Big Data can be Expected to Advance Veterinary Medicine

Applying the Human Medical Success of Big Data to Our Animal Companions

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Summary: Big Data is revolutionizing the human healthcare system by providing a way to organize the influx of information as well as potentially find patterns through new algorithms that they were unable to use before a unified system was available. This paper aims to defend the reasons why veterinarians should adopt a Big Data system. We urge veterinarians to make the switch over to electronic health record systems so that their patient’s anonymous health information can be pooled to discover epidemiological trends within the data. This will dramatically improve animal healthcare like it has been shown to do for human medicine.

Video Link: https://youtu.be/0U0veeTVtUc

Issue: Getting Animal Health on Board in the Big Data Era (JF)

Big data is revolutionizing human medicine. The ability to analyze electronic medical records of millions of people is revealing information that would have otherwise gone undetected. The same could be true for veterinary medicine. However, the infrastructure for inclusion of electronic medical records of animals into a global database is in its infancy. Additionally, veterinarians on a more limited budget do not use pricey software (which may not be as sophisticated as the electronic health records used for people) and are therefore not sharing potentially very important animal health information. So, how do we get veterinary medicine on board?

What is Big Data? (JK)

Big Data provides a way to organize great volumes of data which, upon analysis, can identify patterns through new algorithms that yield information unable to be realized before.

As time moves forward, so does everything happening around it. Big Data is revolutionizing the world we live in today. It is used to find patterns and gives us the ability to create new forward thinking ideas throughout companies and within a shared market. Big Data has revolutionized the business and insurance area by making it easier to keep track of employee health, send business and delivery statistics in real time, and keep up with the ever essential customer service and reliability.

Small businesses become major corporations, populations go from a few hundred to thousands, diseases turn from outbreaks to epidemics and many more rapid changes occur every day. The problem with an ever-changing lifestyle is having such new methods, ideas and opinions and not being able to keep track of it. The creation of the Big Data system is to have a universal way of keeping track of the three v’s of life, “volume, velocity and variety” (1). The 3 v’s explain the density of information that is already present and the addition of new material, the speed with which the data is presented and the range of ways to obtain such data (Appendix A). Originally
starting in the business world, Big Data aimed to find patterns, anomalies or new ideas within millions of data points throughout a company, or several companies, when combined in one business market. With big business markets and millions of ways to acquire information via handwritten, digital or through trends on social media, Big Data has begun to bring it all together in a more organized fashion (2).

**Not Just Business (JK)**

Big Data has had a monumental impact in industries like the business and insurance industries (Appendix B), but has begun moving away from the business world and incorporating itself into more personalized corporations, such as healthcare. Having a form of Big Data in the healthcare system allows these health companies and their providers to organize the influx of information they receive every day and potentially find ways to do everything involved in organizing and correlating data to provide the best care for as many people as possible (3). With one collective data set developed from millions of sources, medical care is revolutionized to care for as many people as possible and potentially find the most effective ways of finding and curing diseases of all different kinds without struggling to find the necessary materials in order to do so. In one system, everything is readily accessible and available whenever it is needed and this is why Big Data is so beneficial and necessary to health-care.

As Big Data begins to migrate away from the business world and expand, healthcare systems are seeing more practical applications of gathering and storing information in a similar path to what business have created. The important aspect to applying this system to healthcare is “leveraging the collection of patient and practitioner data” to “improve the overall quality and efficiency of healthcare delivery” (4). Keeping patient and practitioner knowledge up to date with the latest medical information is key to maintaining a well-rounded medical system.

**Human Benefits of Big Data**

**Embracing Big Data (JK)**

Although a universal data system is not in place in human medical care yet, the National Health Service of England (NHS) is starting to embrace the changing times. This healthcare system realizes it needs to implement more accessible knowledge and that “because such a system will be used by tens of millions of users: it needs to be available at GP practices, walk-in centers and hospitals across the nation, too, so that falling ill 200 kilometers from home will no longer mean a local doctor cannot call up your patient record” and that data will be stored for other practical use if necessary (5). Changing the way data is collected and stored is a very difficult process that involves many factors on behalf of the patients and the providers that would be entering the data. The system needs to be easy to understand and use along with easily accessible. The NHS is predicting to create “always-on, available-everywhere cloud computing services. Cloud computing allows data to be made available to authorized users anywhere, allowing analytics algorithms that predict and help prevent sickness to be developed and run on those data (5). Dr. David Angus, a firm advocate in Big Data in healthcare, strongly believes “[t]he solution for many of the diseases we’re talking about is in the databanks of the NHS” and that “[i]t needs to be liberated” (6).

**How Big Data Will Make a Difference? (JK)**
By putting more emphasis on “developing and validating new technologies” for animals in regards to their health, people are benefitting from it as well (7). Applying Big Data to veterinary medicine allows for a wide range of information to be organized and accessible for all types of industries including human medicine along with food production and disease control. Having all of this information on hand allows the vulnerability of human contact with new diseases to be reduced along with treatment options to be more easily compared.

**Big Data Effect on Fast Moving Diseases** (SB)
The effects of Big Data have been felt profoundly throughout the medicinal community. It has been used in countless medical situation in combating the effects of major outbreaks and diseases that our governments, universities, and hospitals have had to deal with. One of the many examples of a way that Big Data has assisted in combating common and devastating diseases was the outbreak of Ebola in 2014 (8) . The CDC and a Swedish nonprofit called Flowminder were able to use a Big Data system called Biomosaic to track the movement of populations affected and from this they were able to figure out where the next spots of outbreaks were most likely to occur (8). This allowed them to be more prepared for the fight against Ebola, since Ebola was a type of infectious disease that had never been dealt with before. Having the ability to use Big Data’s analysis is the primary reason that Ebola was able to be contained in such a timely manner. Another way that Big Data used is to help in the fight against fast moving diseases like influenza. The National Health Institute funds a task force that is known as Models of Infectious Disease Agent Study (MIDAS) (8). MIDAS has created a program that uses machine-learning algorithms to screen social media platforms for keywords such as “flu” or “influenza” to provide possible insight on where the next flu outbreak might occur (9). These newly created Big Data websites and tools that give scientists the ability to get ahead of these outbreaks, thus keeping a healthier and happier population.

**Big Data’s Effects on Past Diseases** (SB)
Big Data has proved its usefulness in the fight against fast moving diseases such as Ebola and Influenza, but it has also had profound effects on early diagnosis and treatment of Sepsis. Sepsis, which is also known as blood poisoning does not move as quickly as a disease such as Ebola. It occurs when the body produces extreme immunoresponses to fight off infection which can lead to inflammation and eventually organ failure (8). Sepsis is one of the most expensive conditions to treat, because the symptoms are very generic and happen in many common illnesses (8). By the time the real symptoms begin to occur, they are normally irreversible and mortality rates are extremely high. Over one million people in the US alone are diagnosed with severe sepsis (8). Amara Health Analytics was created because of this to pool together the data from heart rate monitors, respiratory rate, and indicators that gave doctors the a clear and confident readings that their patient was suffering from the symptoms Sepsis (8). This system has made it possible to recognize the early stages of sepsis and has been known to recognize a person who is experiencing the symptoms of Sepsis up to 24 hours earlier than without Big Data (8). More testing must be done in order to take people’s genetic factors into account, but with the algorithms we currently have, the morality rates of Sepsis have been cut 13%-17% (8).

**Big Data and the Effects on Cancer Treatment** (SB)
Cancer treatment options have always been a race against time. Since cancer is a fast moving disease, it has always been up to doctors and physicians to come up with a diagnosis quickly to
allow better chances of survival. As technology advances so do the astounding medical breakthroughs on the war against cancer. Precision medicine has now come into the light which is allowing doctors to identify important molecular and genomic details that make that cancer specific to a certain individual (10). With this new type of precision medicine, doctors and oncologists have now been able to identify things as small as DNA changes within the genetic makeup of a person who has the cancer. This allows for them to adapt treatments which more accurately and precisely to fit the patient’s genomic profile (10). Shridar Ganesan, an associate director of translational science at Rutgers Cancer Institute of New Jersey stated, “What we have learned through the years is that cancer is not a single disease, but rather a collection of diseases, each with unique features… Instead of determining cancer type only by the organ in which it originates, time-saving genomic analysis opens the door for additional classification by the set of changes present in each cancer, which can guide more precise, or tailored, therapy” (10). This time-saving genomic analysis can only be known as one thing: Big Data. Individuals at the Rutgers Cancer Institute with the help of Big Data are now computing genomes and identifying the patterns of patient specific cancers faster than ever. This approach of tackling cancer has been developed by the Rutgers Discovery Informatics Institute (RDI) and RUCDR Infinite Biologics, who has the world’s largest university-based catalog of sequenced genomes in the world (10). By recognizing data patterns and matching them to similar algorithms they are generating analyses of certain kinds of cancers that usually would take multiple days, in hours (10). This is providing treatments at record breaking speeds because it negates the need for the trial- and –error approaches that were used to combat cancer originally.

One example of how this groundbreaking way of medicinal treatment was able to help someone is Kevin Touhey of Medford, New Jersey (10). A former basketball coach and motivational speaker, Touhey developed Stage IV lung cancer without ever picking up a cigarette (10) His lung cancer was genetic, and after looking over their Big Data analysis of his condition, the physicians believed that a specific targeted treatment would be the best way to combat his Stage IV lung cancer (10). He was given an anticancer drug that was designed to target his specific mutation, and miraculously saw improvement in three days (10). He has now returned to more strenuous activity such as workouts and body surfing because of this life saving treatment that was case specific (10).

The doctors and scientists who are working on this Big Data form of cancer treatment have made it their goal to try and tackle the ‘poor-prognosis’ cancers such as certain types of pediatric cancers, sarcomas, ovarian cancer, and pancreatic cancer. These breakthroughs in the ability to treat poor-prognosis cancers now are giving hope to the patients and their families since this method increases the likelihood of life.

**Why Stop with People? (JK)**
Like the rapid changes in medicine for humans, veterinary medicine is a progressing and modernizing field as well. Human medicine has a variety of fields for people of all ages and with all different ailments. As veterinary medicine becomes more prominent, specialists in the veterinary field develop from taking care of animals including everyday house pets to farm animals. By integrating a form of Big Data into this relatively new field, the goal is “to be able to do things like identify shifts in pet health trends as they happen, or spot the next major livestock disease outbreak while there’s still time to control it” (11). The goals of Big Data in the
The veterinary world is aimed to do the same thing as in the medical field for humans, find cost effective ways to provide care and reduce any potential threats to the well-being of a species. Although having Big Data for animals will take time on a universal scale, starting small allows “the benefits of being able to track drug interactions, treatment regimen effectiveness or disease spread across countless clinics” worth the struggle of getting it started and spreading the word (11). Stopping at making a system universal for people that could benefit countless individuals is unfair to the other species that humans are so affected by every day.

**Impacts of Big Data on Animals Thus Far** (ML)

Although Big Data has a long way to go in the veterinary industry, we can already see some impacts it has made for animals across the globe. The innovation and spread of big databases is slowly picking up with creations like VetCloud, PigWise, VETport, LifeLearn, and many others contributing to this revolution. Using PigWise as an example, hog farms have used this web-based platform to virtually share herd health and disease data with other veterinarians. Sharing this has already helped maximize the reproductive performance of the pigs, prevent extremely contagious respiratory diseases on their farms, and understands the transmission path of new diseases being spread (12). The spread of Big Data has also surprisingly helped increase the milk yield from cows in India. Each cow on this farm has a tag that will send their health information to their owner such as their blood profile, whether or not they are in heat, need to be vaccinated, have proper nutrition, and so much more. Having all of these features in their system has helped increase the lifespan and milk production of their cows (13). Another huge contribution to animal science from big data analysis is the pooling of images from the rain forest to detect population declines. In the past, the only way to monitor if a species was becoming endangered or not was to simply observe them. Because of Big Data, the cameras that have been set up in the forests can send massive amounts of images to Conservation International to detect patterns and become aware if a species population is dropping (14). While doing our research on the topic of Big Data in veterinary medicine, it became difficult to find massive amounts of cases where it has greatly impacted animals. While there are a select few that have been mentioned, there are not nearly as many cases as we can find in human medicine. This troubling considering what a close relationship we have with animals. With the finalization of this project, we hope for that to change.

**Vetcloud: Their “Big Picture” Goals** (ML)

There are many electronic health record systems out there, but we will use VetCloud as an example to demonstrate how these cloud based systems are used to improve pet health care. It sets out to replace many of the outdated veterinary systems available today with bookings, payments, client profiles, etc. However as it may seem like any ordinary system out there, they aspire to improve more than just those aspects of the veterinary practice. It has a cloud-based platform much like the iCloud software on cell phones that can sync data automatically to various locations. This will be useful in collecting their data and sending it to government agencies or pharmaceutical companies, where they can search for important pharmacological and epidemiological information or trends within the data. Ultimately, VetCloud hopes to use it to “identify shifts in pet health trends as they happen, spot the next major livestock disease outbreak while there’s still time to control it...track drug interactions, [or] treatment regimen effectiveness...”(11).
Other Benefits (ML)
Veterinarians need to quickly examine their patients and record what is necessary, and this system makes that quick and easy for them to accomplish. Each patient has a profile and their important information is displayed automatically. Each patient in the system has a timeline which can be used to view the records of lab results, images, documents, diagnoses, previous medications, and even their insurance information. Anything the veterinarian might need to know about the patient’s past is readily available. This creates a very accessible network for the vets and a great visual aid to help them in their practice. After creating these pages the veterinarian can then share the information through the system with the pet owners so they are completely within the know (15). These additional features will benefit the veterinarian from an office standpoint by delivering speed and efficiency, which makes these kinds of systems very admirable.

Pet Wellness Report (SB)
Another system that is a step in the right direction of introducing Big Data into veterinary medicine is the (PWR) Pet Wellness Report (16). “The PWR is the first broadly available, standardized Health Risk Assessment for use in veterinary medicine. The report is designed to identify modifiable lifestyle risks, provide clues to early warning signs of disease, and facilitate client communication and education (16).” This report which is given alongside an animal’s standard physical exam, allows veterinarians to obtain additional information which makes it easier to determine potential health risks or diseases. The PWR is also making owners more accountable for the health and wellness of their pets and leaves them more informed about the diseases or potential risk their companion may have (16). In a study done that was sponsored by Zoetis, they tested 400 dogs and 100 cats from 19 veterinary hospitals that the PWR was given out and it was found that newly diagnosed health problems were discovered in 36% of dogs and 28% of cats (16). This is a small scale example of the unparalleled assistance that Big Data can give to improving the wellness of companion animals. One could only imagine the help that could be done if this report was given out at every single veterinary hospital.

Oppositions to E.H.R. (ML)
Some veterinary practices might be against using VetCloud or other EHR software’s for various reasons. Most of the reasons being they are reluctant to change their current system and the potential costs of a new one may be a little steep. These software companies understand this, and VetCloud has ensured help in both of those categories. They have provided a free demo trial period, where the practice can use that time to import their data into the new system. It happens automatically and simply has to be downloaded. They also offer training options that allow the users to feel more comfortable with the new systems. They offer online training, can visit the practice, video conference, or offer help over the phone. In addition, there is always a “Feedback” page in VetCloud that is offered so they can improve their system based on the users experiences. When it comes to the pricing, all EHR systems cost money for the users. Luckily, VetCloud gives you various pricing options that can be specific to your individual practice depending on what you want out of the software. No matter the opposition, the benefits outweigh the consequences when considering the lives that can be saved using Big Data.

Big Data and How Information on Animal Medicine can Impact Human Medicine and vice versa (SB)
Research findings and information realized in one species may provide valuable information in another species. In 1975, Merck laboratories were testing compounds for their antiparasitic effects against heartworm in dogs. One of the compounds that they received was a soil sample from a Japanese golf course that contained a factor which had significant antiparasitic effect; this drug was called Ivermectin (17). After changing its chemical formula to reduce its toxicity it was shown to work as an anti-heartworm medication in animals. This medicine was able to cure this parasite in animals, which prevented early death in house pets. With more studying being done on this chemical, it was found that this drug could also have antiparasitic effects on the human parasite that causes River Blindness (17). After this drug was brought to clinical trials, it was found that with a single annual dose the amount of parasite present was almost brought to zero (17). These remarkable results allowed people in Africa, but also Latin America and Yemen, to move back to their villages that they had to abandon (17). So discoveries realized using Big Data could greatly impact both veterinary and human medicine.

Community Action

The importance of an organized system of animal health care is to increase the longevity of life for all animals from an everyday house pet to all the animals that live on a farm. The main idea is we want to make veterinarians aware that Big Data has the potential to significantly advance animal healthcare. We decided to write the following Letter to the Editor to the American Veterinary Medical Association in hopes that it would get published in their newsletter. We sent a similar letter to many veterinary hospitals. Considering most of AVMA’s readers would be veterinarians, we are hoping that this will spread the word of what a great impact Big Data could have on animal science and veterinary medicine. We hope that veterinarians after reading our letter, will make the decision to switch to an electronic health record system so that their patient data can be pooled with others and contribute to advances in the healthcare of our companions!

“Please consider publishing the letter to the editor below in your AVMA newsletter.

The growing use of Big Data has revolutionized human health with new discoveries in disease prevention, diagnosis, and treatment. Pooling the large amounts of anonymous data has been widely beneficial in finding patterns among certain diseases, deciding the most effective treatment regimens, and ultimately improving patient healthcare overall. Veterinarians and animal health researchers haven’t yet hopped on the bandwagon. Most veterinary offices still rely on pen and paper to record their patient data, which can easily get lost in the shuffle and is not entirely efficient. Most importantly, these records cannot be used for the greater good of other animals and their health. A cloud-based of electronic health record system that anonymously collects patient’s health information would enable researchers to analyze this “big data” and discover epidemiological trends within the data. This will dramatically improve animal healthcare like it has been shown to do for human medicine.

We are urging veterinary offices to make the switch over to electronic health record systems in anticipation of major advances in veterinary medicine. We invite your readers to watch our video clip at the following link: https://youtu.be/0U0veeTfTuC

Thank you,
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By tying together our entire community action we will ultimately be informing the veterinary community as a whole of the great potential a Big Data system could have in animal science. The overall goal is to increase the knowledge veterinarians have of the beneficial uses of Big Data, and in turn to help improve the methods of taking care of animal ailments that greatly affect their everyday lives.

References


Appendix A: History - How Big Data came about

Evolution of Storage Techniques (ML)
Within the last century, big data has been a widely discussed topic before it was known to be addressed by such a term. In 1941 the phrase “information explosion” came about and was being used to describe the overload of data being collected. This data raised the question of what to do with it, and the answer has always been changing. We have always been altering the techniques to gather such massive amounts of information and how to organize it. With the realization that scientific journals and papers could not withstand this exponential growth of the supplied data, people began to brainstorm the options of machine use. Peter J. Denning, a distinguished computer scientist, was a pioneer in this brainstorming. He imagined a way to organize the vast amount of information so that the important data could be saved in a machine, quickly accessed if needed, and used to find patterns within it (18). By 1996, digital means of storage became the most efficient and practical, and within the next year the term “big data” was first used in the ACM digital library.

Internet Explosion (ML)
Before the turn of the millennium, predictions surrounding the explosion of the internet were anticipating it would dominate all other media and data sources. Heading into 2000, the term “Big Data” was well-known to computer scientists and was described by Francis X. Diebold as, “the explosion in the quantity (and sometimes, quality) of available and potentially relevant data, largely the result of recent and unprecedented advancements in data recording and storage technology,” (19). As the internet grew, many scientists and researchers continued to predict its expansion, and every year these predictions became larger and larger. These were not just predictions in quantity, but also in what the data could revolutionize. In 2008, Randal E. Bryant and others published a journal stating that, “big-data computing can and will transform the activities of companies, scientific researchers, medical practitioners, and our nation’s defense and intelligence operations...” (20). Over the course of our history the techniques in which we store and access information have developed immensely, and as the scientists predicted, have had revolutionary effects on the practical uses of the data.

Appendix B:

Big Data Means Business
Using Big Data for Health Care: (SB)
Big Data has the ability to help with medical advancements, but it also has the ability to help businesses find a reliable method for tracking employee health. Companies being able to have access to the medical history of their employees allows them to see how much time has been taken off by an individual because of illness and conditions that these individuals may have. This initiative aims to help companies cut their medical expenses. For example, if a company is aware that an individual has a pre existing back problem, they may be able to send the employee information on home remedies and physical therapy instead of them having to get an extremely expensive back surgery to fix the problem (21). Another example of how this would be beneficial to companies would be if they noticed that one of their employees has stopped refilling their birth control prescriptions because they are looking to get pregnant, they can send them inexpensive nannies or babysitters that can take care of the baby while the employee is at
work. This can reduce stress of their employees while also saving employers money by cutting costs on paid days used to take care of their children or themselves (21). This big data is obtained by only using employee numbers, and the companies are not given access to their names. The Big Data used must be collected in this manner and they must receive employee consent to access this information because otherwise it is a violation of the employees privacy. (21). With the information that the companies are able to access through Big Data, employers are able to assist employees in benefiting their health and the health of their families which in the long run will improve their work ethic.

**Businesses using Big Data:** (SB)
Big data can also predict future outcomes of how their businesses are going to run in the near future. It can predict shipping costs, so that the individual will know if it is better to ship by bus, truck, or airplane and which the most cost efficient is for the company (22). There are many companies such as Oracle, IBM, Tibco, and Esri to name a few that can apply algorithms to the company's data (ex what they are shipping, how much they are shipping) and will be able to yield answers in real time of the best ways to improve company statistics (22). An example of how this predictive data is used is by our government. They can predict when Federal Aviation Administration airport ground stoppages before they even begin to occur (22). They could then give this information to distributors and they would be able to relay the information to customers about a delay in their shipment.

The biggest problem that businesses have with shipping and customer service has to do with the variables (22). Weather and other unforeseen circumstances such as traffic or cargo carries breaking down all provide variability in the way that companies are able to serve their customers. The solution to this problem is that Big Data can now be used in real time to combat these issues. By installing an analytics powered Big Data application on ones phone, this can replace the work that was once done by a clipboard (22). Truckers, field workers, and even men on docks can use this mobile app to display future conditions such as storms and road work delays all in the time that it is actually occurring making businesses more productive (22). These analytics systems can also be used to improve customer satisfaction, sending them live alerts about different arrival predictions further allowing them to send alerts and messages to their customers letting them know the change in arrival time (22). Although this type of Big Data is not the focus of health and the well being of the population, it allows businesses to operate more orderly and efficiently.

**Big Data Changes the Face of Insurance** (SB)
Not only does Big Data improve the business world by allowing businesses to interact with their employees and clients more efficiently, but it has also improves the way that insurance operates as well. Big Data has had the ability to change the structure of the insurance and the long standing problems that the industry has faced (23). Insurance industries manage an individual’s risk of doing something; they collect money from the individual based on their lifestyle, health, and job and from this information they build them a policy that their customers can use if something unfortunate happens (23). Companies are now using Big Data to do this by analyzing the risk of certain clients based on their past claims and using it to determine an appropriate amount of coverage. They are also using Big Data to insure that they are not charging their customers too much money, because this means that they will not buy insurance from the
company if the premiums are too high (23). Since the insurance industry is a highly competitive industry (think of how many car insurers you can think of off of the top of your head) it is imperative for these companies to be able to stay ahead of the competition by providing greater customer satisfaction and appropriate coverage to its members; which is all can now come from Big Data informatics (23).

Another aspect of why Big Data is so important in the insurance arena is because with all of this new technology and data it is essential for companies to provide excellent customer service for their policy holders. As stated before insurance is an incredibly competitive industry, and it is important for these companies to get as many clients as possible (23). With the need for clients, they must make their information simple and obvious, because now a day’s people are looking to get as much as they can for as little as they can. Big Data can be used to predict customer behavior when developing these policies by using information at call centers and customer retention analysis from the customers purchasing these policies and adjusting them accordingly (23). In the past, policies were determined based on information on how policies had worked previously, but now with Big Data and the technology revolution companies are readily able to make changes to meet customer expectations and also make informed decisions to not only assist the customers but also assist in getting their claims answered as fast as possible (23).