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Initial evaluation of PetPace activity monitor

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ABSTRACT

Mobility is considered a vital component of health and quality of life in humans and companion animals. Wearable devices for pets that can monitor activity and other aspects of health are increasingly being marketed to veterinarians and owners, with claims around their ability to monitor aspects of health. However, there is little scientific evidence to support the validity of these claims. To address this, the objective of this study was to assess the correlation of the activity measurement from the PetPace device compared to activity output from Actigraph and the validated Actical device. Ten client-owned, healthy dogs were used for the study. The three devices were mounted simultaneously on a dedicated collar and activity was recorded during a period of 7 days. There were moderate correlations between the Actical and the PetPace ($R^2 = 0.59$, $p = <0.001$). There was high correlation between the PetPace and the Actigraph ($R^2 = 0.85$, $p = <0.001$) and between the Actical and the Actigraph ($R^2 = 0.72$, $p = <0.001$). If the Actical activity counts were limited under 50,000 per hour, there was strong correlation between the Actical and the PetPace ($R^2 = 0.71$, $p = <0.001$) and between the Actical and the Actigraph ($R^2 = 0.86$, $p = <0.001$). PetPace has a moderate correlation with the most validated activity monitor that has been used in veterinary medicine. Its real-time data acquisition, user friendly interface for owners and cost make this device an attractive tool for monitoring activity in dogs. Further studies maybe needed to evaluate its performance, validity and clinical utility in the field.

Introduction

The impact of chronic pain and inflammation associated with osteoarthritis on activity levels of the dogs has been documented (Brown et al., 2010a) and improvement of impaired mobility is considered a primary and important therapeutic goal of treatment of osteoarthritis-associated pain. Traditionally, assessing response to treatment of chronic pain in dogs with OA has relied heavily on veterinarians' assessments and/or objective force platform data (Vasseur et al., 1995). More recently, clinical metrology instruments (owner questionnaires) have been developed and validated, and used to assess response to treatment in dogs with OA (Brown et al., 2007, 2008). However, these are prone to be affected by various biases (Bowling, 2005; Choi and Pak, 2005; Cook, 2010) including recall bias. The best developed for dogs are the Liverpool Osteoarthritis in Dogs (LOAD) (Hercock et al., 2009; Walton et al., 2013) and the Canine Brief Pain Inventory (CBPI) (Brown et al., 2007, 2008).

Recently, activity monitors, such as accelerometers, have become increasingly popular, and provide the opportunity for objective measurement of activity. Accelerometers are non-invasive monitoring devices that record changes in acceleration that relate to the intensity, frequency, duration of movement, and pattern of activity (Dow et al., 2009; Brown et al., 2010a). Certain accelerometers have been evaluated and found to be valid surrogate measures of spontaneous activity in humans and dogs (Yamada and Tokuriki, 2000; Hansen et al., 2007; Murphy, 2009; Michel and Brown, 2011; Yam et al., 2011; Preston et al., 2012). The Actical accelerometer has been used to evaluate the efficacy of treatment in both chronic and acute pain settings (Culp et al., 2009; Mayhew and Brown, 2009; Brown et al., 2010b; Wernham et al., 2011; Walton et al., 2013; Lascelles et al., 2015). There is growing commercial interest in the incorporation of activity monitors (based on varying technology) in veterinary medicine for monitoring progression of disease or evaluating the efficacy of a treatment. There are twenty two currently being marketed to

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Table 1
Summary of the activity monitors currently being marketed to veterinarians and/or the general public for monitoring activity and other aspects of health (as of search performed January November 2018). As far as the authors are aware, the only devices for which there are published studies testing the validity of output are the Actical, Actigraph and Whistle monitors.

Actical-Z	Mini Mitter Co., Inc., Bend OR (US)	http://www.actigraphy.com/solutions/actical
Actigraph wGT3X+	Actigraph, LLC, Pensacola, FL (US)	http://actigraphcorp.com/
Actigraph wGT3X-BT	Actigraph, LLC, Pensacola, FL (US)	http://actigraphcorp.com/
Babelbark	Babel Bark Inc., Newton, MA (US)	https://babelbark.com/
Fitbark	Fit Bark Inc., Kansas City, MO (US)	https://www.fitbark.com/
Garmin Delta Smart	Garmin Ltd., Canton of Schaffhausen, Switzerland	http://www.buy.garmin.com/
Heyrex	Heyrex Limited, Karori, New Zeland	http://www.heyrex.com/en/
Kyon	Kyon Ltd., Limassol, Cyprus	https://www.kyontracker.com/
Link AKC	Smart Pet Technologies, LLC, Stamford, CT (US)	https://www.linkakc.com/
MyPoof Bean	SYNC technology Ltd., Freemont, CA (US)	https://www.mypoof.com/
MyPoof Pea	SYNC technology Ltd., Freemont, CA (US)	https://www.mypoof.com/
Nuzzle	Petpomm, Inc., Punta Gorda, FL (US)	https://www.hellonuzzle.com/
Oggi	Oggway Ltd., Tel Aviv (Israel)	http://www.oggii.com/
PetPace	PetPace, LLC, Burlington, MA (US)	https://petpace.com/
PitPat 2	Pitpatpet Ltd., Cambridge (UK)	https://www.pitpatpet.com/
Vetrax	AgLogica Holdings, Inc., Norcross, GA (US)	http://www.vetrax.com/
Voyce	One Health Group, LLC., Chantilly, VA (US)	http://www.voyce.com/
Wagz	Wagz, Inc., Hampton falls, NH (US)	https://wagz.com/
Whistle 3	Whistle Labs, Inc., San Francisco, CA (US)	https://www.whistle.com/
Whistle FIT	Whistle Labs, Inc., San Francisco, CA (US)	https://www.whistle.com/
Wonderwoof	Wondermento Inc., Brooklyn, NY (US)	https://wonderwoof.com/
WUF	Ridogulous Labs, Inc., Boulder, CO (US)	https://www.getwuf.com/

veterinarians and/or the general public (Table 1). Despite this, little scientific research assessing these monitors has been published. Only one device (Whistle, Whistle Labs, San Francisco CA) has been evaluated for performance against a 'known' monitor (Actical, Mini Mitter Co., Inc., Bend OR), and output of the Whistle was shown to strongly correlate with total activity from the Actical device (Yashari et al., 2015).

Actical is the first, and currently only, monitor to be evaluated for its validity as a measure of activity and distance moved in dogs. This device contains an omnidirectional accelerometer. A piezoelectric sensor generates a voltage when the device is subjected to a change in acceleration. The voltage is converted to a digital value that is used to adjust a running baseline value that permits filtering out constant accelerations such as those caused by gravity. The current digital value is compared with the baseline value, and the difference from baseline is used to create a raw activity value for the measurement period (epoch). The raw activity value is converted by the associated computer software and reported as an activity count. Epochs can be set by the user to be 1 s,15 s, 30 s or 1 min. Several years ago Hansen et al. compared video graphic measures of movement in dogs and simultaneously collected activity 'counts' from the Actical, and found a strong correlation between activity counts and various measures of movement (Hansen et al., 2007). It was these data that led to it being used in clinical studies as a measure of activity (Hansen et al., 2007; Lascelles et al., 2007; Lascelles et al., 2008). The Actigraph wGT3X+ (Actigraph, LLC, Pensacola, FL) measures acceleration in three individual orthogonal planes and produces activity counts as a composite vector magnitude of these three axes (Murphy, 2009; Preston et al., 2012). The Actigraph has been used to assess physical activity and the effects of obesity and weight loss in dogs (Morrison et al., 2013; Morrison et al., 2014). Another study used the Actigraph to assess differences in intensity of activity in dogs on a flat versus inclined treadmill (Preston et al., 2012). Reliability of the Actigraph was reported to be high in comparison with subjective direct observation of movement in dogs (Yam et al., 2011), but its output has not been evaluated for validity as a measure of movement in dogs. The Actical and Actigraph cannot provide real-time information (Yashari et al., 2015) and the devices need to be removed from the pet to export and analyze data. They are designed primarily for scientific research. Many of the marketed activity monitors allow for upload of data to the cloud via various means, and provide user-friendly user interfaces.

One such device is PetPace (PetPace, LLC, Burlington, MA). This collar-mounted product specifically designed for dogs purports to record real-time activity parameters and vital signs (heart rate, respiratory rate, temperature). The device syncs the data collected wirelessly to a gateway connected to a ethernet port and the data is uploaded to the cloud-based server. The data are analyzed and presented to owners and veterinarians via online service that can be remotely accessed. In addition, these data can be shared between owners and veterinarians. Potentially, this allows owners and veterinarians to detect changes that may be associated with early signs of illness and disease and veterinarians may be able to use the device for at-home monitoring or for detailed follow-up of outpatients. However, the validity of the output from this device has not been evaluated yet.

Thus, the aim of this pilot study was to compare the PetPace and the Actigraph against the Actical. Although ideally each monitor would be evaluated against a 'gold standard' measure of movement, such as video measures of activity used in previous work (Hansen et al., 2007), it is also appropriate to evaluate novel monitors against one that has been validated as a measure of activity in dogs. We hypothesized that the PetPace and the Actigraph activity data output would show strong correlation (>0.7) with the Actical data when worn simultaneously by dogs in the home environment.

Material and methods

Ten healthy dogs belonging to staff and students of the College of Veterinary Medicine at North Carolina State University were enrolled in this study. Dogs were recruited such that five dogs were suitable for a 'medium' Petpace collar, and five were of suitable size for a large sized collar. The dogs were required to be considered healthy by the owners, and not showing any signs of osteoarthritis, on a physical, orthopedic and neurological examination. Dogs greater than one year old and considered by owners to be able to exercise for 5 min were included in this study. The study protocol was approved by the institutional animal care and use committee (Protocol ID: 15-144-O, approved on 8th August 2017) and written owner consent was obtained after full explanation of the study.

An Actical, and an Actigraph were mounted either side of a PetPace monitor mounted on the PetPace collar (Fig. 1), with the Actical and the Actigraph attached