THE UNIVERSITY of EDINBURGH

Edinburgh Research Explorer

Are pressure vests beneficial at reducing stress in anxious and fearful dogs?

Citation for published version:
Buckley, L 2018, 'Are pressure vests beneficial at reducing stress in anxious and fearful dogs?', *Veterinary Evidence*. https://doi.org/10.18849/ve.v3i1.152

Digital Object Identifier (DOI):
10.18849/ve.v3i1.152

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Publisher's PDF, also known as Version of record

Published In:
Veterinary Evidence

General rights
Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

OPEN ACCESS

Download date: 20. Apr. 2024

Are Pressure Vests Beneficial at Reducing Stress in Anxious and Fearful Dogs?

A Knowledge Summary by

Louise Anne Buckley PhD, RVN *

* Corresponding Author (louisebuckleydyson@msn.com)

ISSN: **2396-9776**
Published: **02 Mar 2018**
in: **Vol 3, Issue 1**
DOI: http://dx.doi.org/10.18849/ve.v3i1.152
Reviewed by: **Sue Badger (MEd, Cert Ed, RVN) and Erik Fausak (MSLIS, MA, CVT, LVT, RLAT)**
Next Review Date: **02 Sep 2020**

PICO question

In fearful or anxious dogs does wearing a pressure vest, compared to not wearing one, result in reduced behavioural and physiological signs of stress?

Clinical bottom line

Four studies of variable quality and limitations were identified that investigated the use of pressure vests, using various physiological and behavioural proxy measures of anxiety. Most behavioural outcome measures associated with a positive effect were subjective assessments, with unblinded assessors. Subjectively, many of the owners believed that pressure vests had a positive effect on their dogs' anxiety levels.

The take home message for the veterinary professional is that pressure vests may have small but beneficial effects on canine anxiety and that habituating the dog to the vest, assessing for comfort and using repeatedly may improve the likelihood of any benefit. However, the owner should be cautioned that they should not expect their dog's anxiety to be fully alleviated or prevented, and it may have no beneficial effect at all.

Clinical Scenario

During veterinary nursing clinics, the veterinary nurse encounters dogs that the owners describe as being fearful, anxious or stressed in a range of situations (e.g. separation anxiety, noise phobia, etc). Aware that there is a plethora of products available on the market aimed at reducing negative emotional states in dogs, she is keen to ensure that she only recommends products to these clients when there is evidence to support their use. A couple of clients have mentioned the use of pressure vests and have suggested that the veterinary practice stock them for use with other clients, therefore she decides to examine the evidence base for these products.

The Evidence

Three studies were identified (Cottam et al., 2013; King et al., 2014; Pekkin et al., 2016) that specifically aimed to test the efficacy of commercially available pressure vests at reducing indices of stress in canines. Of these, only one (Pekkin et al., 2016) reported measuring and standardising the pressure exerted by the vests, the other two papers reported fitting (or asking owners to fit) the vests firmly in accordance with the manufacturers' instructions. On this basis, a fourth paper (Fish et al., 2017) that looked at the effect of fitting a telemetry vest (the authors report snuggly fitting these spandex vests) on physiological and behavioural parameters of dogs exposed to a stressor was also included. A fifth paper (Cottam and Dodman, 2009) was identified that also used an item of torso clothing (a cape) to use reduce stress in dogs naturalistically exposed to thunderstorms. However, this study was devised to examine the effects of an anti-static lining, and both the control and the experimental dogs wore capes (both of which reduced the anxiety levels of dogs exposed to thunderstorms). Furthermore, the authors do not report fitting the cape firmly (or any other adjective to indicate that the cape exerted pressure on the torso). Thus, this paper was not included in the evidence summary.

Summary of the evidence

Cottam (2013)	
Population:	Healthy, house-trained dogs fearful of thunderstorms and living in one of 11 American states known for having frequent thunderstorms and whose owners responded to an advert in the Vet School newsletter. Dogs had to meet the inclusion criteria to be designated 'thunderstorm wary' and not currently be on any pharmacological treatment for this fear. Inclusion criteria (based on owner self-reporting): 1. Dogs had to show anxiety during thunderstorms at least 85% of the time. 2. During thunderstorms, dogs had to show three (or more) of the following signs of anxiety: - Panting - Shaking - Escape attempts or damage property - Inappropriate elimination - Pacing - Attention seeking - Whining - Inappetence - Salivation - Hiding
Sample size:	32 dogs started the study, but only 18 dogs could be used for the Thunderstorm Anxiety Score analysis, and only 19 dogs could be used to answer the overall effectiveness of the Anxiety Wrap analysis. Further details. 32 dogs started the study. This reduced to 26 at the end of the baseline phase. This reduced to 21 dogs by the end of the experimental phase, but not all these provided enough material to be used in all analyses. Drop-outs were defined based upon completed surveys at the end of each stage. No explanation is given for the drop outs at the end of the baseline phase. Of the five owners who did not complete the survey at the end of the experimental phase, the reasons were as follows (one dog per reason): risk of aggression during fitting vest, medical illness, no reason, failed to return form, and vest the wrong size. Of the 21 remaining dogs, three failed to complete surveys for five thunderstorm episodes during the experimental phase (reduced to 18 for the related analysis). For the overall effectiveness score, owners of dogs that had experienced three or more thunderstorms while wearing the Anxiety Wrap were eligible to be included. This reduced the sample from 21 to 20. A further owner failed to provide

	an overall effectiveness score, reducing the sample for this section to 19.
Intervention details:	The intervention evaluated for efficacy at reducing anxiety during thunderstorms was the commercially available Anxiety Wrap (Animals Plus LLC, Huntington, IN), and animals were used as their own control in a before treatment/during treatment clinical trial. **Study design:** The clinical trial was divided into two phases: 1. Baseline phase (control/no treatment during two thunderstorms) 2. Treatment phase (experimental phase/pressure vest worn during five thunderstorms) Owners completed a questionnaire after each thunderstorm, that asked the owner to provide the following information: a) The existence and severity of specific anxiety behaviours (except escape/damage) listed in the inclusion criteria. b) Interactions with their dog during the thunderstorm c) Severity of the thunderstorm Owners of dogs included were requested to discontinue (for the duration of the study) any other treatments they currently used for the treatment or management of thunderstorm fear. **Post-trial:** Owners were asked to complete a survey that assessed how effective they felt the Anxiety Wrap was at reducing their dog's thunderstorm phobia. Further information: **Sample selection:** The first 32 dogs whose owners responded to the newsletter advert and who met the inclusion criteria were included in this study. **Exposure to the Anxiety Wrap:** Owners were provided with an Anxiety Wrap given directions on how to fit and remove it and instructed to fit it during thunderstorms. They were also asked to practice fitting it once before a thunderstorm (and to associate its fitting with a reward for the dog) and three times during non-stormy days (to prevent the dog associating the vest with thunderstorms).
Study design:	Clinical trial
Outcome studied:	The main three outcome measures relevant to answering this PICO were: 1. Thunderstorm Anxiety Score

	2. Presence (yes/no) of the nine individual anxiety behaviours exhibited by the dogs during thunderstorms. 3. Owner's subjective assessment of the overall effectiveness of the Anxiety Wrap at reducing anxiety during thunderstorms (scored as: 0%, 1 – 24%, 25 – 49%, 50 – 74%, 75 – 100% effective). The Thunderstorm Anxiety Score was generated from the nine inclusion criteria behavior (except escape/damage). For each storm, owners had to report whether the dog showed the specific behavior (yes / no?). If yes, the owner was asked additional question(s) about the intensity/frequency/duration of the behavior (varied according to behavior). This was done to assess anxiety severity and a score (maximum 5 per behavior, 45 if all behaviours exhibited at maximum severity) awarded. As not all dogs showed all behaviours, the authors converted the resultant score into a ratio based upon the number of points awarded for behavior severity, divided by the maximum number of points it could have obtained given the behaviours shown: i.e. the actual score divided by (5 multiplied by the number of behaviours for which the owner answered "yes" the dog displayed this behavior during the thunderstorm) = the standardised ratio score. Thunderstorm severity was also analysed to look for interactions between Thunderstorm Anxiety Score and thunderstorm severity (e.g. do dogs show more severe levels of Thunderstorm Anxiety Score when thunderstorms are particularly bad?)
Main findings: **(relevant to PICO question):**	Thunderstorm Anxiety Score: - No significant differences were found between baseline thunderstorm 1 and 2 - There was no significant effect of thunderstorm severity on baseline Thunderstorm Anxiety Score. - A significant difference ($F_{5,102} = 3.99$, $P = 0.002$) was found between the mean baseline Thunderstorm Anxiety Score and the thunderstorms during which an Anxiety Wrap was worn (experimental Thunderstorm Anxiety Score). - Post-hoc testing indicated that the treatment Thunderstorm Anxiety Score was significantly lower than the baseline Thunderstorm Anxiety Score for thunderstorms 4 and 5 (both $P = 0.003$). - However, numerically, the mean ratio treatment Thunderstorm Anxiety Score was lower than the baseline Thunderstorm Anxiety Score for all five thunderstorms.

	Individual anxiety signs:
	- Baseline thunderstorm 1 versus treatment thunderstorm 5 (treatment phase):
	  o No significant differences were observed in the presence of any of the nine anxiety signs.
	  o There was a tendency for shaking (P = 0.08) , pacing (P = 0.07) and salivation (P = 0.07) to be different, but the authors do not report the direction of the effect.
	- Baseline thunderstorm 2 versus treatment thunderstorm 5 (treatment phase):
	  o The percentage of dogs that exhibited shaking (P = 0.03) and pacing (P = 0.03) behaviour during the thunderstorm was 33% lower in thunderstorm 5.
	  o No other behaviours showed a significant difference or a tendency to be different.
	- The authors did not compare behaviours between baseline and treatment thunderstorms 1 – 4.
	
	Overall effectiveness:
	- Significantly more owners (n = 17) rated the Anxiety Wrap as effective, than those who said it was not effective (n = 2) (χ^2= 11.842, P = 0.001).
	- The overall level of effectiveness at reducing thunderstorm anxiety reported by the owners who used the Anxiety Wrap on three or more thunderstorms was:
	  o 1 – 24% effective: n = 2
	  o 25 – 49% effective: n = 3
	  o 50 – 74% effective: n = 7
	  o 75 – 100% effective: n = 5
	- Eighty percent of owners said they would continue to use the Anxiety Wrap now the study had finished.

Limitations:	- The study was supported financially by the manufacturers of the Anxiety Wrap. - The owners were directed to fit the vest in accordance with the manufacturer's directions but no attempt was made to quantify what level of pressure this exerted or to ensure this was standardised between dogs. - There was a high drop-out rate plus additional individuals that, while not classified as a drop-out, nevertheless failed to provide enough information to be included in at least one of the analyses. If this was influenced by perceived product efficacy, then it will have introduced bias into the data set. - The study relied entirely on owner reporting of clinical signs. Owners not blinded to treatment. High risk of placebo effect/bias. - The authors rely heavily on the results of THUNDERSTORM ANXIETY SCORE. This is an un-

	validated method for assessing canine anxiety during a thunderstorm. - The analysis and reporting of the individual behaviours could be improved. It is not clear why the authors chose to analyse each baseline measurement separately (instead of the mean of both), but this meant that 18 tests needed to be performed. No allowance has been made for this statistically (e.g. by applying a Bonferroni correction). - The authors report that for the two behaviours that were significantly reduced between baseline 2 and treatment thunderstorm 5, that there was a 33% reduction in owners reporting each of these two behaviours, but it is not clear how much of a reduction this represents in numerical terms (i.e. how many owners/dogs stopped seeing these signs?). - Some of the discussion does not match up with the tables that the text signposts the reader towards.
King (2014)	
Population:	Anxious juvenile and adult (i.e. > 6 months) pet dogs with no other health problems. To qualify as "anxious" dogs needed to be diagnosed by a veterinarian or animal behaviourist as having one of the following conditions: - Separation Anxiety (SA) - Generalised Anxiety Condition (GAC) No breed restrictions were in place and the dogs used were a variety of sizes and breeds or crossbreeds. Some dogs were on anti-anxiety medications at the time of the study.
Sample size:	Total number of dogs used: 90 (SA: n = 50; GAC: n = 40), with 30 dogs per treatment group.
Intervention details:	The intervention that was evaluated for efficacy was the Thundershirt® (a commercially available pressure vest). Dogs were randomly allocated to one of three treatment groups (all n = 30): 1. Control group (no pressure vest worn) 2. Snug fit vest (pressure vest worn and fitted snugly, as per the manufacturer's instructions) 3. Loose fit vest (pressure vest worn and fitted very loosely so that it exerted no pressure) All dogs also wore a heart rate monitor strapped over their chest. Experimental design: - Dogs were fitted with the equipment (Heart rate monitor ±

	the pressure vest) - A 1-minute baseline heart rate was recorded - The dog was put into a walk-in kennel (1.2m x 3m) and kept in this kennel for 15 minutes - While the dog was in the kennel their behaviour was video recorded for later analysis - Immediately after putting the dog into the kennel, owner and experimenter left the room and monitored the dog's response remotely - Each dog was tested individually and the kennel cleaned before the next dog was tested. The outcome measures studied (heart rate and behaviour) are detailed below. - Heart rate was measured non – invasively and remotely using a heart rate monitor. - Behaviour was video recorded and each video watched independently by two researchers. The researchers were not blinded to the treatment received. Observations recorded by each were assessed for inter-observer agreement and correlations between the behaviour assessments were good for most parameters ($r_{average}$ = 0.99) (exception: licking, r = 0.64).
Study design:	Randomised controlled trial
Outcome studied:	1. Heart rate (average heart rate and maximum heart rate) - Baseline (before entering kennel) - Experimental (during the 15 minutes housed in kennel) 2. Behavioural signs of anxiety (pacing, panting, yawning, tongue-flicking, drooling, elimination, barking, stress-whining, howling, licking, orientation towards door) or non-anxiety (calm presentation)
Main findings: **(relevant to PICO question):**	Average heart rate: - There was a significant interaction ($F_{2, 1618.93}$ = 8.53, P < 0.01) between time (change in HR between baseline measurement and HR averaged over the 15-minute period of kenneling) and treatment group. - Post-hoc, pairwise comparisons indicated that the change in HR over time of snug fit vest dogs differed from both control groups (P = 0.022) and loose fit vest dogs (P = 0.001). - Snug fit dogs showed a decrease in HR over time; the other two groups showed an increase in average heart rate. - Removal of the dogs on anxiety medication (New treatment group sample sizes: Control: n =27; Snug fit: n = 21; Loose fit: n = 25), and re-analysis of the remaining data found the same direction of effect, with snug fit dogs differing from

	both control dogs (P < 0.001) and loose fit dogs (P < 0.001). Maximum heart rate: - Significant differences in increase in maximum heart rate (from baseline) were found between groups ($F_{2,86}$= 4.51, P = 0.01). Post-hoc testing indicated that snug fit dogs had a lower maximum heart rate increase than loose fit dogs (P = 0.02); but neither experimental group differed significantly from control dogs. - The author's report removal of the dogs on anxiety medication (Numbers removed from each group: Control: n =3; Snug fit: n = 9; Loose fit: n = 5), and re-analysis of the remaining data but they then describe this data in terms of average heart rate (despite starting off describing the analysis in terms of maximum heart rate). Therefore, it is not clear what they are reporting here (average or maximum) and so it is not reported here. Behavioural signs of anxiety: - The only behavioural parameter that was significantly different (P = 0.02) between groups was orientation towards the kennel door. Ninety percent of control dogs orientated towards the door, whereas only 53% of snug fit vest dogs and 67% of loose fit vest dogs did. - The authors report that the dogs in the snug fit vest group showed a statistical tendency to show less yawning and tongue flicking compared to the other two treatment groups but the statistical handling of this data is problematic (see limitations).
Limitations:	- The authors report a statistical tendency for dogs in the snug fit vest group to show less yawning and tongue flicking. However, this claim is based upon a Kruskal Wallis test which indicates that a significant difference exists between the medians of at one least of the treatment pairs (but not one(s)). The authors do not undertake post-hoc testing. - Despite reporting, this behavioural data was often highly skewed, they present this data using means and standard deviations which conceals the true spread of values. - The owners were directed to fit the vest in accordance with the manufacturer's directions (snug fit dogs only) but no attempt was made to quantify what level of pressure this exerted or to ensure this was standardised between dogs. - Two types of anxiety condition were accepted under the inclusion criteria, but no attempt was made to undertake a randomised block design in which each condition was equally/near equally distributed across the three treatment conditions. - Observers were not blinded to treatment. - Dogs were not habituated to vest wearing before the study. The baseline heart rate measurement was recorded after the pressure vest was fitted, and both loose and snug fit

	groups had a mean baseline heart rate that was numerically higher (the authors do not report analysing baseline group differences) than the control group, suggesting that the vest was initially anxiety-inducing.
Pekkin (2016)	
Population:	Finnish-based adult dogs (various breeds, both genders and either neuter status) known to usually (60 – 100% of occasions) react fearfully to fireworks. Firework fear was assessed using a validated questionnaire (Tiira & Lohi, 2014) that had a good test-retest reliability when assessing noise-related fears. The questionnaire was completed by the dogs' owners. The questionnaire provided the authors with a measure of the dogs' noise reactivity, noise fear frequency, and general fearfulness. Exclusion criteria: fear towards strange people or situations, bitches in season, dogs using regular medication (other than non-steroid anti-inflammatories).
Sample size:	28 dogs were recruited to the study. A full set of data was not collected for each dog. For the oxytocin analysis, two urine samples were obtained from 24 of the dogs. For the cortisol analysis, four saliva samples were obtained from 20 dogs. For the behavioural analysis, 25 dogs participated in all tests.
Intervention details:	The intervention that was evaluated for efficacy was the Lymed Animal™ Supporting Garments (a commercially available pressure vest). There were three treatment groups, with each dog planned to experience each of the treatments. The three treatment groups were: 1. Control (no pressure vest fitted) 2. Light pressure (pressure vest fitted lightly, exerting a pressure on the dog of approximately 2 – 3mmHg) 3. Deep pressure (pressure vest fitted firmly, as per the manufacturers' recommendations, and exerting a pressure on the dog of approximately 10 – 12mmHg) Dogs were semi-randomly allocated (balanced for gender) to one of three groups, with each group experiencing the three treatments in a different order. The study was divided into three main sections:

	1. Urine sampling (to measure oxytocin), vest fitting, and experimental enclosure habituation 2. Three episodes (one per treatment) of exposure to noise in the experimental enclosure, behavioural data collection, and saliva sampling (to measure cortisol) 3. Post-study owner self-reporting of deep pressure vest efficacy in the home environment Further details of each phase are below: First section: The dog (and owner) are given 30 minutes to habituate to the experimental room before a urine sample is taken. A pressure vest is then fitted, and a 30-minute habituation period allowed before a second urine sample is taken. The vest is then removed. Second section: This section is repeated three times (one per treatment), a minimum of one week apart. A saliva sample is taken and then the dog has a vest is fitted / handled as if one was being fitted (dependent upon treatment phase). The dog and owner (separated from dog) then wait in the test arena for 20 minutes before a second saliva sample is taken. Video recording then commences (no experimenter present) for six minutes to identify the dog's behavior under the following conditions: - First 2mins: No noise. - 2 – 4 mins: Fireworks noise (track from Sounds Scary CD, Sound Therapy for Dogs, 4 Pets, UK) played at 70 – 73dB. - 4 – 6 mins: No noise. Third and fourth saliva samples are taken after a further 18 and 38 minutes respectively. A person that was blind to both the study aims and treatment then watched the videos and recorded the dogs' behaviour using the ethogram provided (see outcome measures). Third section: The owner was sent two follow up questionnaires (one two months after the study finished, one just after New Year's Eve) that asked about vest use and perceived efficacy generally or specifically on New Year's Eve.
Study design:	Randomised controlled trial
Outcome studied:	The outcome measures studied that were relevant to addressing the PICO included: Physiological:

	1. Urinary oxytocin levels 2. Saliva cortisol levels Behavioural: 1. Body positions 2. Lying 3. Sitting 4. Standing 5. Motor activity – fence manipulation 6. Tail position 7. Location 8. Location in arena (divided into grids) 9. Location in relation to a table (under table? Yes / no) 10. Vocalisation 11. Oral behaviours 12. Lick nose or lips 13. Pant 14. Other – trembling Owner self – reporting (survey data): 1. Did the owners use the vest during daily life? 2. Did the owners use the vest on their dog on New Year's Eve? 3. Did they think it was useful for their dog?
Main findings: **(relevant to PICO question):**	Selected findings (directly relevant to the PICO): Physiological: 1. Oxytocin: - There was no significant effect of wearing a deep pressure vest on urinary oxytocin levels. 2. Cortisol: - There was no significant effect of treatment on saliva cortisol levels. However, saliva cortisol levels were significantly higher 20 minutes after the fireworks CD finished playing (cortisol sample 3), than immediately before the noise test (cortisol sample 2), or after a 40-minute recovery period (cortisol sample 4). Behavioural: - Dogs spent less time lying down during the two-minute period during which the fire work noise was being played when they were wearing the deep pressure vest, compared to when they were wearing no vest (control) ($P < 0.03$). The median (interquartile range) seconds spent lying down was: deep pressure: 0.0 (66.9); light pressure: 12.7 (110.1); control: 39.0 (209.0). - There was a positive correlation between duration of time

	spent lying down and general fearfulness (P < 0.05) and noise fear frequency (P < 0.05). - No other behavioural treatment effects were identified (P > 0.05). Owner reports: - Of the 28 owners who completed the first post-study survey, 17 had used the pressure vest at home. Of these, 14 reported that its use had mainly positive effects, and three were neutral. - Of the 26 owners who completed the second post-study survey (regarding its use on New Year's Eve), 20 dogs had worn the vest on New Year's Eve. Of these, 16 reported positive effects, and four were neutral about its use.
Limitations:	- Authors report semi-randomly allocating dogs to the order of treatment, but do not report what they mean by 'semi' or how this was achieved. - Only 25 dogs took part in all three treatments. However, the authors report using all 28 dogs in the analysis. This may have introduced bias into the study. They fail to report in sufficient detail which dogs dropped out, at what stage, and which treatment(s) they had completed (i.e. were included in the statistical analysis) and which they hadn't. - Behavioural outcome measures were often proxy measures that do not necessarily measure anxiety. - Exposure to the firework stimulus acted as a very short acute stimulus and may not represent the normal conditions under which a dog is exposed to noise stressors like fireworks. - The study reports that the observer was blinded to treatments but it is not clear how that blinding was achieved (e.g. were the vest images pixelated? Did the authors mean blinded to when the audio-recording was being played?). - The study was supported financially by the manufacturer of the pressure vest used in the study.
Fish (2017)	
Population:	Adult, male and female field-trial-bred Labrador Retrievers purchased by a military training facility and kennel housed at the research facility that carried out this study. Dogs had been used in previous studies, including one using telemetry vests and one utilizing the Open-field Test (OFT).
Sample size:	16 dogs (8 per treatment group)
Intervention details:	The intervention was the wearing of a telemetry vest during testing within the OFT. Two treatment groups: 1. Vest (n = 8)

	2. No Vest (n = 8) Each dog was given three OFTs, held on three consecutive days, and each of nine minutes duration. During tests one and three, dogs were exposed to no auditory stimuli while in the OFT area. During test two, dogs were exposed to a thunderstorm audio recording during the middle three minutes of the nine-minute test. Dogs were filmed during the OFT for later anxiety scoring using one partially-blinded, trained observer (blind to thunderstorm stimulus occurrence, not blind to vest wearing). Immediately prior to each OFT, a telemetry vest was fitted to each dog, and the dog's heart rate and temperature were then manually recorded. The vest was then left on (Vest dogs) or removed (No Vest dogs) for the OFT. Immediately after the OFT, the dog's heart rate and temperature were manually recorded again. Further detail: The spandex vest was standardised for pressure by fitting the vest to each dog tight enough to only allow two fingers to be inserted under the vest. Dogs were allocated to treatment group using a randomised match-pairs design. They were pair ranked (lowest to highest value) according to their Global Anxiety Score (obtained in a previous study, Gruen *et al.* 2015), and then the first of each pair member randomly allocated to either the Vest or No Vest group, and the remaining pair member allocated to the alternative group.
Study design:	Randomised controlled trial
Outcome studied:	Outcomes relevant to addressing the PICO included: Physiological data: **1.** Heart rate (beats per minute, bpm) **2.** Rectal temperature (centigrade, ˚C) were recorded immediately after fitting the vest (both treatment groups, just before entering the OFT arena) and immediately after the nine-minute OFT. Behavioural data: **1.** Mean Anxiety Score during each three-minute period of the OFT. Anxiety assessment was subjective and based on a subjective qualitative ordinal scale (1 – 6, 1 = no anxiety behaviours observed, 6 = severe anxiety observed most of the time). Dogs were initially scored separately for negative/passive anxiety (e.g. freezing, hiding, etc) and positive/active anxiety

	(e.g. escape attempts, bolting, etc). The mean of these two scores was used in the analysis.
Main findings: **(relevant to PICO question):**	Findings relevant to the PICO: Physiological data: 1. Heart rate: - On OFT days (pooled data from the three days), Vest dogs had significantly (F = 11.7, P = 0.0009) lower heart rates than No Vest dogs. The mean (standard error of the mean, s.e.m.) was: Vest dogs: 95.5 (± 1.5 bpm); No Vest dogs: 103.9 (± 2.0 bpm). 2. Rectal temperature: - On OFT days (pooled data), mean rectal temperature did not differ between Vest dogs and No Vest dogs. The mean (s.e.m.) temperature was: Vest dogs: 39.1 (± 0.1˚C); No Vest dogs: 39.0 (± 0.2˚C). Behavioural data: 1. Mean Anxiety Score: - On OFT days (pooled data), the MAS of Vest dogs was significantly (F = 0.241.3, P = 0.0031) lower than No Vest dogs. The overall (mean, ± s.e.m.) MAS was: Vest dogs: 1.9 ± 0.4; No Vest dogs: 2.9 ± 0.4 (T = - 1.80, P = 0.0471). - There was a statistically significant (no test statistic reported, P < 0.05) difference between Vest and No Vest dogs in terms of the change in MAS between the pre-phase and the during-phase of day 2. Vest dogs had a 40% lower MAS during the thunderstorm stimulus than No Vest dogs.
Limitations:	- The most severe limitation is the reporting that heart rate was higher in No Vest dogs, but the pre-OFT heart rate was taken while both Vest and No Vest dogs were wearing the vest (i.e. dogs were being treated identically at this point). The authors do not report accounting for this issue in their data handling (e.g. by only using post OFT heart rate data). - Pairwise comparisons were performed using a one-tailed Student t-test. The authors report adopting this approach because of their directional hypothesis, but it is possible that Vest wearing could have had the opposite effect and this would also be clinically relevant to the study's aim. The analysis and reporting would have been more robust if a two-tailed approach had been taken. If it had been adopted, the overall mean MAS would not have been significant as the P value would have been P = 0.0942. - Some data reporting is not precise enough to allow the reader to determine how the data was handled/being reported. For example, what does "overall" MAS mean? How was it determined? - The authors report using data pooled from the three days for some of the statistical analyses, but they do not report how this data was pooled or the rationale for this. - It was a very small sample size (n = 8 per treatment) and the

	authors do not report using a power calculation to determine the appropriate sample size.
	- The population of dogs studied was not like the pet dog demographic that pressure vests might be recommended for.
	  ○ These were not pet dogs raised and living in a pet environment.
	  ○ Only one breed of dog was used in the study.
	  ○ Dogs were not selected for the study based on known anxiety/fear towards thunderstorms (the stressor applied) or exceeding a more general threshold for anxiety.
	  ○ These were not particularly anxious dogs. The Global Anxiety Score (GAS) ranged from 1 – 6. The mean (s.e.m.) GAS was: Vest dogs: 1.16 (± 0.30); No Vest dogs: 1.36 (± 0.33).
	- It is not clear how the authors obtained baseline GAS scores (used for treatment allocation) of < 1.0, as these were obtained from a previous study (Gruen, *et al*. 2015) that assessed anxiety levels using the same ordinal scale reported in the current study (with values ranging from 1 – 6).
	- The purpose of this study was not specifically to look at the role of pressure vests in reducing anxiety in dogs.
	- Observers were only partially blinded to which treatment the dogs were receiving. They could not hear the auditory stimuli but could see which dogs were wearing vests.

Appraisal, application and reflection

In terms of external relevance, of the studies that were included, three of the papers (Cottam et al., 2013; Pekkin et al., 2016; Fish et al., 2017) used noise stressors (thunderstorm, firework or thunderstorm sound recordings respectively) to induce an anxiety or fear response. The stressors have external relevance as thunderstorms, fireworks and separation-related stress are all stressors that clients will frequently approach veterinary professionals to seek assistance with the management or treatment of their dog's negative response towards. However, whilst the Cottam et al. (2013) study used field data based on known thunderstorm-fearful dogs' responses to actual thunderstorms whilst in their home environment, the other studies used study designs that may have reduced the applicability of the study findings in a real-life scenario. The three studies investigating commercially available pressure vests all selected pet dogs drawn from a population of dogs known to be fearful or anxious of either the sound stressor used in the study (Cottam et al., 2013; Pekkin et al., 2016) or of having separation anxiety or a generalised anxiety disorder relevant to triggering anxiety under the isolation kennel facilities (King et al., 2014). Thus, applicability to client-owned dogs is likely to be good from this perspective. The Fish et al. (2017) study was more problematic in this respect. These were kennelled dogs, drawn from military working dogs and housed under research conditions. Although the dogs were scored using a global anxiety score (scores carried over from a previous study, Gruen et al., 2015) this was undertaken to allocate dogs evenly across treatment groups, and being anxious (either specifically in response to thunderstorms or more generally) was not part of any inclusion criteria. Although dogs *per se* will clearly all experience fear and anxiety at some point (and the data in this study indicates that these dogs did show an increase in their anxiety score during testing compared with the mean global anxiety

score), clients seeking assistance or advice may be disproportionately drawn from dogs known to be fearful or anxious (or, more severely so) in the presence of a given stressor. Thus, the dogs studied in this study may differ from those we wish to apply any findings too and this should be borne in mind.

In terms of internal validity, each of the studies had its merits and limitations. The Cottam et al. (2013) study was a field-based, clearly client-relevant, commercially funded study that relied heavily on owner reporting of behaviour. The authors reported that the use of a pressure vest, compared with baseline measurements, was associated with a numerical reduction on the anxiety scores during all thunderstorms in the treatment phase. However, only during treatment thunderstorms 4 and 5, was the mean anxiety score sufficiently lower than the baseline anxiety score for any potential difference to be significant. This downward trend in anxiety scores may suggest that there may be an element of associative learning to any therapeutic effect of pressure vest use. Owners reported a variable level of efficacy, but most owners felt that the vest had some positive effect on their dog's thunderstorm fear. However, the owners were not blinded to treatment, and thus there is a high risk of placebo effect or bias being present in the reporting of these results. However, with a cautionary note that the Thunderstorm Anxiety Score is an un-validated method for quantifying thunderstorm anxiety severity, this study does provide some limited evidence of a beneficial effect of pressure vests on dog anxiety during thunderstorms.

The King et al. (2014) paper used a positive control (loose fitting vest) as well as a traditional control group that allowed the authors to identify whether any apparent benefit of wearing a pressure vest was due to simply wearing an item of clothing (e.g. dogs associated it with going for a pleasant walk) or genuinely an effect of pressure exerted on the dog's torso. The strongest finding in this study was the demonstration that dogs in the snug fit vest group showed a decrease in heart rate between the baseline (pre-kennel/isolation) and the average heart rate of the dog when in the kennel for 15 minutes. This contrasted with both other treatment groups which demonstrated the converse. The behavioural data also demonstrated that snug fit dogs spent less time orientating towards the door (53% of dogs, as compared to 67% of loose fit dogs, and 90% of control dogs). This is more problematic to interpret as this would suggest that wearing a vest per se reduced door orientation behaviour. These dogs were not habituated to pressure vest wearing at the start of the study and the authors do not report information regarding the dogs' prior coat-wearing history so it is difficult to assess the likelihood of this alternative interpretation. The authors report a statistical tendency for snug fit dogs to show less yawning and tongue flicking but their statistical handling and reporting of this data made it more problematic to draw conclusions from the behavioural output. They report the data was highly skewed and use a non-parametric test to undertake inferential testing but then report the data using the mean (± standard deviation) which makes independent interpretation of the data problematic. However, the study does provide some evidence that a pressure vest can reduce a physiological measure of arousal during short term isolation from the owner/confinement to an unfamiliar area.

Also commercially funded, the Pekkin et al. (2016) study found very little evidence of pressure vests having a beneficial effect in their main study (though the owners, when surveyed, subsequently reported a positive effect under field conditions). No physiological parameters (oxytocin, cortisol) were affected by wearing a pressure vest (either fitted loosely or firmly), but the cortisol levels increased post-audio stressor across all treatment groups, suggesting that the dogs did find the audio-stressor stressful. However, when the dogs were wearing a firmly fitted vest they spent less time laying down during the audio-stressor than under either other treatment condition, and laying down behaviour was (independent of treatment) shown to be positively correlated with fear. This might indicate that, when wearing a firmly fitted vest, dogs felt less fearful during the audio recording of fireworks. However, it cannot be discounted that lying down in a tight-fitting vest is less comfortable than when wearing a vest loosely or no vest at all. No other behaviour parameters were affected by treatment. The weakest part of this study was the owner survey which was very sensitive to bias and the placebo effect. However, the main study may provide some very limited evidence that firmly fitted pressure vests may have a positive impact on one behavioural sign of canine anxiety, but this would be more convincing if more of the outcome variables were affected by a firmly fitted pressure vest and more research is needed here.

The Fish et al. (2017) study reported that the use of a telemetry vest resulted in a lower heart rate, lower anxiety scores during the open field tests and reduced increase in anxiety score during the audio recording of thunder, compared with dogs not wearing a vest. However, a small sample size (n= 8 per group) and

methodological issues reduce the reliability of these findings (particularly, the significant difference in heart rates between treatment groups). Further research, using a large sample size (determined using a power calculation) would be beneficial here.
In conclusion, four studies of variable quality and limitations were identified that investigated the use of pressure vests, using various physiological and behavioural proxy measures of anxiety. Most behavioural outcome measures associated with a positive effect were subjective assessments, with unblinded assessors. Differences between study designs, stressors and outcome measures used, and what parameters were affected by pressure vest wearing make it difficult to meaningfully triangulate findings and draw firmer conclusions. The take home message for the veterinary professional is that pressure vests may have small but beneficial effects on canine anxiety and that habituating the dog to the vest, assessing for comfort and using repeatedly may improve the likelihood of any benefit. However, the owner should be cautioned that they should not expect their dog's anxiety to be fully alleviated or prevented, and it may have no beneficial effect at all.

Methodology Section

Search Strategy	
Databases searched and dates covered:	Pubmed (1900 – 14/09/2017); Science Direct (1901 – 14/09/2017); CAB Abstracts (1973 – 2017, week 35)
Search terms:	Pubmed: (dog OR dogs OR canine OR bitch OR bitches OR canid OR puppy OR puppies) AND (vest OR shirt OR jacket OR coat OR wrap OR cape) AND (anxiety OR anxious OR fear OR fearful OR stress OR stressed OR stressful OR panic OR phobi*) Science Direct: Restricted to: <Advanced search><journals only><title-abstr-key> (dog OR dogs OR canine OR bitch OR bitches OR canid OR puppy OR puppies) AND (vest OR shirt OR jacket OR coat OR wrap OR cape) AND (anxiety OR anxious OR fear OR fearful OR stress OR stressed OR stressful OR panic OR phobi*) CAB Abstracts: 1 (dog or dogs or canine or bitch or bitches or canid or puppy or puppies).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes] (195323) 2 (vest or shirt or jacket or coat or wrap or cape).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes] (40414) 3 (anxiety or anxious or fear or fearful or stress or stressed or stressful or panic or phobi*).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes] (311937) 4 1 and 2 and 3 (36)
Dates searches performed:	Pubmed: 14/09/2017; Science Direct: 14/09/2017; CAB Abstracts: 11/09/2017

Exclusion / Inclusion Criteria	
Exclusion:	Pre-defined exclusion criteria: non-English language, popular press articles, conference abstracts
Inclusion:	Any comparative (control group utilised) study in which the effect of pressure vests on anxiety (or similar) in dogs was studied.

Search Outcome						
Database	**Number of results**	**Excluded – did not answer PICO question**	**Excluded – not English language**	**Excluded – conference abstract only**	**Excluded – duplicates**	**Total relevant papers**
Pubmed	41	40	0	0	1	1
Science Direct	35	32	0	0	0	3
CAB Abstracts	36	30	0	1	5	0
Total relevant papers when duplicates removed						**4**

CONFLICT OF INTEREST

The author declares no conflicts of interest.

REFERENCES

1. Cottam, N, Dodman, N. H. 2009. Comparison of the effectiveness of a purported anti-static cape (the Storm Defender®) vs. a placebo cape in the treatment of canine thunderstorm phobia as assessed by owners' reports. *Applied Animal Behaviour Science* 119: 78 – 84
   DOI: https://doi.org/10.1016/j.applanim.2009.03.014
2. Cottam, N., Dodman, N. H., Ha, J. C. 2013. The effectiveness of the Anxiety Wrap in the treatment of canine thunderstorm phobia: An open – label trial. *Journal of Veterinary Behaviour* 8: 154 – 161
   DOI: http://dx.doi.org/10.1016/j.jveb.2012.09.001
3. Fish, R.E., Foster, M. L., Gruen, M.E., *et al.* Effect of wearing a telemetry jacket on behavioral and physiologic parameters of dogs in the Open – field Test. *Journal of the American Association for Laboratory Animal Science* 56: 382 – 389

4. Gruen, M. E., Case, B. C., Foster, M. L., *et al.* The use of an open field model to assess sound-induced fear and anxiety-associated behaviours in Labrador retrievers. *Journal of Veterinary Behavior* 10: 338 – 345 DOI: 10.1016/j.jveb.2015.03.007
5. King, C., Buffington L., Smith, T. J., *et al.* The effect of a pressure wrap (Thundershirt®) on heart rate and behavior in canines diagnosed with anxiety disorder. *Journal of Veterinary Behaviour* 9: 215 – 221 DOI: https://doi.org/10.1016/j.jveb.2014.06.007
6. Pekkin, A., Hänninen, L., Tiira, K. *et al.* The effect of a pressure vest on the behavior, salivary cortisol and urine oxytocin of noise phobic dogs in a controlled test. *Applied Animal Behaviour Science* 185: 86 – 94 DOI: https://doi.org/10.1016/j.applanim.2016.09.003
7. Tiira, K., Lohi, H., 2014. Reliability and validity of a questionnaire survey in canine anxiety research. *Applied Animal Behaviour Science*155: 82 – 92: http://dx.doi.org/10.1016/j.applanim.2014.03.007

Intellectual Property Rights

Authors of Knowledge Summaries submitted to RCVS Knowledge for publication will retain copyright in their work, and will be required to grant to RCVS Knowledge a non-exclusive license of the rights of copyright in the materials including but not limited to the right to publish, re-publish, transmit, sell, distribute and otherwise use the materials in all languages and all media throughout the world, and to license or permit others to do so.

Disclaimer

Knowledge Summaries are a peer-reviewed article type which aims to answer a clinical question based on the best available current evidence. It does not override the responsibility of the practitioner. Informed decisions should be made by considering such factors as individual clinical expertise and judgement along with patient's circumstances and owners' values. Knowledge Summaries are a resource to help inform and any opinions expressed within the Knowledge Summaries are the author's own and do not necessarily reflect the view of the RCVS Knowledge.

Veterinary Evidence and EBVM Network are RCVS Knowledge initiatives. For more information please contact us at editor@veterinaryevidence.org

RCVS Knowledge is the independent charity associated with the Royal College of Veterinary Surgeons (RCVS). Our ambition is to become a global intermediary for evidence based veterinary knowledge by providing access to information that is of immediate value to practicing veterinary professionals and directly contributes to evidence based clinical decision-making.

www.veterinaryevidence.org

RCVS Knowledge is a registered Charity No. 230886.
Registered as a Company limited by guarantee in England and Wales No. 598443.

Registered Office:
Belgravia House
62-64 Horseferry Road
London SW1P 2AF

This work is licensed under a Creative Commons Attribution 4.0 International License.