Teaching to the Test or Teaching for the Future?

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The purpose of a veterinary curriculum is to give the skills and knowledge that are necessary for our graduates to succeed. As academics, we spend an enormous amount of time defining what is "necessary" and this is usually focused on what students need before writing their licensing exam. If they pass, we claim success. However, I believe that this thinking is far too short term for a simple reason: the diseases that they will see, their understanding of their causes, and their ability to diagnose and treat them will change over the course of their careers as animal health professionals. These changes will stem from new insights or understanding of diseases, emergence of new diseases and health concerns, and technology and societal expectations that change how we practice. If change is inevitable, then surely we need to prepare students for what is to come. I believe that we currently fail in this. Adaptability is a mindset but also a skill that can be learned and improved with practice, just like surgery or pregnancy checking in cows. Therefore, we can and should build it into the modern veterinary curriculum.

Knowledge Changes

One of my great grandfathers, my father's father's father, graduated in 1883 from the Montreal Veterinary College (1866-1903). A few years later, he wrote in a letter to his brother that "*ignorance makes a man timid*". He believed in the importance of education but also understood that knowledge changes over time. In one of his notebooks from school, he wrote about the disease called glanders which was a serious and prevalent disease of horses at the time. We now know that glanders is caused by the bacterium *Burkholderia mallei*. However, in 1883, the germ theory of disease was not fully accepted and specific causes of infectious disease were largely unknown. The notebook cites one of his professors saying that glanders was hereditary because foals born to mares with glanders would soon develop the disease themselves. However, the next line cites a second professor, "McE", with a different opinion. He describes over-crowded conditions as being important and also noting that the disease was highly contagious. It took years of investigation to reveal the true cause of glanders.

"McE" was short for Duncan McEachran who was one of the most important figures in the history of veterinary medicine in Canada. He was involved in establishment of the Ontario Veterinary College, later founded the Montreal Veterinary College and he became Chief Veterinary Inspector for Canada in 1885. He helped to promote the position of veterinary medicine in society and was also a passionate proponent of comparative medicine, working closely with William Osler who was in the medical school at McGill University at the time. McEachran and Osler worked on the nature of infectious diseases and their control, and recognized what we now call zoonotic diseases. They practiced One Health, though over 150 years before we called it that.

Jump ahead to 1983, the year that I started veterinary school and also the year that the 6th edition of the book "Veterinary Medicine" by Blood, Radostits and Henderson was published. The description of the disease scrapie is interesting because it refers to the cause as a "viroid particle". The term "slow virus" was also used in the literature at the time because of very long incubation periods, years not days for a typical virus. While we now know that scrapie is caused by prions which are misfolded forms of a normal cellular protein that propagate by seeding the misfolding of normal forms of the protein. The prion hypothesis was published in 1982 and yet there were decades of evidence that should have challenged the idea that scrapie was caused by a virus, and it was years of more work before it was accepted in the mainstream science community. Scrapie was first described in 1732 and was recognized as being contagious but it had unusual properties that were described in the early to mid-1900's. Specifically, it was resistant to heat, UV radiation and formalin fixation unlike bacteria, viruses and fungi. No virus-like particles were observed by electron microscopy and purified forms of the infectious material contained protein but little or no nucleic acid.

The evidence that scrapie could not have been caused by a virus seems compelling in retrospect. The fact that it took decades for veterinarians and scientists alike to accept that there was a new type of infectious agent is an important cautionary tale. The notion that there could be a genome-less infectious agent was far too revolutionary of an idea to be accepted right away as the central dogma of molecular biology that DNA begets RNA which begets protein held too much influence. We ignored the evidence that scrapie could not have been caused by a virus until we had some other explanation to shift our minds to. Since the 1980's, new prion diseases have emerged including Bovine Spongiform Encephalopathy (BSE) in cattle and Chronic Wasting Disease in cervids (e.g., deer, elk). Looking back 40 years, the discovery of prions revolutionized our thinking about infectious agents and was a dramatic example of how we are still discovering new things about biology and disease.

Health Concerns Change

Of course, it is not just prion diseases that have emerged as new concerns in veterinary practice. There are many examples of new diseases that weren't even imagined when I went to veterinary school, including infectious diseases such as West Nile Virus, Porcine Circovirus, SARS and COVID-19. Environmental exposures to things like tailing ponds for wildlife and fish, the risk of fracking on freshwater quality for people and animals in rural settings, lameness in feedlot cattle, and increasing incidence of obesity in pets are modern problems. New issues are emerging all the time often related to "progress" in the modern world including infringement into wild habitat, production animal practices and now climate change.

In addition to diseases and health concerns that are new, it is true that some things that have disappeared such as glanders in horses through hygiene and eradication. Glanders is now considered a reportable disease in Canada. Similarly, I recall as a child that our local veterinarian would come to the farm to test for Tuberculosis and Brucellosis in cattle and yet they are not common problems anymore. Some other issues have been controlled through

breeding and management including a dramatic decline in calving difficulties in beef cattle. Imagine telling a cattle veterinarian graduating in the 1960's that their income from doing TB testing and C-sections would almost disappear by their mid-career.

Ways That We Practice Change

What we do as veterinarians has changed dramatically in the last few decades due in large part to advances in technology. With respect to diagnosis, imaging by ultrasound and digital X-ray, and in clinic evaluation of blood samples are in routine use. These advances have greatly increased access and reduced time to diagnosis. Devices for remote sensing in real-time are on the near horizon including accelerometers on animals to detect locomotion, gait analysis systems to detect lameness, thermal imaging for temperature monitoring, and systems for monitoring feed and water intake. Some technologies are adopted seamlessly from human medicine such as real-time glucose monitoring for diabetes management. When such devices are not tested and approved for animal use, or perhaps not in all animal species, it is up to veterinarians to do the evaluation. Given that, we must think about whether or not we adequately prepare our graduates to collect and/or evaluate data.

Beyond diagnosis, how we prevent and manage disease will change. The rapid development of vaccines for COVID-19 in humans has suggested that RNA- rather than protein-based vaccines are on the horizon, vastly reducing development times. Stem cell-based therapies are being offered for both humans and animals and yet, in most cases, are still under investigation for their effectiveness. Precision medicine based on the patient's individual genome, that influences how an individual will respond to a drug for example, has arrived for some human diseases and is surely around the corner for animals given the rapid decline in the cost of doing genome analysis. Some cattle feedlots already make decisions on which growth implants to use based on simple genetic testing.

A consequence of technology is that it changes the roles of veterinarians in practice, but whether that is for the good or the bad depends on your perspective. Information on the internet about animal disease, diagnosis and treatment is available to anyone, meaning that increasingly animal owners will have made their own diagnosis and treatment plan even before seeing their veterinarian. Therefore, the starting point for that appointment is very different. Some veterinarians have embraced this, including the Cornell College of Veterinary Medicine that has a website to allow anyone to search for diseases and symptoms. The philosophy is, if you can't stop it then at least enable it. Feedlot practice in the world is increasingly being down using remote diagnostics whereby technicians on farm are trained in necropsy and send digital images to veterinarians that could be anywhere in the world for their consultations. It seems likely that automated image analysis and artificial intelligence will one day even displace the front line veterinarian from this role. Likewise, robotic surgery is under development for humans, allowing a surgeon to be anywhere in the world. For complex and delicate surgeries, such technology will eliminate the need to travel and increase access to the best surgeons available.

Other changes in the nature of practice for production animals stem from the changing nature of farms. While the number of food-producing animals in North America has increased in the last few decades, the number of farms has declined ,meaning more animals per farm. There has also been a decline in the number of veterinarians dedicated to food animal production. This is nicely described in a book from the National Research Council in 2013, called "Workforce Needs in Veterinary Medicine. In 2000, Dr Lonnie King set these trends in context and re-framed them as a challenge to the profession:

"With the changing nature of food-animal production in America, the overall demand for traditional veterinary services has declined. Nevertheless, if future food-animal veterinarians can master a broad understanding of the complex challenges of production medicine, there is a great potential to redefine the role of food-animal medicine in the intensive livestock and poultry industries, while at the same time fulfilling the profession's responsibilities to an American public concerned with food safety, drug residues, animal welfare, and stewardship of the environment. If not, the veterinary medical profession is in danger of relinquishing its role in animal production to others who are able to consider the economic needs of producers but who have less understanding of the complexity of animal health and public health."

I believe that this call to action has not been given the attention that it deserves.

Advancing Knowledge is Embedded in the Canadian Veterinary Oath

While we may not be doing a good job now of giving all veterinary graduates the skills to evaluate new information, adapt to new insights and adopt new practices, the Canadian Veterinary Oath actually sets the proper expectations as highlighted below:

"As a member of the veterinary medical profession, I solemnly swear that I will use my scientific knowledge and skills for the benefit of society.
I will strive to:

- *promote animal health and welfare,*
- *prevent and relieve animal suffering,*
- *protect the health of the public and the environment, and*
- *advance comparative medical knowledge.*

I will perform my professional duties conscientiously, with dignity, and in keeping with the principles of veterinary medical ethics.
I will strive continuously to improve my professional knowledge and competence and to maintain the highest professional and ethical standards for myself and the profession."

I could not have said it any better.

Adaptability as a Skill to be Practiced

Our ability to take advantage of new challenges depends on us keeping an open mind ("growth mindset") and building skills that instill confidence even when faced with something new or uncertainty of outcome. Skills improve with practice and so we must embed this into the

curriculum early and often. But what to include? There are several excellent published sources for what is important to build adaptability in people, but I like this one: https://ca.indeed.com/career-advice/career-development/adaptability-skills

In short, the key attributes and skills of someone who is adaptable are:

- Responsiveness
- Experimentation
- Resilience
- Interpersonal skills
- Teamwork
- Effective communication
- Organization
- Problem-solving
- Creative and critical thinking

Discussion about adding something to a curriculum often creates tension as it implies that something would be lost. However, I believe that incorporating these skills into the curriculum need not displace other "necessary" elements but rather can help re-frame what we do by giving it a different purpose. Why can't our communication labs and professional skills courses produce graduates who not only better serve clients but who are also better prepared to adapt to changing information, context, societal expectations and/or their own practice realities?

Let's enable our veterinary graduates to not only survive, but to thrive.