Article

Remote Monitoring of Canine Patients Treated for Pruritus during the COVID Pandemic in Florida Using a 3-D Accelerometer

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Simple Summary: This study describes the use of a motion-detecting device (3-D accelerometer) to remotely monitor therapy in dogs who have been diagnosed and treated for itch by a dermatologist during the 2020–2022 COVID pandemic. Ensuring dog owner adherence to recommended protocols; getting early warning of flare ups and maintaining close monitoring of patient condition are factors that can dramatically improve the outcome. Movement monitoring devices linked with data recording apps combined with real time communication with the veterinary practice can help to address these challenges and lead to improved medical management.

Abstract: Medical management of chronic canine pruritic dermatologic conditions is challenging and often frustrating. This is a report that shows one way of aiding the management of pruritic dogs using a remote monitoring device. It is often difficult for veterinarians to get dog owners to return to the clinic once a dog is treated. It is possible that a 3-D accelerometer device could provide information to the clinic staff on the success or failure of a pruritus treatment plan while the dog was cared for at home. Eighty-seven dogs and their owners came to a Florida dermatology specialty clinic or its general practice hospital to be evaluated and treated for pruritus. An ANIMO® 3-D accelerometer was placed on the collar of dogs diagnosed and treated for pruritus. Dogs that completed the study were monitored for 120 days (4 months). The ANIMO app monitored a dog's daily scratching, shaking, sleeping, activity, resting, barking and calories consumed and summarized this information in a daily report visible on the pet owner's smart phone. An additional variable (grooming minutes per day) could be seen by the Sure Petcare R&D Team that was not yet available in the app. The use of a 3-D accelerometer enabled veterinarians to continuously monitor dogs at home when they were being treated for itching. Clinic staff kept in touch with the owners by phone and could change therapy or bring the dog back for a recheck if problems were seen. Daily reports were combined into line charts that showed plots of scratching, shaking, grooming and sleeping over four months. Veterinarians were able to remotely monitor dogs that had been treated for pruritus for up to four months through the use of a collar-borne monitoring device. Dog owners and clinic staff used the daily summaries which were accessible through a smart phone app. Dogs seemed to tolerate the device well because of its small size and unobtrusive nature.

Keywords: pruritus; 3D-accellerometer; monitoring; allergic skin disease; canine atopic dermatitis

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1. Introduction

Dog dermatologic diseases are frequently associated with pruritus that leads to skin self-trauma, notable skin injury and is associated with impaired rest profiles for both the owner and the dog, although rest profile changes are not readily measured. The dog's motor responses to pruritus produce characteristic motions that can be detected with a monitoring device. ANIMO® (Sure Petcare, a division of Merck Animal Health) is a 3-dimensional accelerometer device developed in 2018 to detect changes in dog motion (behavior) and enable tracking of these over time. ANIMO clips onto the dog's collar, has a battery life that typically lasts over 5 months (22 weeks) and can monitor motions associated with many behaviors including pruritus, response to therapy for pruritus and other behaviors, over an extended time.

Over the last 10 years, several accelerometer devices were introduced to capture the motion of individuals in several animal species. A 3-D accelerometer ear tag for cattle (Allflex, Merck Animal Health) was recently introduced and this device can detect rumination [1]. Other studies report the use of 3D accelerometers including: in dogs to detect a variety of health related movements (arthritis [2], seizures [3]); in cats (sleep quality [4], physical activity [5]); in cattle (Bovine Viral Diarrhea [6], bull breeding [7], signal pre-processing [8], lying behavior [9], behavior on pasture [10], grazing [11]); in chickens (motion intensity [12], caged bird behavior [13]); in horses (motor behavior [14]); in sheep (grazing and rumination [15]); in arctic muskox (breeding and life events [16]); and in dolphins (startle responses [17]).

ANIMO measures canine movement in 3-dimensions and, when placed on a dog's collar, produces a constant stream of data specifying motions made by the dog. These can then be analyzed with data management algorithms and classified into different types of activities including standard daily activities such as sleep quality, active time, resting time, calories burned, and also potentially adverse or undesirable behaviors including barking, scratching, and shaking. When undesired behaviors are recorded over time periods beyond established norms then an alert is sent to the data presentation app, usually installed on a handheld smart phone. In addition, these alerts can be further shared with others including a study center and investigator(s) through the smart phone app.

The primary objectives of this study were to evaluate the potential medical value of ANIMO-measured motions in dogs under treatment for pruritus for management of these cases including the potential for early warnings of pruritus recurrence ('flare up') in dogs with pruritus. Flare up is a common phenomenon in dogs with pruritic skin disease, and early detection can improve the prognosis for case management including early intervention to reduce self-trauma.

2. Materials and Methods

The veterinarians in this study examined, tested, and diagnosed dogs presenting with pruritus and then recommended treatment according to their best clinical judgement within routine daily function of a referral veterinary dermatology hospital. Written informed consent was obtained from all participants before enrolment in the trial and initiation by attaching the ANIMO to the dog's collar and owner confidentiality was strictly maintained.

The ANIMO device is a small (1.45 inch diameter × 0.45 inch depth; 0.78 oz) round waterproof device (IP67 protected from immersion in water with a depth of up to 3.3 feet for up to 30 min) that is mounted on the dog's collar and comes with a CR 2032 battery that reportedly lasts up to 6 months. Acceptable collar widths range from 0.5 inches up to 1.25 inches. It records specific acceleration in three dimensions when fixed to a dog's collar and comes with a 1-year warranty. Sure Petcare (SPC) indicates that the ANIMO will measure the daily amount of scratching, shaking, sleeping, daily activity, resting time, barking and calories consumed by a dog. SPC is also evaluating a new experimental variable (time spent grooming) which was not included in the pet owners report but was available to the researchers. A newer version of ANIMO includes GPS tracking although this was not available at the time of the study. ANIMO is reported to use a combination of Bluetooth and unique algorithms to monitor the dog's movement. When first attached to the dog, ANIMO takes 1-2 weeks to learn the typical behavior for the dog. The device has a retail price of US $90.00 on the website (https://www.surepetcare.com/en-us/animo/animo-classic, accessed 21 February 2023).

The study was conducted in Florida, a high-risk region for pruritic disease in dogs including flea infestation and allergic skin disease. This was a non-interventional prospective cohort study of dogs presented to a specialty dermatology animal hospital for pruritus of any cause. All dogs were seen by a veterinarian and had their source of pruritus diagnosed–as far as possible-and treated. ANIMO was attached to the dog's neck collar which was then remotely monitored at home through the ANIMO App (Sure Petcare–ANIMO, Activity and Behavior Monitor) installed on the owner's smart phone. After fitting ANIMO at the veterinary hospital, dogs were followed for an initial 14 days of calibration to allow ANIMO to normalize to the dog's individual movement profile. All enrolled dogs' behaviors were then tracked over the subsequent 4-month period.

The owner "synced" with the app every few days to upload stored ANIMO data although up to 2 weeks of continuous data could be stored in the device between syncing. Once uploaded, all data were stored in the cloud for monitoring and were available to the owner and hospital staff through the smart phone app.

This study evaluated the potential for ANIMO to provide a health profile to veterinarians that could be used to monitor response to treatment, document therapeutic progress, and capture evidence for relapse. Additionally, dog owners could see the improvement in their dogs' movement profiles following treatment for dermatologic disease. The variables reported by ANIMO and available to the veterinarian, veterinary staff and pet owner are listed in Table 1.

Table 1. Daily variables provided by ANIMO.

Last Data Sync with the App	Number of Days Since Last Sync
Daily Activity Intensity	Time of day X active/inactive chart
Type of Activity (low, medium or high intensity)	Minutes per day
	Activity broken out per day over weeks/months.
Sleep quality (Last night, Average Score)	Percent of sleep time with good sleep
	Minutes awake, restless, normal, deep sleep
Daily resting (night rest, day rest)	Minutes per day or night
	Day rest/night rest for day/week/month/year
Calories burned (each day and average versus daily goal)	Calories burned per day
	Calories burned for day/week/month/year
Wellbeing (scratching and shaking per day)	Minutes per day for each variable
Timeline of barking bouts per day	Total barking minutes and time of day when barking
	Comparative barking X last 7 days

At the conclusion of the study, each dog owner completed a short survey on their ANIMO experience. Additionally, selected daily variables (Table 1) were compiled by the authors into a single line chart (Figure 1) to visualize the amount of scratching, shaking, grooming and sleeping over 4 months of monitoring. The daily grooming time is a new parameter not yet available to the pet owner in the ANIMO App during the period of this study.

The line chart for an individual dog (Figure 1) gives a longitudinal picture of trends in daily minutes of scratching, shaking, grooming and sleeping and simplifies observation of changes in daily sleep quality, along with the presence and timing of alerts related to specific, potentially injurious, behaviors including scratching and shaking. Each individual dog had a unique wave pattern, with some dogs making only tiny amplitude waves, some making moderate amplitude waves (Figure 1) and others making large amplitude waves.

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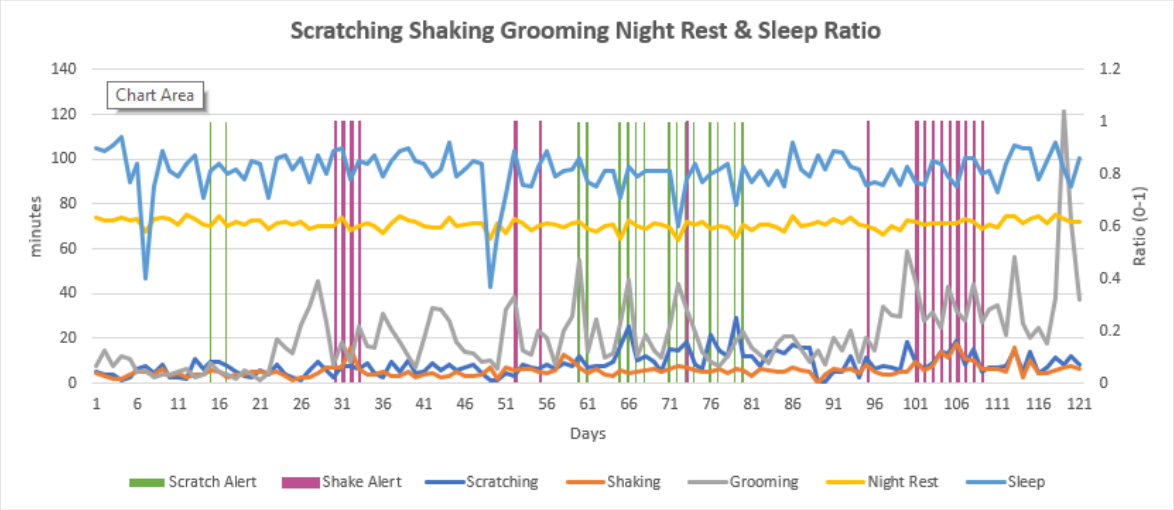

Figure 1. An example of a 4-month line chart for a single dog making moderate amplitude waves also showing scratch and shake alerts. The left vertical axis is minutes per day for scratching, shaking and grooming and minutes of night rest per day are divided by 3 to fit a similar range seen for other daily measures. The right vertical axis is the sleep ratio per night (light blue line) a units-free assessment with a result between 0 and 1 that assesses the time proportion spent in sleep behavior during the night.

3. Results

Eighty-seven dogs were diagnosed with pruritic skin disease and subsequently completed four months of monitoring by ANIMO. The study was initiated on 1 April 2020 with a rolling enrollment period that lasted for 16 months, with the last dog completed on 16 July 2021. The study period extended for a longer duration than the planned initial 1 year because of enrolment delays associated with the COVID-19 pandemic. The clinic was closed for several weeks in early 2020 and then partially opened with a limited number of patients seen each day. Dog owners had to wear masks and remain in their car while their pet was evaluated. Owners were reluctant to come to the clinic, particularly before COVID vaccines became available.

Each morning, the app presented owners of dogs with the ANIMO device a summary of the data generated. The study team also provided a summary of the previous weeks' monitoring data to the veterinary clinic staff. This summary included: a list of scratch and shake alerts, notification when an owner was delayed in syncing their dog's data, updates on devices needing a battery change, and reports of dogs not wearing the ANIMO device. Clinic staff used this weekly report to review the status of enrolled dogs and determine whether a call to the owner was needed for an update or action. When a scratch or shake alerts was recorded, owners were asked if they were seeing increased scratching or shaking and then had an opportunity to set up a recheck visit and/or adjust therapy.

An example is included to show how information from the app flagged an increase in itching. A male neutered 9 your old 6 kg pug cross dogs was previously diagnosed with atopy that was being treated at home. ANIMO provided warning of a flare up in his pruritic condition before this was observed by the owner. Communication between the veterinarian and owner was initiated leading to modification of the pruritis management protocol and improvement in clinical signs.

Line charts were developed by the study team to visually represent 4 months of information. This information could be compiled from the ANIMO App by examining data fields on consecutive days. Specific calendar dates were aligned with study days (day 1 to day 120) to allow association between events in the medical notes (communication with the pet owner, for example) and activities in the 4-month line chart. The wave amplitude for scratching, shaking and grooming behavior and

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the number of shake or scratch alerts was unique to each dog but remained consistent for individuals during the 4-month monitoring window.

The exit survey was completed by 77 dog owners although a few dog owners did not answer all questions. Almost all (96% or 74/77) responders felt that they had a good experience with ANIMO. Owners reported checking the app daily (62%, 47/76), weekly (36%, 27/76) or monthly (2%, 2/76). More than 80% of responders named the activity information (low/medium/high, graphs and goal setting), sleep quality, daily resting time, calories burned as well as minutes of scratching and shaking as useful information provided by the app. Owners indicated that they received warnings for scratching or shaking (71%), decreased sleeping score (33%) and excessive barking (41%). A high proportion (90% 69/77) of participants would recommend ANIMO to a friend. Several owners indicated that they felt encouraged to increase their dog's exercise based on the reported daily calorie expenditure.

4. Discussion

Accelerometer movement monitoring by a collar-attached device provided valuable medical management data for dogs presented with pruritus to a veterinary dermatological referral practice. Owners and veterinarians received information that assisted in understanding the movement pattern for these dogs over a 4-month monitoring period. In particular, the potential to provide an early alert of pruritus "flare up" offered notable value.

This study was conducted against the background of a global pandemic that began in 2020 and continues into 2022, at the time of writing. This timing was unexpected and coincidental; however, provided a unique opportunity to evaluate a remote movement monitoring device to follow therapy for dogs being treated for pruritic skin disease. The ANIMO monitor battery life provides up to 5 months of continuous monitoring. To deliver uninterrupted data collection, the owner needs to ensure that the phone application automatically or manually synchronizes with the ANIMO software more frequently than every 14 days. Syncing uploads data stored in the ANIMO to the cell phone for processing followed by the generation of notifications to the owner, the clinic staff and the veterinarian. This kind of remote monitoring is not dependent on how close the owner lives to the veterinary clinic because data are delivered to the cloud whenever the owner has access to a cellular phone network.

ANIMO measures movement that is translated into specific parameters and this report focuses on those expected to be more related to itch. Owners were able to see other variables (Table 1) of interest including reduced nightly sleep quality, daily energy expenditure and increased grooming, scratching or shaking minutes. ANIMO detected and record these behaviors at all times, including at night when the owner was usually not observing their dog. Sleep quality assessment for the dog may translate to owner sleep quality since many of the dog's sleep with or near the owners. On one case, the clinic staff called the pet owner to inquire about the dog's episodes of interrupted sleep. The owner reported that the dog was getting up every time she experienced insomnia and the app was able to detect this.

The veterinarian can also use ANIMO to monitor their patient, in cooperation with the dog owner, and for this the vet should set expectations because data provided are not diagnostic and help to monitor behaviors indicating response to treatment and potential recurrence of clinical signs. The owner gains from veterinary assistance to interpret reported results, with the timing of communication dependent on the speed of change and severity of clinical signs. Occurrence of reports alerting owner and veterinarian about deviations from the normal movement standard for the dog can be a trigger for communication. There was a patient who experienced an otitis flare while the primary caregiver was out of town and the accelerometer alert triggered the owner to inquire about the patient resulting in treatment being prescribed in advance of the return of her veterinarian.

Veterinary hospital staff already communicate regularly with owners, however, ANIMO reports offer an innovative change because the dog's behavior is the stimulus for the veterinary hospital staff to contact the owner for an update. This inverts the traditional approach where the owner would contact the veterinary hospital about an observed behavior of concern. The requirements of this study

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meant that owners were contacted to communicate a concern or question arising from reported ANIMO data or they were reminded to sync. One vet hospital staff member was assigned as the primary contact for ANIMO owners, providing continuity in the communication. This veterinary hospital found using text messaging to owners was more effective than voice calling or emailing. All communication was documented in the medical record at the time of occurrence.

Each daily ANIMO report provides a 24-h snapshot for the dog and these can be compared sequentially to look for trends over the previous days or weeks. Veterinary hospital staff regularly examined daily trend reports for monitored dogs and then reached out to owners for dogs with results that suggested that pruritus was more severe or more frequent. Once contacted, owners could elect to continue monitoring at home; to work with the veterinarian to institute a change to therapy; or elect to return to the practice for a recheck visit. Contacting the pet owner soon after the alert (within a day or two) helped to ensure the health status of the dog while the dog's current behavior was still current in the owner's memory. Since this study was completed, the ANIMO app also offers a view of the previous week of data.

On occasion, owners removed ANIMO from the dog's collar at the time of bathing, swimming or visits to the groomer. Sometimes owners needed a reminder to put the collar back on the dog to ensure no loss of data. ANIMO can hold 14 days of data internally before re-syncing without data loss. Dog owners were sometimes reminded by the clinic staff to put the device back on the collar and/or re-synch the data to the smartphone.

To observe sequential data in this study, daily data summaries for each dog were compiled into a single line chart for the full four-month monitoring period showing scratching, shaking, grooming and sleeping trends. These charts were created at the end of the study. A new variable, grooming (in minutes per day), was developed but not yet available to device users, but was included in the four-month line chart. Four continuous months of data in one chart make clear the uniqueness of each dog's movement patterns and the ANIMO interpretation of this movement. Dogs generated scratch or shake lines with small, medium, or large amplitude waves in a pattern apparently consistent for each dog over the course of the study. Each patient had a baseline pattern of scratching or shaking which could show a an increased amount of activity that is characteristic for that dog but different from other dogs. These multi-month line charts allow the veterinarian to evaluate changes in the baseline for each variable that identify potential episodes of increasing pruritus or show signs of treatment response and increased comfort. ANIMO monitoring showed the greatest monitoring value for these patients in this study by early identification of potential flares in itching.

Daily ANIMO activity reporting motivated some owners to increase their daily activity with their dog. Several owners mentioned that if the dog did not reach an identified activity goal, then they would go out at night to walk with the dog to meet or exceed the calorie goal. This was an unexpected very positive outcome for owners participating in the study and could provide a positive benefit in their own physical and mental health. Some owners with multiple conflicting pressures may not be as observant of their dog and ANIMO provided guidance to owners regarding their dogs ongoing behavior. Several observant owners noted changes on their daily ANIMO activity report and were able to work with the veterinarian to get early intervention for their dog's skin disease in the initial stages of a flare up.

5. Conclusions

Accelerometer use provides an additional layer of monitoring for pruritic skin disease especially when close monitoring is difficult or neglected. The use of a remote monitoring device allows veterinary hospital staff to see how dog owners are progressing with managing their dog's pruritus at home. The ability of the dog owner, clinic staff and/or veterinarian to observe the amount of daily calories burned, sleeping, scratching, shaking (and grooming when available) provides a more complete picture on the dog's response to therapy. Recording exercise also drives many dog owners to increase their own exercise when they increase the exercise of their pets to meet daily goals. Use of movement monitoring devices are a potentially valuable new aid for the management of chronic pruritic skin disease of dogs.

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Institutional Review Board Statement: Ethical review and approval were not required for this study as it was an observational study conducted as part of normal veterinary clinical practice.

Informed Consent Statement: Informed consent was obtained from all dog owners involved in the study.

Data Availability Statement: The data compiled for this study is not openly available as it is part of the patient's medical record.

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Conflicts of Interest: Michael Canfield and Timberly Canfield own Animal Dermatology South and Animal Hospital of Regency Park and Bridgette Sampeck, Jennifer Thomas and Tonya Springer work for Animal Dermatology South. Robert Lavan works for Merck & Co., Rob Armstrong and Gal Gingold work for Merck Animal Health.

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