

All Data Great and Small: Digital Innovation and Animal Health in the 21st Century



Our world is changing – and changing fast. By 2020 there may be 20 - 50 billion devices connected to the internet – in a world with 8 billion people. Advances in semi-conductor technology mean that performance is increasing and power demand and prices are falling. There is a seemingly insatiable demand for wearables, apps, medical devices, home automation, and for adoption of these tools into every facet of our lives. Interconnectivity between these sources of data promises a world of smart cities, transport systems, energy supplies, health systems, government services, food supply, retail and, of course, entertainment. Machine-to-machine communication is becoming a reality – maybe your bathroom scales will interact with your Fitbit, your store cupboard and your kitchen to ensure you don't consume more calories than you burn. These interconnected data, the internet of things, promises to disrupt every aspect of our lives. This article considers what this may mean for animal health and veterinary services.

One hundred years ago, the horse was the engine of our industry, of our armies and our farms. Equine medicine and welfare were the cornerstone of the veterinary profession. Koch, Theiler, Salmon and Ross were pre-eminent in shaping our understanding of the infectious nature of disease. In many ways, our delivery of veterinary medicine has changed little since that time, despite threats from climate change, to global food security, disease emergence and antimicrobial resistance in our increasingly Anthropocene world. Of course, there is much more focus upon companion animals and on the productivity of farmed livestock; sophisticated new medical and surgical interventions are possible, and our understanding of the genetic basis of disease has been transformed. Nevertheless, for most veterinarians in practice most of the time, their work is the diagnosis and treatment of disease in individual animals or groups of animals. Curing disease is a contribution to animal welfare – but preventing disease and enhancing welfare are arguably greater. Can the digital revolution change the role of the veterinarian? And if so, are today's veterinarians trained and equipped to take advantage of this opportunity? And finally – if change is possible and desirable, who will pay for it?

Can the Digital Revolution Change the Role of the Veterinarian?

According to a report produced by IDTechEx - <http://www.idtechex.com/research/articles/wearable-technology-for-animals-a-2-6bn-market-worth-watching-00006576.asp>, the animal wearable market currently engages more than 100 companies and is predicted to grow to a value of US\$2.6 billion by 2025. Uses include tracking and identification, behaviour monitoring and veterinary diagnosis. There are even games for animals to play – see <http://www.bitrebels.com/technology/iphone-apps-for-pets-a-frog-lizard-cat-dog-play-games/> for a bearded lizard playing “ant crusher”. Pharmaceutical companies, including Zoetis, are developing

digital platforms and technologies for animals combining interaction with owners and their vets with healthcare reminders and with monitoring of behaviour, exercise and nutrition. Precision livestock farming demands animal tracking and detection of events, including parturition, oestrus, rumination and early indicators of ill health such as lameness. Smart milking parlours measure productivity and nutrition, whilst grassland management is also facilitated by remote sensing. There is no doubt that technologies are being created – but will they be adopted? This depends on:

- **Expectations** – amongst people, communities and clients.
- **Execution** – organisation and delivery.
- **Environment** – data, capabilities and interfaces.
- **Enablement** – infrastructure and technology.

Scenario One: Pet Dialog + (Zoetis)

Use of a collar-mounted movement sensor to predict the behaviour of a dog. Through longitudinal analysis of an individual animal's behaviour, early signs of aberration can be detected, advising the owner and their veterinarian to undertake a consultation. Early evidence of osteoarthritis leads to advice on lifestyle changes to prolong mobility and avoid or delay prescription of pain relief to mask clinical signs. Over time, epidemiological analysis of data from many dogs leads to identification of risk factors and to advice on prevention.

Our client base are increasingly engaged with the digital world in other parts of their lives. Their appetite for seeing this extend to their animals will vary according to factors including age and experience. Amongst livestock farmers who may be adopting digital innovation in other aspects of their business, they may be ahead of the veterinarians in understanding opportunities. Given a desired outcome, will a digital product or service actually operate seamlessly? Experience with highly sophisticated products in our personal lives – banking, travel websites, gaming – leads to impatience with products seen as “clunky”, with a poor user experience, time-outs or excess clicks to reach a result. Data quality is an essential prerequisite for meeting expectation. Whilst the promise that integrating multiple data sources will deliver new intelligence is genuine, the rubbish in: rubbish out rule still applies. As additional data streams are brought together, errors may multiply, leading to misleading results and poor decisions. Even where data of verified quality are being combined, the power to generate new knowledge and to use this for better decisions lies in the algorithms and analysis that may operate in an unseen “black box” in the cloud. The value lies not in the data – these are just the raw materials, the bricks that can be used to build something beautiful or left as an ugly heap – but in the intellectual property invested in the interrogation of these data to deliver useful outcomes to end users. So to answer the question – the digital revolution

inevitably will change the role of the veterinarian. Current veterinary practice business models will be challenged; if existing businesses do not change, then the new enterprises that will emerge will eventually threaten some of them with extinction – think Kodak!

Are Veterinarians Trained to Take Advantage of Digital Innovation?

Scenario Two: SMART Pig Health:

Environmental monitoring and remote sensing of pig behaviour in a finisher barn enables early detection of sub-clinical respiratory disease. Control is managed by manipulation of stocking density, diet and ventilation, protecting animal welfare, avoiding use of antibiotics and ensuring a high level of productivity. A network of similar enterprises share their data, enabling researchers to examine trends in time and provide early warning of the emergence of new diseases.

High school students who choose to join vet school are informed by their own preconception of what this vocation entails – typically driven by a sense of service to animals and their owners. They are highly motivated, academically high achievers and are used to excelling in their chosen activities. They are also a new generation for whom the smartphone, the gaming console and the internet are as much a part of their lives as the television and the automobile are for their parents. Life without this technology is unimaginable. So as a profession, we are privileged that very talented individuals want to join us, and who bring with them an expectation that these technologies will be a part of their working lives. Their potential to shape and lead our profession in the future is immense. However, the veterinary curriculum is crammed with the underpinning scientific knowledge and development of clinical skills needed to develop what in the United Kingdom is defined by the Royal College of Veterinary Surgeons as a Day One Competent veterinarian. This challenge of learning may seem to preclude inclusion of yet more content devoted to digital technology. However, innovation in delivery of teaching and examples of outcomes derived from innovation in practice do afford the opportunity to create interest and curiosity. More senior members of the profession, whom these students will take as their role models, whether in academia or in practice, may be resistant to change and even regard digital technology as a threat to their personal vision of what it means to be a veterinarian. Today's students have immediate access through their mobile phones to more information than their predecessors could have gained from months immersed in a quiet and dusty University library relying on the printed word. New knowledge emerges and is communicated rapidly – and can also be immediately open to challenge. Therefore, whether as qualified professionals or as students, our challenge is to navigate these oceans of information, distinguishing that which is of value and discarding the dubious or downright false. The skills we learn as clinicians, where each case demands that we seek explanations, test hypotheses as to the cause, and use ancillary diagnostics to support or refute our diagnosis, engenders problem-solving ability that should translate into taking advantage of

opportunities afforded by digital innovation. In the UK, the VetFutures initiative, which is jointly supported by the Royal College of Veterinary Surgeons and the British Veterinary Association, has proposed a biennial innovation symposium to showcase new technologies and promote their adoption within the profession – see <http://www.vetfutures.org.uk/resource/vet-futures-action-plan-2016-20/>.

As veterinary professionals, we do not need to be able to be software developers, to be able to design and implement machine-learning algorithms or to personally interrogate so-called “big data”. Our primary role is in defining and understanding the outcomes that our clients expect us to deliver for them and beyond that, to create new services that we believe will bring benefit to them and their animals. This might include, for example, wellness clinics based on health data captured through digital technology, or dairy herd health and productivity assessments based on data derived from multiple monitoring and sensor devices. Finally, clinicians should consider the benefits from sharing their own data to evaluate the efficacy of treatments, to consider how to differentiate amongst clients or, e.g., target marketing and messaging and to review their business efficiency.



Livestock have a vital economic and cultural role in many low- and middle-income countries. They may offer a pathway out of poverty <http://www.ilri.org/EADD> and also provide high-quality protein to supplement meagre diets for vulnerable groups such as women in pregnancy and young children. However, access to veterinary services is often poor and animal health is threatened by epidemics that may also impact human health. These complex agro-ecosystems are a focus for so-called One Health initiatives. Africa is one of the most rapidly growing markets for mobile phones and these have already transformed lives through, e.g., access to banking <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:22551641-pagePK:146736-piPK:146830-theSitePK:258644,00.html>. There is huge scope to develop and introduce digital innovation into animal healthcare in these countries.

It is important to realise that there are significant barriers to the digital dream: confidentiality; data security; incompatibility and mistrust amongst users amongst them. However, historically these barriers disappear when there is a public demand for the benefits they gain as individuals – think of the data that we willingly give away in supermarkets, to Google and via social media sites.

Who Will Pay for Implementation of Digital Technology in the Veterinary Marketplace?

My first job as an assistant vet in a rural practice required hand-written accounts and cash kept in a box in the cupboard under the stairs. Today's practices are already heavily invested in business software to ensure efficiency in performance, and investment in new technology to improve business performance should pay for itself. This should include critical evaluation of the outcomes of treatment and other interventions. Clients' expectations will also be changed by their interaction with websites – for example, <http://www.petmd.com/dog/dog-symptom-checker>. They may well arrive at the clinic with preconceived notions of their animal's ailments and consequently challenge the veterinarian with respect to both diagnosis and treatment. The greater challenge lies in the development of entirely new products and services for animal owners. An important part of this concept must be in the opportunity to provide a wellness service rather than purely a treatment and routine healthcare service – see, for example <http://www.banfield.com/preventive-care/optimum-wellness-plans>. New technology is also available that promises to monitor companion and livestock health – e.g. <https://www.fitbark.com/>; <http://voicy.com/>; <http://moomonitor.dairymaster.com/>; <http://o.zoetisus.com/pigwise.html>. It will be necessary for veterinarians to engage with these and to integrate these new sources of information into their interactions with clients. Pharmaceutical companies including Merial and Zoetis anticipate the role of apps “to reinforce the relationship between the different parties” (Sebastien Lafon, Merial), e.g. <https://www.petpluspaxie.com>. Zoetis intend to “put mobile tools in the hands of either pet owners or farmers, who can use them to create data, then pull that data back into a central environment, apply analytics to it, and present it back to the vet” (Ned Flaxman, Zoetis). Meanwhile, pet insurance companies are investing in solutions to enable

fees to be paid direct to vets instead of requiring customers to seek reimbursement of fees – see <http://trupanion.com/about/media-resources/trupanion-rolls-out-new-veterinary-software>. Therefore, veterinarians should probably not be thinking about how to pay for or charge for digital technology directly, but should see these innovations as a route to new services that meet the needs of animal owners and thus drive business. There are also new business opportunities, which may be exploited by veterinarians or others, to create and promote innovative digital solutions.

Conclusions

Digital technology is set to revolutionise animal health and thus the role of the veterinarian, whether in practice or in other facets of our professional lives. There are great potential benefits for business and, as importantly, for improving the health and wellbeing of the animals under our care. Unless vets embrace these changes, there is a risk that the animal-owning public will move on by. Whilst vets will retain their role in delivery of specialist diagnosis and surgical intervention, they could find others are delivering wellbeing and health management services. Vets have the insights to understand the outcomes that may be reached through intelligent use of these tools, and new business models will emerge that depend on these technologies.



Figure 1: Across a century: Students at the UK's newest School of Veterinary Medicine at the University of Surrey, mobile phones in their hands, meet the National Theatre's Warhorse puppet



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