THE FUTURE IS NOW
Wearable devices can be used to track pet activity and generate health data across a larger network.

TECHNOLOGY

The State of Big Data and the Animal Internet of Things

Scott McKinney

In veterinary medicine, patients can't speak up to describe what is wrong and where it hurts. But new technologies such as big data and the animal Internet of Things (IoT) are emerging to help give pets and production animals a voice.

The IoT refers to the collection of physical devices—sensors, wearable devices, etc.—that connect via the internet and share large amounts of data. For humans, this includes a vast array of devices, from your smart phone to a smart doorbell. The application for animals may not be as widespread, but it can have an impact on veterinary medicine.

Veterinary medicine is in the early days of tapping the potential of data and new IoT monitoring devices such as wearables, says Aaron Massecar, assistant director of continuing education at Colorado State University's Translational Medicine Institute and former executive director of the Veterinary Innovation Council.

"Veterinarians are always producing information, and it'd be amazing if you could collate all these medical records and generate actionable insights about animals," says Massecar. "For instance, how many incidents of cancer in golden retrievers do we have? How often are they getting bladder stones? How often are animals on grain-free diets getting dilated cardiomyopathy?"

THE STANDARDIZED CODING BARRIER

The problem is that veterinary medicine does not have the standardized coding that exists in human medical records. As a result, you can't always collate data from different doctors at the same practice, let alone across practices. There is potential to use advanced artificial intelligence (AI) techniques like natural language processing (NLP) to dig through records. "There's a project called DeepTag that was taking reams of medical records, running some NLP algorithms, then distilling that into quantifiable data sets," says Massecar. "If we could do that on a broad scale, you could drive insights from that, but nobody's really doing that."

Another interesting benefit from medical record analysis pertains to disease tracking, especially with zoonotic diseases. "A vet might look at an animal presenting with a particular condition and think it's strange, it might be a rare disease," says Massecar. "If you had 2 doctors saying that at the same time in closely related practices, you might be able to identify it's a tick-borne disease, or a seasonal thing."

SOURCING DATA

One of the most promising ways to generate big data

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from animals, with the goal of doing what's in the best interest of the animals, is IoT technologies like wearables. Wearable technology, such as smart collars, provides a way to monitor animal behavior and detect anything that's out of the ordinary.

"Some of these wearables are doing a really good job of producing data sets and dashboards for their animals, everything from data around movements and scratching, to heart rates," says Massecar. "If veterinarians saw these as opportunities for pre-op or post-op care, and get year-over-year information about the health of their animal, they could move away from the subjectivity associated with owners taking those measurements, breathing rate, heart rate, and activity level of their animals and build a reputation as a progressive, forward-looking practice."

THE CURRENT STATE OF WEARABLES

There are 2 ends of the spectrum: consumer-driven wearables and diagnostic devices. But some convergence is happening between them. Vetrax (**vetrax.com**), for instance, started as an activity tracker, but expanded to look at the relationship between pet activity and diet after forming a partnership with Hill's Pet Nutrition.

Another wearable collar provider is Whistle (Mars Petcare, **whistle.com**). Whistle partnered with the Pet Insight Project and Banfield Animal Hospital to conduct a large-scale study of pet health that examined the links between pet behaviors, activity, and health.

"Whistle tracks pets' health, location, and fitness, and provides access to on-demand televet services. By combining pet science and technology, Whistle trackers and its app help pet parents care for their best friend in ways not previously possible," says Scott Lyle, head of the Pet Insight Project. "Tracking scratching and licking is one of the most important and often highly praised features, since they can be tied to more serious issues from unknown allergies to dermatological issues. We've made it easy for pet parents to seamlessly convey health updates to their local vet by easily emailing a 30-day report directly to their vet through the app."

The Pet Insight Project has distributed approximately 100 000 devices and collected 16 billion minutes of accelerometer data. "The way we're researching this is by correlating high-resolution Whistle accelerometer data with the pet's health records to tell a health story. This combination allows us to map relevant patterns of pet behaviors and movement with illness, to aid in more precise detection of ailments so we can provide early warnings," says Lyle.

PRODUCTION ANIMAL WEARABLES

In some ways, the IoT scene for large, food, or production animals is ahead of companion pets.

One reason is the considerable return on investment. "Food animal producers, specifically in the dairy industry, track key metrics that are important to the animal's health. For instance, these metrics can measure rumination time, milk production, and even alert that a cow is approaching a targeted time for artificial insemination," says Aaron Wallace, co-CEO at Lacuna Diagnostics, Inc, a digital pathology provider. "Dairy producers need to maximize the period an animal can produce milk while balancing optimal health and decreasing stress on the animal. Tracking key

CLARO®

(florfenicol, terbinafine, mometasone furoate)
Otic Solution

Antibacterial, antifungal, and anti-inflammatory
For Otic Use in Dogs Only

CAUTION: Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

DESCRIPTION:
CLARO® contains 16.6 mg/mL florfenicol, 14.8 mg/mL terbinafine (equivalent to 16.6 mg/mL terbinafine hydrochloride) and 2.2 mg/mL mometasone furoate. Inactive ingredients include purified water, propylene carbonate, propylene glycol, ethyl alcohol, and polyethylene glycol.

INDICATIONS:
CLARO® is indicated for the treatment of otitis externa in dogs associated with susceptible strains of yeast (*Malassezia pachydermatis*) and bacteria (*Staphylococcus pseudintermedius*).

DOSAGE AND ADMINISTRATION:
Shake before use.

CLARO® should be administered by veterinary personnel.

Administer one dose (1 dropperette) per affected ear. The duration of effect should last 30 days.

1. Clean and dry the external ear canal before administering the product.
2. Verify the tympanic membrane is intact prior to administration.
3. Remove single dose dropperette from the package.
4. While holding the dropperette in an upright position, remove the cap from the dropperette.
5. Turn the cap over and push the other end of the cap onto the tip of the dropperette.
6. Twist the cap to break the seal and then remove cap from the dropperette.
7. Screw the applicator nozzle onto the dropperette.
8. Insert the tapered tip of the dropperette into the affected external ear canal and squeeze to instill the entire contents (1 ml) into the affected ear.
9. Gently massage the base of the ear to allow distribution of the solution.
10. Repeat with other ear as prescribed.

Cleaning the ear after dosing may affect product effectiveness.

CONTRAINDICATIONS:
Do not use in dogs with known tympanic membrane perforation (see **PRECAUTIONS**).

CLARO® is contraindicated in dogs with known or suspected hypersensitivity to florfenicol, terbinafine hydrochloride, or mometasone furoate.

WARNINGS:
Human Warnings: Not for use in humans. Keep this and all drugs out of reach of children. In case of accidental ingestion by humans, contact a physician immediately. In case of accidental skin contact, wash area thoroughly with water. Avoid contact with eyes. Humans with known hypersensitivity to florfenicol, terbinafine hydrochloride, or mometasone furoate should not handle this product.

PRECAUTIONS:
Do not administer orally.

The use of CLARO® in dogs with perforated tympanic membranes has not been evaluated. The integrity of the tympanic membrane should be confirmed before administering the product. Reevaluate the dog if hearing loss or signs of vestibular dysfunction are observed during treatment. Use of topical otic corticosteroids has been associated with adrenocortical suppression and iatrogenic hyperadrenocorticism in dogs (see **ANIMAL SAFETY**).

Use with caution in dogs with impaired hepatic function (see **ANIMAL SAFETY**).

The safe use of CLARO® in dogs used for breeding purposes, during pregnancy, or in lactating bitches has not been evaluated.

ADVERSE REACTIONS:
In a field study conducted in the United States (see **EFFECTIVENESS**), there were no directly attributable adverse reactions in 146 dogs administered CLARO®.

To report suspected adverse drug events and/or obtain a copy of the Safety Data Sheet (SDS) or for technical assistance, contact Bayer HealthCare at 1-800-422-9874.

For additional information about adverse drug experience reporting for animal drugs, contact FDA at 1-888-FDA-VETS or online at http://www.fda.gov/AnimalVeterinary/SafetyHealth.

PHARMACOLOGY:
CLARO® Otic Solution is a fixed combination of three active substances: florfenicol (antibacterial), terbinafine (antifungal), and mometasone furoate (steroidal anti-inflammatory). Florfenicol is a bacteriostatic antibiotic which acts by inhibiting protein synthesis. Terbinafine is an antifungal which selectively inhibits the early synthesis of ergosterol. Mometasone furoate is a glucocorticosteroid with anti-inflammatory activity.

MICROBIOLOGY:
The compatibility and additive effect of each of the components in CLARO® solution was demonstrated in a component effectiveness and non-interference study. An *in vitro* study of organisms collected from clinical cases of otitis externa in dogs enrolled in the clinical effectiveness study determined that florfenicol and terbinafine hydrochloride inhibit the growth of bacteria and yeast commonly associated with otitis externa in dogs. No consistent synergistic or antagonistic effect of the two antimicrobials was demonstrated. The addition of mometasone furoate to the combination did not impair antimicrobial activity to any clinically significant extent.

In a field study (see **EFFECTIVENESS**), at least 10 isolates from successfully treated cases were obtained for *S. pseudintermedius* and *M. pachydermatis.*

EFFECTIVENESS:
In a well-controlled, double-masked field study, CLARO® was evaluated against a vehicle control in 221 dogs with otitis externa. One hundred and forty six dogs were treated with CLARO® and 75 dogs were treated with the vehicle control. All dogs were evaluated for safety. Treatment (1 mL) was administered once on Day 0 to the affected ear(s). Prior to treatment, the ear(s) was cleaned with saline. The dogs were evaluated on Days 0, 7, 14, and 30. Blood work and urinalysis were obtained on Day 0 pre-treatment and Day 30 at study completion. Four clinical signs associated with otitis externa were evaluated: erythema, exudate, swelling, and ulceration. Success was based on clinical improvement at Day 30. Of the 183 dogs included in the effectiveness evaluation, 72.5% of dogs administered CLARO® solution were successfully treated, compared to 11.1% of the dogs in the vehicle-control group (p=0.0001).

ANIMAL SAFETY:
In a target animal safety study, CLARO® was administered aurally to 12-week-old Beagle puppies (4 dogs/sex/group) at 0X, 1X, 3X, and 5X the recommended dose once every 2 weeks for a total dosing period of 28 days (3 times the treatment duration). No clinically relevant treatment-related findings were noted in hearing tests, body weight, weight gain, or food consumption. CLARO® administration was associated with post-treatment ear wetness or clear aural exudate, increased absolute neutrophil count, decreased absolute lymphocyte and eosinophil counts, suppression of the adrenal cortical response to ACTH-stimulation, decreased adrenal weight and atrophy of the adrenal cortex, increased liver weight with hepatocellular enlargement/cytoplasmic change, and decreased thymus weight. Other potentially treatment-related effects included mild changes to AST, total protein, inorganic phosphorus, creatinine, and calcium.

STORAGE INFORMATION:
Store between 20°C – 25°C (68°F – 77°F), excursions are permitted 15°C – 30°C (59°F – 86°F).

HOW SUPPLIED:
CLARO® solution is supplied in a single-use dropperette in a blister. Each dropperette contains one 1 mL dose.

CLARO® is available in cartons of two, ten, or twenty dropperettes.

Manufactured for
Bayer HealthCare LLC, Animal Health Division
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performance indicators from wearables helps maximize production and health while alerting producers if data suggests medical or other intervention is needed. In a sense, the data is helping producers and veterinarians monitor animals while also perfecting the reproductive cycle. When this cycle is off, the ROI goes down." CowManager (cowmanager.com), an ear tag that has an accelerometer similar to a Fitbit, is one such device. It tracks temperature, activity, rumination, eating, and resting time in order to provide insight into health and fertility.

Farm Jenny (farmjenny.com) is another venture in the equine and bovine space. Its founders, Pennsylvania-based Rob and Tammy Crouthamel, built Farm Jenny after more than 25 years of experience in big data and wearable technology, along with personal experience raising and caring for horses.

"Tammy has a good gut sense of animals, but we were missing things when we couldn't be on the farm," says Rob Crouthamel. "When obvious signs of disease show up, the only option is to call an emergency vet, but if you detect those subtle signs earlier, you can take steps to avoid the crisis."

Farm Jenny is designed to recognize those subtle changes in behavior as early and as accurately as possible. It monitors behaviors such as activity level and compares them to the other animals in the herd. It's moving toward detecting more specific, subtle behaviors such as head motions, kicking, and biting the side.

Its wearable device is a sensor attached to the horse's soft headband or a cow's ear tag, and uses a gyroscope to detect motion. The sensors can run for months on battery without maintenance. They connect to solar-powered field receivers around the farm, then via cellular connection into the cloud. "Connectivity is particularly challenging on farms, where you can't expect Wi-Fi. One of our unique plays is cellular connectivity and mesh connectivity using Thread," says Rob. "Wherever the animal is on the farm, we continuously get that stream of data uploaded to the cloud."

Farm Jenny takes that constant stream of each animal and analyzes the behavior. If it senses any behavior out of the ordinary, it can alert the farmer's smartphone. The historical data is where the real value comes. The system is designed to meet the needs of small to midsize operations, from a single horse and stall up to hundreds of acres and thousands of animals. There are a couple of ways Farm Jenny provides data access to a veterinarian. Multiple people can sign in, so a single veterinary professional can have continuous behavioral tracking of all of their clients' animals. Farm Jenny also has machine learning–based behavior detection that correlates sensor data and camera footage, and offers that as a standalone product to universities, research hospitals, and pharmaceutical companies.

A TRANSMITTER IN THE LITTER

The IoT goes beyond wearable collars for feline patients. "Since 2008, and possibly longer, feline patients simply do not routinely visit veterinary hospitals nearly as often as dogs do," Wallace says. "One of the many exciting IoT advancements currently being developed are digital litter boxes. You can measure how frequently a cat is going to the litter box and how long they're spending in the litter box. It also alerts the owner if the cat is going too frequently, which could be a sign of UTI or constipation. The boxes can also alert the owner if the cat is spending too much time in the litter box, which could be an early

indication of urethral obstruction, a common life-threatening medical problem we treat in the veterinary E.R."

In-clinic workflow is another area ripe for innovation with wearable technology, says Dr. Caleb Frankel, practicing veterinarian and founder of Instinct Science, an electronic medical records and workflow platform.

"I don't think anyone is working on the in-clinic side," says Frankel. "One of the problems for every practice is staffing. Smart devices that can automate vital sign gathering during the check-in process could help. You might even improve the accuracy of these measurements, since it's often stressful for pets at that initial part of a visit. It seems like a huge opportunity for wearable devices that can augment staff, improve patient care, and enhance workflow."

THE NEXT STEPS

"When we think about big data in veterinary medicine, our patients can't tell us something is wrong," says Frankel. "One of Lacuna's mantras is 'time is trauma.' We believe if we can diagnose cancer or infection faster, our pets can get treatment faster, which leads to a better medical outcome with less suffering."

If a wearable collar tells you a patient's heart rate is faster than normal and activity is down, the client can be alerted to schedule an examination. Or if a million cats use digital litter boxes, the ability to examine that data to see what behavior and clinical signs serve as a precursor for emergency treatment. Taking that data and applying AI techniques could even allow veterinarians to diagnose emergencies before they emerge.

In the big picture of big data and the animal IoT, we're in the early phases. The costs of AI are high. "Currently, everyone who obtains a degree or has experience with AI has several career opportunities out there from self-driving cars to human medicine, but I look forward to the time when we have more experts working on these neural networks in the veterinary space," Wallace says. "In 5 to 10 years, veterinary medicine will have a whole different look through the eyes of data than we have now. When we look at IoT, eventually we will have a collar or device that accurately measures and constantly surveys patient activity, appetite, gait, respiration rate, and many other important data points that can assist pet parents before medical conditions progress to emergencies. It is truly exciting to think about how we can combine IoT devices with big data techniques, for it will most certainly lead to new ways of diagnosing. These are topics the veterinary industry needs to see." **TVP**

Scott McKinney

Scott McKinney is a Knoxville-based freelance writer specializing in B2B software. Unlike other writers, he comes from a mathematics background. He has a BA in math from Cornell University and 15 years' experience teaching and tutoring advanced math. Now he works with trade publications on articles about software and writes marketing materials for software companies. When he's not working, he walks 3 to 5 miles a day and practices Qi Gong.

Osurnia®
(florfenicol-terbinafine-betamethasone acetate)

Otic gel
For Otic Use in Dogs Only

CAUTION: Federal (USA) law restricts this drug to use by or on the order of a licensed veterinarian.

BRIEF SUMMARY (for full prescribing information, see package insert)

DESCRIPTION: OSURNIA contains 10 mg florfenicol, 10 mg terbinafine and 1 mg betamethasone acetate per mL and the inactive ingredients propylene carbonate, glycerol formal, hypromellose, phospholipid, oleic acid and BHT in an off-white to slightly yellow translucent gel.

INDICATION: OSURNIA is indicated for the treatment of otitis externa in dogs associated with susceptible strains of bacteria (*Staphylococcus pseudintermedius*) and yeast (*Malassezia pachydermatis*).

DOSAGE AND ADMINISTRATION: OSURNIA should be administered in the clinic. Clean and dry the external ear canal before administering the initial dose of the product. Administer one dose (1 tube) per affected ear(s) and repeat administration in 7 days. Do not clean the ear canal for 45 days after the initial administration to allow contact of the gel with the ear canal. Cleaning the ear may affect product effectiveness (see **Effectiveness** in the product insert). If alternative otic therapies are required it is recommended to clean the ear(s) before application. Open tube by twisting the soft tip. Insert the flexible tip into the affected external ear canal(s) and squeeze entire tube contents into the external ear canal(s). After application, gently massage the base of the ear to allow the gel to penetrate to the lower part of the ear canal.

CONTRAINDICATIONS: Do not use in dogs with known tympanic perforation (see **Precautions** in the product insert). Do not use in dogs with a hypersensitivity to florfenicol, terbinafine, or corticosteroids.

WARNINGS: Not for use in humans. Keep this and all medications out of reach of children. Consult a physician in case of accidental ingestion by humans. In case of accidental skin contact, wash area thoroughly with water. Avoid contact to the eyes.

PRECAUTIONS: Do not administer orally. The use of OSURNIA in dogs with perforated tympanic membranes has not been evaluated. The integrity of the tympanic membrane should be confirmed before administering this product. Reevaluate the dog if hearing loss or signs of vestibular dysfunction are observed during treatment. Use of topical otic corticosteroids has been associated with adrenocortical suppression and iatrogenic hyperadrenocorticism in dogs (see **Animal Safety** in the product insert). Use with caution in dogs with impaired hepatic function (see **Animal Safety** and **Adverse Reactions** in the product insert). The safe use of OSURNIA in dogs used for breeding purposes, during pregnancy, or in lactating bitches, has not been evaluated.

ADVERSE REACTIONS: The following adverse reactions were reported during the course of a US field study for treatment of otitis externa in dogs treated with OSURNIA with 1 tube per affected ear(s) and repeated after 7 days. The following adverse events are listed in decreasing order: elevated alkaline phosphatase, vomiting, elevated AST, ALT, ALP, weight loss (>10% body weight), and hearing decrease/loss. To report suspected adverse events, for technical assistance or to obtain a copy of the SDS, contact Dechra Veterinary Products at (866) 933-2472. For additional information about adverse drug experience reporting for animal drugs, contact FDA at 1-888-FDA-VETS or online at http://www.fda.gov/AnimalVeterinary/SafetyHealth.

EFFECTIVENESS: Effectiveness was evaluated in 235 dogs with otitis externa. The study was a double-masked field study with a placebo control (vehicle without the active ingredients). One hundred and fifty-nine dogs were treated with OSURNIA and seventy-six dogs were treated with the placebo control. All dogs were evaluated for safety. Treatment (1 mL) was administered to the affected ear(s) and repeated 7 days later. Prior to the first administration, the ear(s) were cleaned with saline but not prior to the Day 7 administration. Six clinical signs associated with otitis externa were evaluated: pain, erythema, exudate, swelling, odor and ulceration. Total clinical scores were assigned for a dog based on the severity of each clinical sign on Days 0, 7, 14, 30 and 45. Success was determined by clinical improvement at Day 45. The success rates of the two groups were significantly different (p=0.0094); 64.78% of dogs administered OSURNIA were successfully treated, compared to 43.42% of the dogs in the placebo control group.

STORAGE: OSURNIA should be stored under refrigerated conditions between 36° - 46° F (2° - 8° C). To facilitate comfort during administration, OSURNIA may be brought to room temperature and stored for up to three months.

MANUFACTURED FOR:
Dechra Veterinary Products
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Product of Great Britain

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