

Annual Report 2018

IDEXX Chair in Emerging Technologies and Bond-Centered Animal Healthcare

**TOGETHER,
AT THE
FOREFRONT
OF DISCOVERY**



USHERING IN A NEW AGE OF ANIMAL WELLNESS

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IDEXX has raised the standard of pet health care through diagnostic testing and stands in a position of leadership as we engage in health informatics.

Wellness and preventive care represent a sea change in veterinary medicine. It will wash in with the tide of data made available through a combination of “omics” (genomics, metabolomics, etc.), electronic medical records and laboratory test data, and the Internet of Things veterinary – like activity monitors, smart litter boxes, and play/reward devices. Practitioners will need to know how to interpret and use these data to develop wellness strategies, as their more-engaged clients seek to monitor their pets’ health as well as their own.

Determining the significance of numerous health measures requires normative data to compare them to, and such data are scattered across the veterinary space. This is why the potential for

IDEXX health data is so exciting. If animal health histories were matched to their diagnostic records on the massive scale afforded through IDEXX, big data analytics could surface powerful, predictive indicators of specific diseases and, also, of optimal health, aging and long life. Armed with this new knowledge, we could offer clients evidence-based wellness plans, early identification and treatment of disease, and an enhanced quality of life for their animals.

The Ontario Veterinary College is grateful for IDEXX’s financial and in-kind sponsorship and together we look forward to a future at the forefront of discovery that will usher in a new age of animal wellness.

Thank you for your support!

HEALTH INFORMATICS: WHAT'S AHEAD?

Sitting at the busy intersection of health and technology, health informatics has tremendous potential for raising the standard of healthcare, and for growth. The President and Chief Strategy Officer of Samsung Electronics, Young Sohn, said, “there are now 340 trillion-trillion-trillion IP addresses on the planet...mostly inside connected devices that already have the ability to talk to each other.”¹ These are sensors connected to the internet with the ability to generate an untold volume of data that can be delivered in real time. Artificial intelligence (AI) will help us make sense of that data. “Sohn envisions a world where vast amounts of personal health and DNA data are stored online for use by AI-driven software.”

Vinod Khosla, co-founder of Sun Microsystems and founder of Khosla Ventures, famously predicted that 80% of what doctors do (not the doctors themselves) will be replaced by AI.² He also stated that innovation in health would occur from the edges in, due to the strong central core of established medical providers, practitioners and regulation. An iconic example would be the introduction of the fitbit™, an activity tracker intended to help people manage their health through weight and exercise. Since its debut over a decade ago, the important relationship between weight and health has become conspicuous, affecting diabetes, cancer, cardiovascular and respiratory disease. Technology has become smaller, faster, smarter, cheaper and more connected, to the point that we can now get a medical grade EKG on our watch or phone in 30 seconds, and monitor for atrial fibrillation.³ Using

sensors for ongoing health monitoring, rather than intermittent clinic visits and scattered medical records, is becoming practicable.

AI has already been shown to improve diagnostic accuracy in evaluating dermatology,⁴ radiology⁵ and pathology⁶ images and it will also help us make better sense of the data stored in medical records, which are often scattered and incomplete. Amazon Comprehend Medical⁷ is a natural language processing service launched in November 2018. It can extract medical information from unstructured text by identifying clinical signs, laboratory tests, and patient diagnosis and treatment data from a variety of sources, such as doctors' notes, clinical trial reports, and patient health records. The service is HIPAA eligible and can meet the standards for General Data Protection Regulation (GDPR). It can identify and preclude protected health information (PHI) such as name, age and medical record number, in preparation for research.

Not only will we have AI tools to analyze data, we will be able to interact with them in the simplest manner using voice. AI voice-based assistants, such as “Alexa” or “Hey Google” are now being combined with visual displays, such as Amazon Echo Show or Lenovo’s Smart Display. Just as people ask how to prepare a meal and are shown an instructional video, one could ask how to perform a surgery or interpret a new laboratory test. “Suki” is a voice assistant that listens to interactions between doctors and patients and converts the conversation into medical and billing terms, creating a clean electronic health record. So “I think I’d like

to see you again if things aren’t better within a few days,” becomes “Schedule three-day follow-up.”⁸ or, “Milo has lost some weight, so let’s do some lab work to see what’s going on” becomes “Order blood work and urinalysis.”

In summary, the future will bring:

- ❖ **Abundant data** from sensors and other sources
- ❖ **AI to analyze that data**
- ❖ **Voice interaction with AI**

As sensor technology becomes more accessible and affordable, it is moving into the veterinary sphere. In 2018, Banfield launched its Pet Insight Project, a three-year program to study the health and wellness of dogs, based on their Whistle FIT activity monitor, which they give away free to clients who have signed up for their optimum wellness plan. Activity is just one component of a comprehensive approach to preventive health which we intend to explore.

The nature of veterinary practice will undergo significant change as the emphasis shifts from sporadically treating disease to the ongoing monitoring of wellness, and veterinarians have new technological tools to assist them. While continuing to offer new health interventions, veterinarians may be expected to adopt the role of a coach, who helps their clients navigate good choices for the health of their animals and interprets incoming information from a variety of sources (e.g. data from sensors, owner observations, laboratory test results, genetic data).

NEW RESEARCH DEVELOPMENTS



• Dr. Barr Hadar (left) and Dr. Ken Lambrecht (right with "Bug")

The annual Veterinary Innovation Summit (VIS) held at Texas A&M in conjunction with NAVC brings together executives, academics and entrepreneurs who all share an enthusiasm for a healthier future fueled by technology. Thanks to IDEXX support, Dr. Bernardo attended VIS in April of 2018, and made important new connections with two veterinary practitioners who share the vision of using technology to maintain closer relationships with their clients and raise the standard of care for their patients: Dr. Barr Hadar and Dr. Ken Lambrecht. Partly with the support of IDEXX, within four months, Dr. Hadar moved from Hawaii to Guelph to begin his PhD in epidemiology. He and Dr. Lambrecht (and his adventure cat "Bug") became key collaborators and connectors in a network of feline practitioners and committed clients, intent on **closing the gap between research and practice**.

A recent study published in *The Lancet* showed that obesity in humans was associated with shortening of life expectancy by 4.2 years in men and by 3.5 years in women.⁹ Dr. Lambrecht, a preventive care practitioner from Wisconsin, is a recognized expert in weight management for cats and in the use of technology to address feline obesity. He has an extensive network through Board Membership and serving on various committees of the American Association of Feline Practitioners, AAHA and the Pet Nutrition Alliance. For a decade, he has led an annual Ideal Weight Contest for shelter cats (*The Biggest Loser* for cats) that makes them more adoptable, helps to fund shelters and raises awareness of the pet obesity epidemic. Drs. Hadar, Lambrecht and Bernardo are investigating a combination of software and hardware to support weight management in cats, including automated

feeders, activity monitors, scales and play/treat devices.

New members of the OVC team include a communication specialist (Dr. Jason Coe), a board-certified nutritionist (Dr. Adronie Verbrugge) and a behavior and welfare specialist (Dr. Lee Neil). They join Dr. Elizabeth Stone (urologist and surgeon), Dr. Zvonimir Poljak (quantitative epidemiologist) and Dr. Deborah Stacey (computer scientist). Made possible in part through IDEXX, a pilot study has been conducted with collaborating veterinarians and their clients to learn about their experiences and preferences using the various devices. Survey results from the pilot will inform a broader research study in 2019 involving more veterinarians and multi-cat households to evaluate the use of a technology ecosystem in weight management and its relationship with the human-animal bond. This new initiative, developing a home health technology ecosystem, will strengthen community building and **engage owners in the health of their animals**.

An analysis of IDEXX preventive care screening profiles from more than 5,000 practices found that laboratory testing regularly yielded results that potentially warranted further action in 15 percent of adults, 21 percent of seniors, and 42 percent of geriatrics.¹¹ As of 2016, however, 51.7 percent of cat-owning households did not obtain routine or preventive care.¹⁰ Weight is something that is easily measured at home and can serve as a trigger for a veterinary visit and earlier detection of underlying issues.



• While visiting OVC, Dr Lambrecht met with an enthusiastic group of veterinary students in conjunction with OVC's Small Animal Club.

PROGRESS IN ONGOING RESEARCH

Using diagnostic data trends to strengthen the veterinary-client-patient relationship

A study by Partners for Healthy Pets which looked at more than five years of data from staff and client surveys found that pet owners don't always hear what veterinary team members think they communicate.¹² We are collaborating with Dr. Jason Coe, OVC Associate Professor of Veterinary Communication, and PhD candidate Natasha Janke to explore how veterinarians can use data trends (e.g. weight and diagnostic test results over time) to strengthen the veterinary client relationship and improve pet health. Field work is nearing completion, approaching the target of **video recording 1,000 veterinary/client appointments** in small animal practices. Analysis of the videos has commenced and will be followed by focus groups and surveys to determine elements contributing to client and veterinary satisfaction with current weight and diagnostic test communication practices. Results will be used to develop evidence-based best practices to enhance veterinarians' abilities to elucidate the value of diagnostic testing to clients, especially the use of data trends over time, for preventative care decisions.



BUILDING HEALTH INFORMATICS LITERACY

Day 1 Competencies in Health Informatics

In 2015, the American Association of Veterinary Medical Colleges (AAVMC) convened a Working Group to develop a framework for competency-based veterinary education (CBVE) with representatives from the U.S., Canada, Europe and the U.K. This was one of the most substantial pedagogical projects ever undertaken by the AAVMC and the resulting framework, released in 2018, will serve as a resource for colleges redesigning their professional curricula. It aims to improve veterinary medical education and ensure the success of new graduates.

The rapid development of new technologies (e.g. point-of-care diagnostics, cloud-based and AI-based practice management and laboratory systems) and modes of service delivery (e.g. home visits, telemedicine) in veterinary medicine present both a challenge and an opportunity for new graduates to add value to the practices they join. In keeping with modern methodology for development of day one competencies, we worked with a small group of veterinary practitioners, who are leaders in the use of information technology to determine the skillsets, attitudes and assessment measures necessary to prepare new veterinarians to successfully integrate these technologies into their practices and businesses.

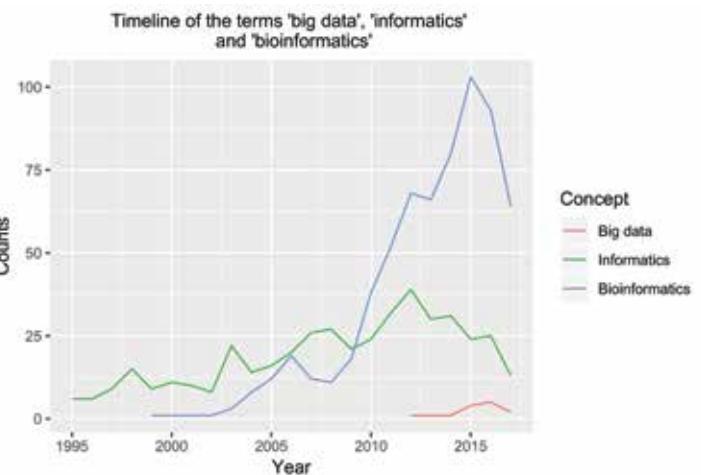
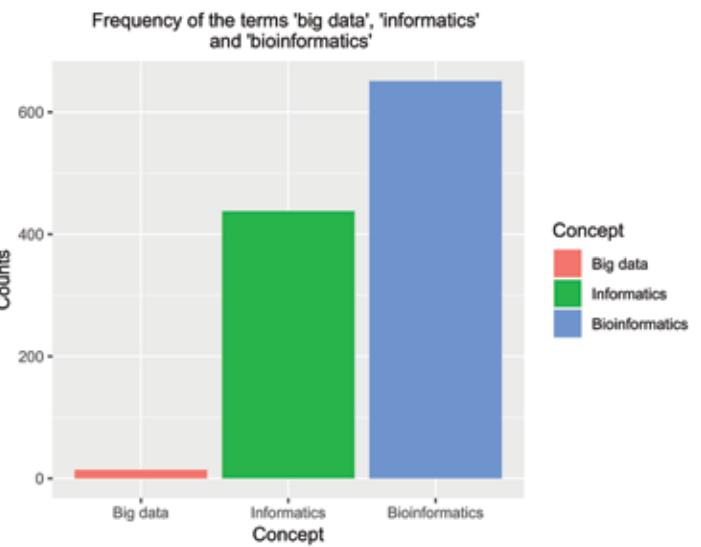
The experts met virtually for a total of 12 hours and came to consensus on the following major competencies, details of which will be published in a veterinary education journal:

- Stay current with emerging technologies
- Assess new technologies and their effects on animal health
- Utilize technologies to optimize the client and patient experience
- Utilize technologies to support the mental health of veterinarians
- Understand regulations regarding technologies
- Select appropriate technologies to improve delivery of veterinary care and to educate the public about pertinent veterinary issues

Scoping review of big data, informatics and bioinformatics

Since health informatics is new territory for veterinary medicine, we wanted to establish a baseline of who is doing what and what they are calling it. We conducted a formal scoping review to determine how the terms “big data,” “informatics” and “bioinformatics” were used in the veterinary medical and animal health literature. We initially identified over 8,000 articles. After relevance screening, about 1,100 remained for analysis. Each article took approximately 15 minutes to review, and there were two reviewers for each article. Only 14 articles mentioned big data, compared to more than 400 referencing informatics and more than 600 referring to bioinformatics.

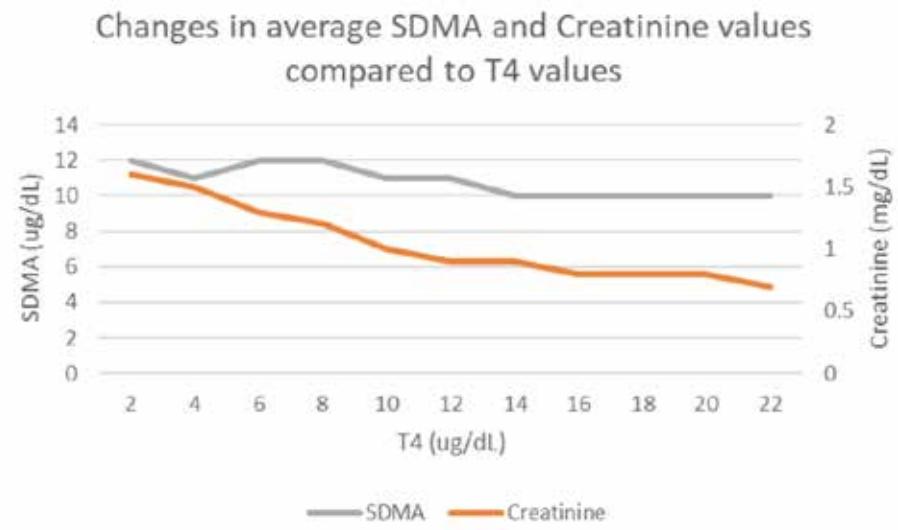
The term “informatics” has trended upward over time. “Bioinformatics” first appeared in 1999 and has risen rapidly, whereas “big data” didn’t appear until 2012. “Bioinformatics” studies tended to use genetic data sources, compared to “Informatics” studies which used a wider variety of data sources (e.g. electronic medical records, sensors, global positioning systems). This work will provide a clearer picture of research completed to date, the species studied and the types of analysis applied. We have been invited to submit this research for an upcoming special issue (June 2019) of *Animal Health Research Reviews* on “Big Data.”



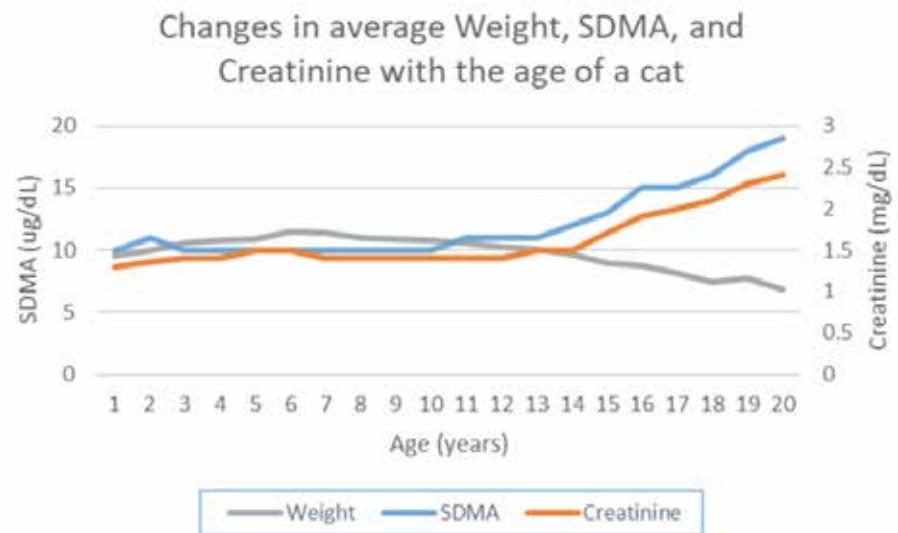
BIG DATA Analysis

Building on our research analyzing the weight of cats over their lifetime, we worked with data provided by IDEXX to explore the relationship among variables linked to chronic kidney disease in aging cats. Specifically we looked at creatinine and SDMA measures, two important biomarkers used in diagnosing and monitoring kidney disease. One of the difficulties in diagnosing kidney disease is the presence of additional diseases, particularly hyperthyroidism, which often masks the presence of kidney disease.

While average creatinine and SDMA values follow a similar trend over the lifetime of a cat, the increase in average SDMA occurs earlier than the increase in creatinine. If the health status of the cats was known, differences in these parameters between healthy and sick cats might be detected. Ideally, having repeat measures of kidney disease parameters throughout the lifetime of a cat would help to elucidate the respective changes in weight, SDMA and creatinine relative to the onset and progression of chronic kidney disease.



Thanks to IDEXX we were able to explore the relationship between SDMA, creatinine and T4 (the key marker for a diagnosis of hyperthyroidism) in over a million cats. This large dataset helped verify that SDMA is a better predictor of kidney disease in the face of hyperthyroidism. Even at high T4 values, there is little change in average SDMA values, whereas average creatinine values decline. Thus, by using creatinine alone we may miss some individuals with kidney disease, if they also have hyperthyroidism.

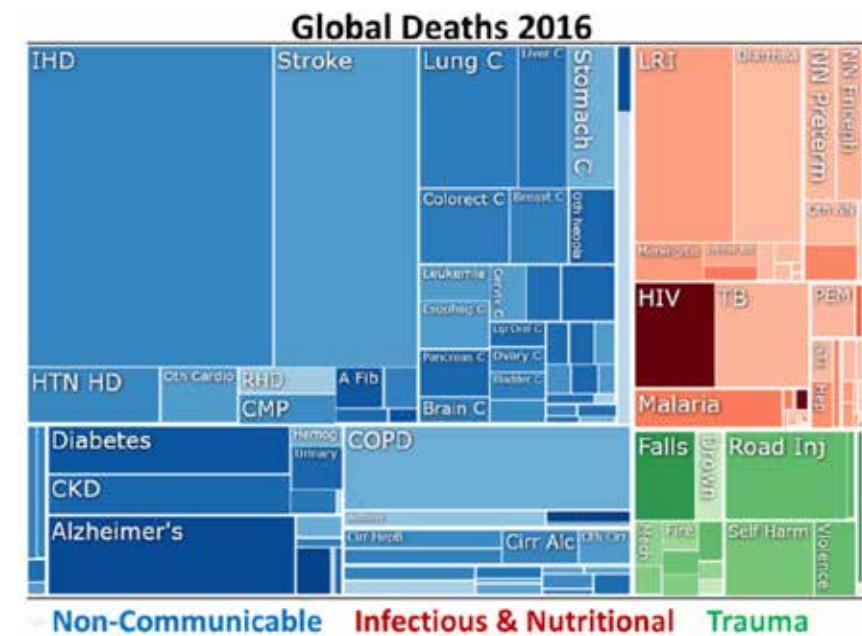


BIG DATA for One Health

The good news in human health is that global life expectancy has more than doubled over the last 200 years. The bad news is that 7 out of 10 deaths are now due to non-communicable disease, led by heart disease, stroke and various cancers. This data comes from the Global Burden of Disease study¹³ that was started by two researchers in the 1990s. It now involves more than 3,000 collaborators, has generated almost 20,000 peer-reviewed publications and has been cited more than 700,000 times. It is a stellar example of what can be achieved by openly sharing data.

We don't yet have a corollary in animal health; however, companion animals face many of the same issues (and underlying causes) of non-communicable disease as humans. Aside from euthanasia, we do know that cancer is the biggest killer of dogs, based on records from insurance companies and teaching hospitals.^{14 15} There is less data for cats, but it indicates that kidney disease is the biggest problem, followed by cancer.^{16 17}

There is a nascent initiative to develop the Global Burden of Animal Diseases, with initial funding from the Gates Foundation and involvement of the World Organization for Animal Health (OIE). Dr. Bernardo has been asked to assemble and lead the health informatics working group. The initial focus will be production animals; however, the potential for linking companion animal and human health is compelling, particularly in light of the common challenge of **reducing chronic disease to achieve more years of healthy life** and the role of our shared environment as a contributor to these diseases. Perhaps one day we will have a Global Burden of Companion Animal Diseases based on IDEXX data.





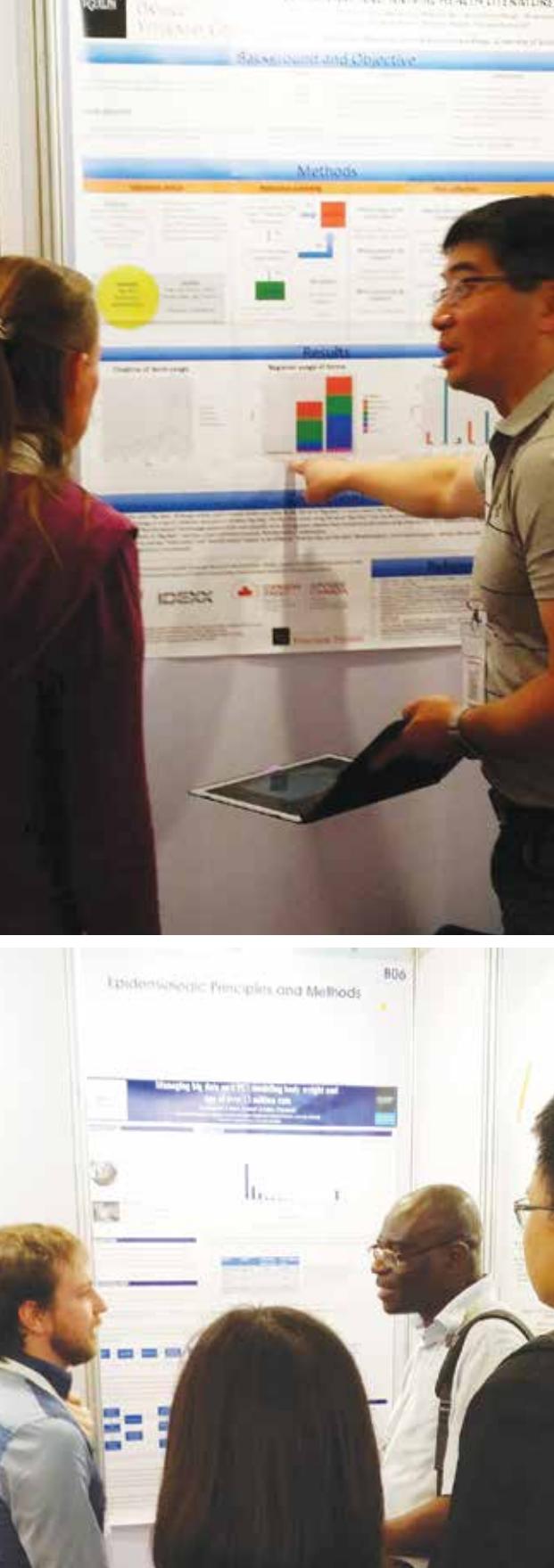
Dr. Bernardo is a member of ISVEE's International Management Committee and gave an oral presentation titled "A Framework for Health Informatics: BIG Ideas from BIG Data" based on our collaboration with IDEXX.

Thailand Symposium Lecture

Every three years, our major international professional meeting, the International Symposium for Veterinary Epidemiology and Economics (ISVEE), is held in a different part of the world. In 2018, ISVEE was held in Chiang Mai, Thailand, with over 700 attendees from 70 different countries.

The IDEXX Chair presented at the International Symposium for Veterinary Epidemiology and Economics.

Drs. Campigotto and Ouyang both received travel grants from the Department of Population Medicine to facilitate their attendance and each presented a poster about their research on analysis of IDEXX data and a scoping review of health informatics, respectively.



ENGAGING STUDENTS IN HEALTH INFORMATICS RESEARCH



🐾 In the summer, our research team is augmented with the contributions of our capable veterinary student researchers: (from left to right) Sophie Bile (OVC 2020); Kate Wycherley (OVC 2019); and Alison Thomas (OVC 2020)

Summer research team and telehealth

In addition to IDEXX Chair funds, we are grateful for support for our summer research students through the Department of Population Medicine and the University of Guelph's Undergraduate Research Assistantship program. Kate Wycherley and Alison Thomas returned to our lab as alumni, providing continuity and contributing to several of our ongoing research projects. Sophie Bile was affiliated with our lab in the summer of 2018 while participating in the Veterinary Entrepreneurship Academy where she was assigned to work on a telehealth survey for market research with the Veterinary Innovation Council. We took advantage of Sophie's experience to develop a research survey on telehealth, which will be administered once it is approved by the Research Ethics Board, and later submitted for publication in a peer-reviewed journal. Dr. Bernardo serves on the College of Veterinarians of Ontario (CVO) Innovation and Technology Advisory Group. The CVO has been a leader in telehealth regulation and has convened this group which includes regulators from around the world.



Barr Hadar, DVM (PhD graduate student)

Dr. Hadar joined our research team in September of 2018, gaining direct entry into the PhD program and receiving the International Doctoral Tuition Scholarship. In addition to a DVM from Colorado State University (2014), he has a BSc in Animal Science. He has four years of experience working in small animal clinics and a large animal mobile practice, as well as operating his own small animal mobile service. During this time, he explored and incorporated new technologies, including 3D printing (surgical planning and client education), imaging systems (CT and PACS), practice management software, communication platforms, client satisfaction analysis, and medical monitoring devices. He is concurrently completing his PhD coursework and has launched research on the development and analysis of a pet health technology ecosystem (activity monitor, smart feeder, smart scale, video camera/exercise device, pet app/portal), initially as a tool in feline weight management, although it has broader potential.



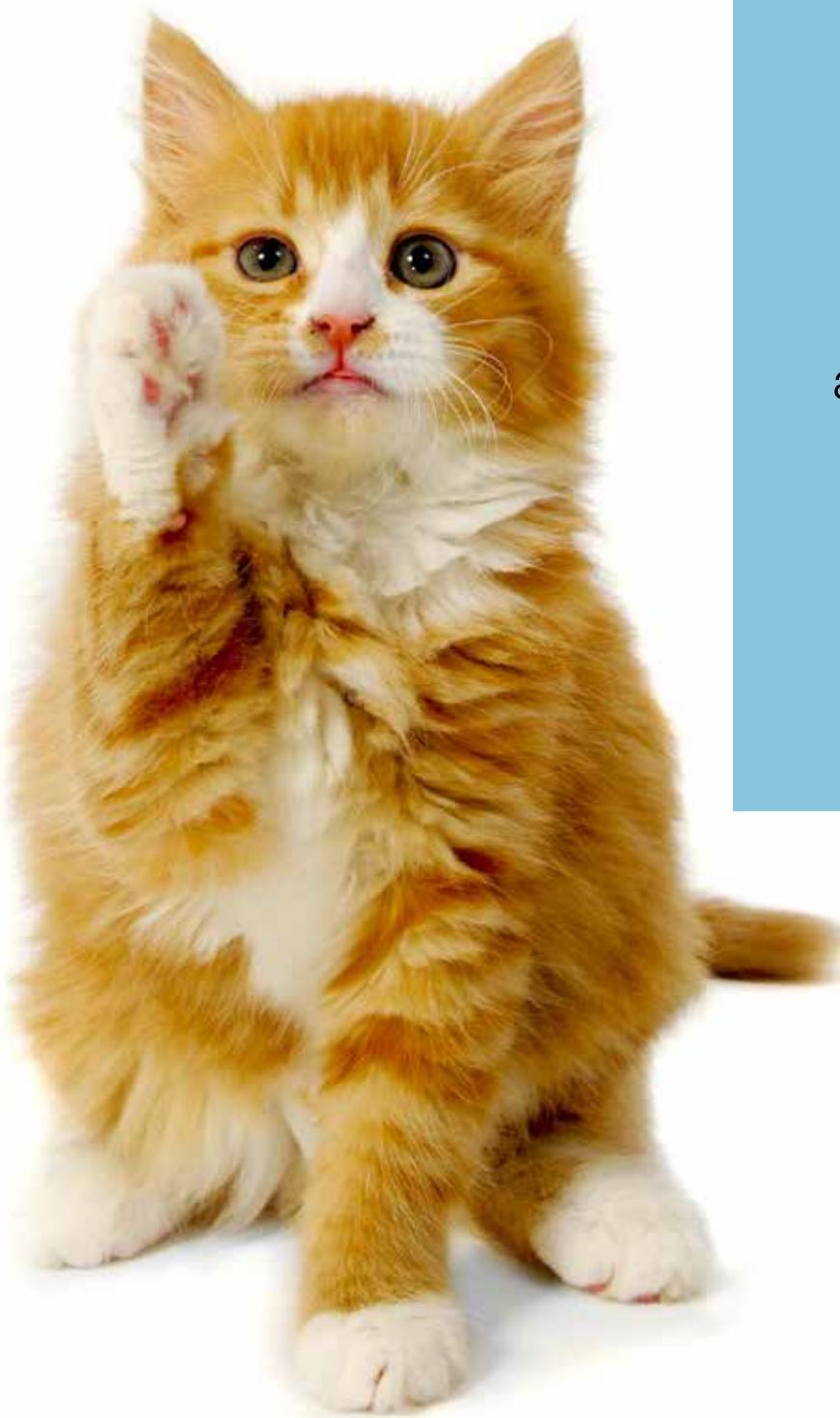
Ben Ouyang, VMD, MS (PhD candidate)

Dr. Ouyang has a VMD from the University of Pennsylvania, as well as masters' degrees in Clinical Sciences (with a focus on epidemiology) and in Applied Mathematics and Statistics from Colorado State University and Johns Hopkins University, respectively. He has progressed from PhD student to PhD candidate, having completed his coursework and passed his qualifying exams in 2018. He continues to receive support through the International Doctoral Tuition Scholarship. Dr. Ouyang is the lead on our research on telehealth, Day 1 competencies in health informatics and the scoping review on health informatics in veterinary medicine. He is interested in applying his quantitative skills to perform predictive analytics on veterinary health data. For example, we have access to data on canine infectious respiratory disease, which could be explored to predict clinical signs based on various risk factors, such as etiologic agents or lifestyle exposures (e.g. visits to a kennel, groomer or veterinary clinic).



Adam Campigotto DVM (PhD candidate)

Dr. Campigotto is a veterinarian (OVC 2015) with an undergraduate degree in biomedical computing from Queens University (2009). He has experience in emergency medicine and continues to do locums. He began his master's degree in January of 2016 and was accepted for transfer into the PhD program in the summer of 2017. He was awarded an OVC Graduate Fellowship and also received the Robert Jameson Memorial Scholarship for Feline Studies in 2018 for his groundbreaking work on feline weight using IDEXX data. His first paper was submitted to the Journal of the American Veterinary Medical Association in July 2017 (accepted in 2018, and slated for publication in 2019), which is circulated to over 80,000 practicing veterinarians. Adam continues to lead research analyzing IDEXX data regarding cat health and wellness. Establishing an evidence base will strengthen the veterinary-client partnership in their mutual quest to provide more years of healthy life for their pets.



We look forward to strengthening our partnership with IDEXX to provide our clients with evidence-based wellness plans, early identification and treatment of disease, and an enhanced quality of life for their animals.



POSTERS AND PRESENTATIONS

IDEXX was cited as a research partner and collaborator in the following posters and presentations:

Bernardo, T.M. (2018). *A Framework for Health Informatics: BIG Ideas from BIG Data*. XV International Symposium on Veterinary Epidemiology and Economics, Chiang Mai, Thailand.

Bernardo, T.M. (2018). *Big Data and Food Security*. Arrell Food Summit. Guelph, Canada.

Bernardo, T.M. (2018). *Big data: real world examples and future implications for health*. World Veterinary Association Congress, Barcelona, Spain.

Bernardo, T.M. (2018). *Innovation at the intersection of health and technology*. College of Veterinary Medicine, Purdue University, West Lafayette, Indiana, United States of America.

Bernardo, T.M. (2018). *Trends in health and technology: a combination for innovation!* World Veterinary Association Congress, Barcelona, Spain.

Campigotto, A., Poljak, Z., Stone, E.A., Stacey, D., and Bernardo, T.M. (2018). *Managing big data on a PC: modeling body weight and age of over 13 million cats*. International Symposium of Veterinary Epidemiology and Economics. Chiang Mai, Thailand.

Campigotto, A., Poljak, Z., Stone, E.A., Stacey, D., and Bernardo, T.M. (2018). *Using Big Data to explore the relationship between signalment and weigh in over 13 million cats*. American Association of Feline Practitioners Conference, Charlotte, North Carolina, United States of America.

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To meet the challenges we face on this planet, the status quo is no longer enough. The future of life as we know it is uncertain. There is no sole solution, no one technology, no single game-changer; what's required instead is collaboration, research that crosses boundaries (natural, artificial and social) and solutions that mirror the complex eco-system of sustainable living. From how we feed the world and preserve its nature to how we live, interact and thrive in our communities and businesses here at home, we must continue to evolve. We must improve.

The University of Guelph, and everyone who studies here, explores here, teaches here and works here is committed to that simple purpose: To Improve Life.

We improve life by focusing on the whole person to shape better citizens of the world. We improve life by passionately engaging in our communities. We improve life through rigorous exploration in the natural sciences. We improve life by finding better ways to nourish all living creatures. We improve life by partnering in and teaching ethical, sustainable business practices. We improve life by teaching the arts and integrating culture into all fields of study. We improve life by engineering solutions that safely connect humankind to this planet and perhaps beyond. We improve life by nurturing positive and respectful social interaction on this campus. We improve life by openly celebrating our capacity to be inclusive.

We improve life by attracting and supporting students, faculty, and staff who share the belief, the passion and the will to do so.

To improve life is our shared challenge. What role will you play? How will you participate locally, nationally and globally? What will you achieve before you leave? What will you achieve after you leave? How will you help us tell the world?

At the University of Guelph, our focus on life has run deep for over 150 years. Today we commit again to improving it for the future.

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