enrolled)			
Elementary	5 (21)	7 (29)	0.61[c]
Junior High	6 (25)	8 (33)	
High School	13 (54)	9 (38)	
Parents' marital status			1.00[c]
Single	11 (48)	12 (50)	
Married	10 (42)	10 (42)	
Divorced	3 (13)	2 (8)	
Pet attitude (PAS)	101.04 (10.50)	100.42 (11.79)	0.85[a]

Note. PAS = Pet Attitude Scale, [a] = *p* value for *t*-statistic, [b] = *p* value for Pearson chi-square, [c] = *p* value for Fisher exact test.

of other school-age children who were not hospitalized (Naidoo, Konkol, Biccard, Dudose, & McKune, 2012).

Because the homogeneity of slopes assumption was not met for the 10-PANAS scores, pre- and post-intervention differences in positive and negative affect were compared between conditions with the independent samples *t*-tests. There were no significant differences in pre- and post-intervention positive affect or negative affect scores between the AAA and control condition (Table 2). Table 3 shows the ANCOVA results with parameter estimates for state anxiety (STAI-C), cortisol, and CRP with the respective post-intervention measures as dependent variables; no significant differences were found in pre- and post-intervention measures or between conditions. Baseline levels of state anxiety, cortisol, and CRP had a significant and large effect on the respective post-intervention measures.

Pet Attitude

Pet attitude (PAS scores) were not significantly correlated with the pre- and post-intervention changes in positive affect or negative affect in children who participated in the AAA condition, nor was the PAS score significantly correlated with state anxiety changes (Table 4). Likewise, pet attitude was not significantly correlated with pre- and post-intervention changes in salivary cortisol or CRP levels.

Human-Animal Interaction

The HAIS instrument contains four items that were not consistently available or were not allowed in our hospital setting: "grooming the animal" (item 8), "offering food to the animal" (item 9), "taking pictures of the animal" (item 12), and the dog "accepting food from you" (item 17). After eliminating these four items, the HAIS score range is −24 to 56. Using the adjusted scoring without these four items, participants' scores in our study indicated a high-moderate level of positive human-animal interaction ($M = 33.00$; SD = 6.09). All participants indicated a score of 0 ("not at all") pertaining to negative human behaviors, which included "declining or avoiding interaction with the animal" or "behaving aggressively toward the animal" (items 13 and 14). Also, all participants indicated a score of 0 ("not at all") pertaining to negative animal behaviors, which included the "animal making unfriendly sounds, behaving aggressively toward the participant, causing a mess or inconvenience, or declining or avoiding interaction with the participant" (items 21–24). All participants responded to the question "Did you enjoy interacting with the animal(s) today?" with a score of 4 ("a great deal"). For the question "Did you make an emotional connection with the animal(s)?" one participant recorded one point greater than "not at all" (scored 1), two participants recorded one point greater than "a moderate amount" (scored 3), and three participants recorded "a great deal" (scored 4).

Discussion

In the current study, we tested the effectiveness of an AAA in reducing biobehavioral stress responses in hospitalized pediatric patients using a randomized controlled design with an existing AAA program in a pediatric hospital. Our findings did not support our hypothesis.

Table 2
Differences in pre/post values between AAA and Control groups in positive and negative affect (10 PANAS-C).

	AAA *M* (*SD*) (*N* = 21)	Control *M* (*SD*) (*N* = 24)	*t* Value	*p* Value	95% CI of the difference	
					Lower	Upper
Positive affect	0.76 (3.71)	0.63 (3.35)	−0.13	0.90	−2.26	1.99
Negative affect	−1.90 (4.11)	−1.50 (3.09)	0.38	0.71	−1.77	2.58

Note. 10 PANAS-C = 10-item Positive and Negative Affect Schedule for Children, AAA = animal-assisted activity.

Table 3
ANCOVA between-subjects effects for state anxiety (STAI-C), and salivary cortisol and C-reactive protein (CRP) with the post-measure as the dependent variable.

Source	*F*	Sig.	Partial eta squared	*B*	95% Confidence interval	
					Lower bound	Upper bound
STAI-C (*N* = 24 AAA; *N* = 23 control)						
Corrected Model	12.7	0.00	0.47			
Intercept	1.04	0.31	0.02	8.13	−2.11	18.36
Condition	1.07	0.31	0.02	−8.19	−24.13	7.76
Pre-STAI-C	37.68	0.00	0.47	0.60	0.29	0.91
Cortisol (*N* = 23 AAA; *N* = 24 control)						
Corrected Model	64.90	0.00	0.82			
Intercept	3.90	0.06	0.08	−0.15	−0.32	0.03
Condition	0.29	0.60	0.01	0.06	−0.17	0.30
Pre-cortisol (log10)	190.10	0.00	0.82	0.99	0.77	1.20
CRP (*N* = 23 AAA; *N* = 24 control)						
Corrected Model	161.69	0.00	0.92			
Intercept	2.47	0.12	0.05	0.01	−0.45	0.48
Condition	2.27	0.14	0.05	0.52	−0.18	1.22
Pre-CRP (log10)	469.83	0.00	0.92	0.99	0.88	1.11

Note. STAI-C = State Anxiety Inventory for Children, AAA = animal-assisted activity.

Hospitalized children who received the AAA did not have significantly larger decreases in anxiety, negative affect, cortisol, or CRP levels or larger increases in positive affect than children in the non-AAA control condition. Although there were larger increases in positive affect and larger decreases in negative affect in the AAA condition, the magnitude of the effect was small, and changes were not significantly different from the responses in the control condition. Irrespective of the study condition, children who had higher levels of anxiety and stress biomarkers (i.e., cortisol and CRP) at baseline had larger decreases than children who had lower levels at baseline. In addition, the level of pet attitude was not significantly associated with pre- and post-intervention changes. Regardless of our nonsignificant findings, our pilot test using the HAIS revealed the participants enjoyed the interaction "a great deal," no negative animal or human behaviors were reported, and most children reported a "moderate amount" to "a great deal" of emotional connection with the dog(s).

Our findings partially agree with prior studies demonstrating that AAAs increase positive feelings in hospitalized children. In a study without a control condition, Wu et al. (2002) examined 30 hospitalized children's responses to an AAA and found that the AAA improved self-reported positive feelings (e.g., happy and joyful). We also found an increase in positive affect in the AAA condition, with larger increases in the AAA condition than in the control condition; however, we found no significant differences in pre- and post-intervention positive affect between the AAA and control conditions. In another previous study using a control condition (playing with people), Kaminski et al. (2002) examined a convenience sample of 70 hospitalized children exposed to an AAA and found that children in the AAA condition reported a higher level of positive behavioral affect than the control condition, but like our study, no significant differences were found in cortisol levels between the two conditions. Unlike their study, we experienced no technical difficulties with saliva collection, and only one specimen had insufficient volume for the bioassay. However, we did experience challenges in scheduling to ensure participants did not eat or drink 1 h before the study.

To our knowledge, the current study was the first to investigate the effects of an AAA on CRP responses. No differences in CRP level were found between the two conditions. The high level of CRP at baseline in our participants may reflect inflammatory responses to illness, trauma,

Table 4
Correlation coefficients for pet attitude (PAS) with positive affect and negative affect (10 PANAS-C), state anxiety (STAI-C), salivary cortisol and C-reactive protein in the AAA condition ($N = 24$).

Source	Pre/post-changes in positive affect ($N = 21$)	Pre/post-changes in negative affect ($N = 21$)	Pre/post-changes in state anxiety (STAI-C) ($N = 24$)	Pre/post-changes in cortisol μg/dL (log10) ($N = 23$)	Pre/post-changes in CRP (log 10) ($N = 23$)
Pet attittude (PAS)	−0.047 ($p = 0.76$)	−0.14 ($p = 0.35$)	−0.211 ($p = 0.16$)	−0.109 ($p = 0.47$)	0.20 ($p = 0.18$)

Note. PAS = Pet Attitude Scale, 10 PANAS-C = 10-item Positive and Negative Affect Schedule for Children, STAI-C = State Anxiety Inventory for Children, CRP = C-reactive protein, AAA = animal-assisted activity.

or surgery rather than acute inflammatory changes related to stress. Furthermore, we did not collect anthropometric data; others (Naidoo et al., 2012) found higher salivary CRP levels in obese compared with normal-weight children.

Similar to the results reported by Tsai et al. (2010) and Barker et al. (2015), who examined anxiety responses to AAAs in hospitalized children, the results of our study could be attributed to a flooring effect that reflects the low levels of anxiety and cortisol levels in our sample at baseline. In addition, our biological results had large inter-individual variation, especially CRP, which requires a larger sample size to determine meaningful, if any, differences between conditions. Similar to Barker et al. (2015), we conducted our study in a large academic medical center with a wide variety of specialists and support services, and in a hospital with Magnet designation, which recognizes nursing excellence (ANCC Magnet Recognition Program, 2016). These environmental factors may influence children's anxiety, mood, and stress when hospitalized (Barker et al., 2015).

The strengths of this study include a biobehavioral approach with biological parameters to corroborate self-reports of psychosocial data reflecting the effectiveness of the AAA. In addition, our study used a randomized controlled trial design following the CONSORT guidelines, the most robust method of testing the effectiveness of different treatments, which limits confounding of extraneous factors and limits threats to internal validity to determine treatment effects. We also controlled for the level of pet attitude to reduce confounding and used repeated measures of outcome variables to maximize power. Lastly, we conducted our study under natural situations, with children 7–17 years of age who were pet owners and non-pet owners using an existing AAA program, which broadens the generalizability of our findings.

However, our study had several limitations, including a sample that was too small to determine significance differences in biomarkers, especially CRP which has high inter-individual variability (Ouellet-Morin et al., 2011). At baseline, our sample of hospitalized children reported moderate levels of positive affect and mild levels of negative affect. In addition, our sample had low levels of baseline anxiety and normal levels of cortisol, which suggests a low level of psychologic and biologic stress. Missing data included three 10 PANAS-C questionnaires, one STAI-C questionnaire, and one saliva sample. Many potential subjects were excluded from participation, primarily due to a language barrier (Spanish-speaking parents) for parental consent. Other potential subjects declined to participate for unknown reasons. Additional potential confounding variables include parental or custodial involvement during the study. Parents or custodians were encouraged to stay at the bedside and participate during the AAA or the control condition, and their participation was variable. Another factor that could have affected our study results was the interruption by physicians who rounded on patients and nursing staff who administered medications; the effects, if any, of such interruptions on study outcomes are unknown, but would be expected to affect both groups equally. Another potential limitation is that we used a control condition without a social contact or a live dog as a treatment for stress reduction. An alternative, evidence-based intervention might have been a better control condition; however, the differences in outcome variables would be expected to be smaller with a stronger control condition.

Clinicians and researchers are in a unique position to collaborate and measure the effectiveness of complementary approaches, such as AAAs, in the management of stress and anxiety that optimize immune function among hospitalized pediatric patients. Rigorous approaches with randomized controlled trials are needed to test the effectiveness of AAAs with larger and more diverse samples that generate evidence-based practices in pediatric hospitals. Further investigation with hospitalized children who have higher levels of anxiety/negative affect, limited parental involvement, and fewer hospital resources using rigorous experimental designs is recommended. In addition, the HAIS instrument could be a useful instrument to understand human and animal behaviors in AAA to guide animal training and animal-child interaction protocols. With their holistic view of patients, nurses are positioned to recommend AAA as a beneficial and safe experience for hospitalized children.

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References

American Veterinary Medical Association (AVMA) (2017). Retrieved from https://www.avma.org/KB/Policies/Pages/Animal-Assisted-Interventions-Definitions.aspx.

ANCC (2016). Magnet recognition program. Retrieved from http://www.nursecredentialing.org/Magnet.

Aytekin, A., Doru, Ö., & Kucukoglu, S. (2016). The effects of distraction on preoperative anxiety level in children. *Journal of Perianesthesia Nursing*, *31*(1), 56–62. http://dx.doi.org/10.1016/j.jopan.2014.11.016.

Barker, S., & Dawson, K. (1998). The effects of animal-assisted therapy on anxiety ratings of hospitalized psychiatric patients. *Psychiatric Services*, *49*(6), 797–801. http://dx.doi.org/10.1176/ps.49.6.797.

Barker, S. B., Knisely, J. S., McCain, N. L., & Best, A. M. (2005). Measuring stress and immune response in healthcare professionals following interaction with a therapy dog. *Psychological Reports*, *96*, 713–729. http://dx.doi.org/10.2466/pr0.96.3.713-729.

Barker, S. B., Knisely, J. S., McCain, N. L., Schubert, C. M., & Pandurangi, A. K. (2010). Exploratory study of stress-buffering response patterns from interaction with a therapy dog. *Anthrozoös*, *23*, 79–91. http://dx.doi.org/10.2752/175303710X12627079939341.

Barker, S. B., Knisely, J. S., Schubert, C. M., Green, J. D., & Ameringer, S. (2015). The effect of an animal-assisted intervention on anxiety and pain in hospitalized children. *Anthrozoös*, *28*(1), 101–111. http://dx.doi.org/10.2752/089279315X14129350722091.

Bossert, E. (1994). Stress appraisals of hospitalized school-age children. *Children's Health Care*, *23*, 33–49. http://dx.doi.org/10.1207/s15326888chc2301_3.

Bouchard, F., Landry, M., Belles-Isles, M., & Gagnon, J. (2004). A magical dream: A pilot project in animal-assisted therapy in pediatric oncology. *Canadian Oncology Nursing Journal*, *14*(1), 14–17. http://dx.doi.org/10.5737/1181912x1411417.

Branson, S., Baun, M., Bergstrom, N., Kang, D., & Barker, S. (2014). *Dosage effects of animal-assisted activity on biobehavioral stress responses.* (Unpublished paper).

Byrne, M., O'Brien-Simpson, N. M., Reynolds, E. C., Walsh, K. A., Laughton, K., Waloszek, J. M., ... Allen, N. B. (2013). Acute phase protein and cytokine levels in serum and saliva: A comparison of detectable levels and correlations in depressed and healthy adolescent samples. *Brain, Behavior, and Immunity*, *34*, 164–175. http://dx.doi.org/10.1016/j.bbi.2013.08.010.

Byrne, M. L., Badcock, P. B., Simmons, J. G., Whittle, S., Pettitt, A., Olsson, C. A., ... Allen, N. B. (2016). Self-reported parenting style is associated with children's inflammation and immune activation. *Journal of Family Psychology*, *31*(3), 374–380. http://dx.doi.org/10.1037/fam0000254.

Charnetski, C., Riggers, S., & Brennan, F. (2004). Effect of petting a dog on immune system function. *Psychological Reports*, *95*, 1087–1091. http://dx.doi.org/10.2466/pr0.95.7.1087-1091.

Cheng, J., Zhang, J., Lu, C., & Wang, L. (2012). Using optogenetics to translate the inflammatory dialogue between heart and brain in the context of stress. *Neuroscience Bulletin*, *28*, 435–448. http://dx.doi.org/10.1007/s12264-012-1246-2.

Chur-Hansen, A., McArthur, M., Winefield, H., Hanieh, E., & Hazel, S. (2014). Animal-assisted interventions in children's hospitals: A critical review of the literature. *Anthrozoös*, *27*(1), 5–18. http://dx.doi.org/10.2752/175303714X13837396326251.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cole, K., Gawlinski, A., Steers, N., & Kotlerman, J. (2007). Animal-assisted therapy in patients hospitalized with heart failure. *American Journal of Critical Care*, *16*, 575–585.

Daly, B., & Morton, L. L. (2006). An investigation of human-animal interactions and empathy as related to pet preference, ownership, attachment, and attitudes in children. *Anthrozoös*, *19*(2), 113–127. http://dx.doi.org/10.2752/089279306785593801.

Daniel, M., Moore, D., Decker, S., Belton, L., DeVellis, B., Doolen, A., & Campbell, M. (2006). Associations among education, cortisol rhythm, and BMI in blue-collar women. *Obesity*, *14*(2), 327–335. http://dx.doi.org/10.1038/oby.2006.42.

Eatough, E., Shirtcliff, E., Hanson, J., & Pollak, S. (2009). Hormonal reactivity to MRI scanning in adolescents. *Psychoneuroendocrinology*, *34*(8), 1242–1246. http://dx.doi.org/10.1016/j.psyneuen.2009.03.006.

Ebesutani, C., Regan, J., Smith, A., Reise, S., Higa-McMillan, C., & Chorpita, B. (2012). The 10-item positive and negative affect schedule for children, child and parent versions: Application of item response theory for more efficient assessment. *Journal of Psychopathology and Behavioral Assessment*, *34*, 191–203. http://dx.doi.org/10.1007/s10862-011-9273-2.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. http://dx.doi.org/10.3758/BRM.41.4.1149.

Fournier, A., Berry, T., Letson, E., & Chanen, R. (2016). The human-animal interaction scale: Development and evaluation. *Anthrozoös*, *29*(3), 455–467. http://dx.doi.org/10.1080/08927936.2016.1181372.

Goodson, J. M., Kantarci, A., Hartman, M. L., Denis, G. V., Stephens, D., Hasturk, H., ... Welty, F. (2014). Metabolic disease risk in children by salivary biomarker analysis. *PloS One*, *9*, e98799. http://dx.doi.org/10.1371/journal.pone.0098799.

Hamer, M., Williams, E., Vuonovirta, R., Giacobazzi, P., Gibson, E. L., & Steptoe, A. (2006). The effects of effort-reward imbalance on inflammatory and cardiovascular responses to mental stress. *Psychosomatic Medicine*, *68*, 408–413. http://dx.doi.org/10.1097/01.psy.0000221227.02975.a0.

Jalalodini, A., Nourian, M., Saatchi, K., Kavousi, A., & Ghaljeh, M. (2016). The effectivenss of slow-stroke back massage on hospitalization anxiety and physiological parameters in school-age children: A randomized clinical trial study. *Iranian Red Crescent Medical Journal*, *18*(11), e36567. http://dx.doi.org/10.5812/ircmj.36567.

Kaminski, M., Pellino, T., & Wish, J. (2002). Play and pets: The physical and emotional impact of child-life and pet therapy on hospitalized children. *Children's Health Care*, *31*(4), 321–335. http://dx.doi.org/10.1207/S15326888CHC3104_5.

Kang, D., Rice, M., Park, N., Turner-Henson, A., & Downs, C. (2010). Stress and inflammation: A biobehavioral approach for nursing research. *Western Journal of Nursing Research*, *32*(6), 730–760. http://dx.doi.org/10.1177/0193945909356556.

Kiliś-Pstrusińskaa, K., Medyńskaa, A., Adamczakb, P., Bałasz-Chmielewskac, I., Grendad, R., Kluska-Jóźwiake, A., ... Zwolińskaa, D. (2013). Anxiety in children and adolescents with chronic kidney disease – Multicenter National Study Results. *Kidney & Blood Pressure Research*, *37*(6), 579–587. http://dx.doi.org/10.1159/000355738.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer Publishing.

McEwen, B. S. (2003). Interacting mediators of allostasis and allostatic load: Towards an understanding of resilience in aging. *Metabolism*, *52*(10 Suppl. 2), 10–16. http://dx.doi.org/10.1016/s0026-0495(03)00295-6.

Morovati, D. R., Steinberg, A. L., Taylor, L. C., & Lee, H. B. (2008). Further validation evidence for the pet attitude scale. *North American Journal of Psychology*, *10*(3), 543 (Retrieved from http://go.galegroup.com.ezproxyhost.library.tmc.edu/ps/i.do?p=HRCA&u=txshracd2509&id=GALE|A191856976&v=2.1&it=r&sid=summon).

Naidoo, T., Konkol, K., Biccard, B., Dudose, K., & McKune, A. J. (2012). Elevated salivary C-reactive protein predicted by low cardio-respiratory fitness and being overweight in African children. *Cardiovascular Journal of Africa*, *23*(9), 501–506.

Nepps, P., Stewart, C. N., & Bruckno, S. R. (2014). Animal-assisted activity: Effects of a complementary intervention program on psychological and physiological variables. *Journal of Evidence-Based Complimentary & Alternative Medicine*, *19*(3), 211–215. http://dx.doi.org/10.1177/2156587214533570.

Orlandi, M., Trangeled, K., Mambrini, A., Tagliani, M., Ferrarini, A., Zanetti, L., & Cantore, M. (2007). Pet therapy effects on oncological day hospital patients undergoing chemotherapy treatment. *Anticancer Research*, *27*, 4301–4304.

Ouellet-Morin, I., Danese, A., Williams, B., & Arseneault, L. (2011). Validation of a high-sensitivity assay for C-reactive protein in human saliva. *Brain, Behavior, and Immunity*, *25*, 640–646. http://dx.doi.org/10.1016/j.bbi.2010.12.020.

Salimetrics (2016, November). Retrieved from https://www.salimetrics.com/assay-kits.

Schneiderman, N., Ironson, G., & Siegel, S. (2005). Stress and health: Psychological, behavioral, and biological determinants. *Annual Review of Clinical Psychology*, *1*, 607–628. http://dx.doi.org/10.1146/annurev.clinpsy.1.102803.144141.

Selye, H. (1974). *Stress without distress*. New York: Signet.

Society for Companion Animal Studies (SCAS) (2013). Retrieved from http://www.scas.org.uk/animal-assisted-interventions/174-2/.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute-psychological stress on circulating inflammatory factors in humans: A review and meta-analysis. *Brain, Behavior, and Immunity*, *21*, 901–912. http://dx.doi.org/10.1016/j.bbi.2007.03.011.

Stoffel, J., & Braun, C. (2006). Animal-assisted therapy: Analysis of patient testimonials. *Journal of Undergraduate Scholarship*, *8* (Retrieved from http://juns.nursing.arizona.edu/articles/Fall%202006/stoffel.htm).

Tarbell, S., Millar, A., Laudenslager, M., Palmer, C., & Fortunato, J. (2017). Anxiety and physiological responses to the trier social stress test for children in adolescents with cyclic vomiting syndrome. *Autonomic Neuroscience: Basic and Clinical*, *202*, 79–85.

Templer, D. I., Salter, C., Dickey, S., Baldwin, R., & Veleber, D. M. (1981, Summer). The construction of a pet attitude scale. *Psychological Record*, *31*(3), 343–348.

Tiedeman, M. E., & Clatworthy, S. (1990). Anxiety response of 5 to 11 year old children during and after hospitalization. *Journal of Pediatric Nursing*, *5*, 334–343.

Tsai, C., Friedmann, E., & Thomas, S. A. (2010). The effect of animal-assisted therapy on stress responses in hospitalized children. *Anthrozoös*, *23*(3), 245–258. http://dx.doi.org/10.2752/175303710X12750451258977.

Wu, A., Niedra, R., Pendergrast, L., & McCrindle, B. (2002). Acceptability and impact of pet visitation on a pediatric cardiology inpatient unit. *Journal of Pediatric Nursing*, *5*, 354–362. http://dx.doi.org/10.1053/jpdn.2002.127173.