

Veterinarian Work, Enhanced by Mobile Technology – An Empirical Study.

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Abstract

The aim of this paper is to find out if mobile technology can be used to enhance a veterinarian's work during house calls. The main focus is toward Equine medicine veterinarians. The results obtained from this research, which were conducted with Finnish veterinarians, are also transferable, to some degree, to other countries. We will find out what the current situation during house calls for veterinarians. We need to understand their daily routines and bottlenecks, how they regard new technology and how they currently use Information Systems (IS) and mobile technology. With this information we can then develop working IS and mobile solutions that will enhance the veterinarians work during house calls and at the same time improve the veterinarian's customer service.

1. Introduction

Traditionally veterinarians have been divided into small animal or large animal specialization. At the University of Helsinki, faculty of veterinary medicine, implement the same during studies toward the Licentiate of Veterinary Medicine degree. Small animal veterinarians treat companion animals, such as dogs and cats, whereas large animal veterinarians treat production animals and horses. Since production animals and horses are more difficult to transport than companion animals, the large animal veterinarians are more likely to make house calls. This study researches the way veterinarians use mobile technology in their daily routines and their attitudes toward mobile technology. The "house call" veterinarians that were interviewed for this paper usually use a paper and pen to record animal treatments and driving distance. This

information was then entered into a computer, so that the diagnoses, treatment plans and bill could be sent to the clients. This method takes time and produces unnecessary duplication of work. Veterinarians need to improve their allocation of time. Especially in the small animal clinics, the development has been to emphasize the business aspects of the clinic more than in equine medicine clinics or amongst private veterinarians. Today in the U.S.A., there are veterinarian clinic chains, both large and small animal, which produce healthcare as part of their business. This development is also seen in private healthcare clinics for humans [1]. A few years ago, this was unheard of in Finland and is currently very rare with small animal practices. It is practically non-existent in large animal or equine medicine practices in Europe.

In human healthcare the digitalization process has already begun. Many papers have been written about the challenges and advantages technology will bring [2, 3, 4, 5]. Identification [3] [5], digitalization healthcare [2] and mobile technology in homecare [4] have been addressed in recent years. A part of the problem is to get common standards within EU [6] and internationally [7]. For livestock there are various Information and Communication Technology (ICT) applications in use. Studies have been made on identification of livestock [8, 9], farm management [10, 11] and practice management [12] to name a few.

In various scientific publications from Australia, Trevarthen (2007), Michael (2008) and Michael (2009) have made extensive studies on livestock identification, information gathering and farm management [5, 9, 10, 13]. In these publications, a large number of animals from various farms have been studied. However, in the farm management articles, information gathering is mostly done at one place (e.g. milking station) on the farm. Furthermore, livestock

identification by Radio Frequency Identification (RFID) tags was introduced to Australia in 1999 and has since expanded to include sheep, cattle and goats [14]. This type of tagging cannot be used with horses since the RFID tag is a plastic tag that hangs from the animal's ear like a human earring. For sport-horses, this is not an option, since it would disturb the horse's concentration. In addition, a horse's earlobe is thicker than on bovine or swine, thus increasing the risk of infection. Horses are identified by inserting a microchip under the skin, as are dogs and cats. Currently the microchip only contains the animal's life number, which can be traced to the animal's owner by e.g. veterinarians. The use of mobile devices such as mobile phones has not been studied to a great extent in articles [5, 9, 10, 11], since these studies concentrate more on the enhancement of knowledge that can be gained from the RFID tags and not the reading terminals of the tags.

In human healthcare studies, the digitalization of healthcare information and the use of mobile technology have been discussed [2, 3, 4, 5]. The veterinarian's house visits to stables and barn environments are not always sanitary giving new aspects and problems for future studies to address.

To get a better understanding on veterinarians' use of mobile technology in their daily routines, the problem has to be divided into three main research questions. These questions are: (i) What are the bottlenecks in a veterinarian's daily routines? (ii) How do veterinarians use mobile technology? (iii) What are their attitudes towards new technological innovations that would support their work? This study does not only contribute to the veterinarian society, but also to production animal farms, sport horses and horse owners. Some of the problems that will be studied in this paper can also relate to problems within human healthcare.

This paper is structured in the following way. The conceptual study, Chapter 2, will present the research domain, concept and literature review. In Chapter 3 the empirical study is presented from data collection to analysis. Chapter 4 is divided into discussions, conclusions and recommended future research.

2. Conceptual study

2.1. Research domain

In the Finnish veterinary system a veterinarian can work on various tasks, but in this research we focus on large animal veterinarians who treat production animals (bovine, pigs, sheep, chickens etc.) and horses. Every county in Finland has to provide a veterinarian on call at all times, to care for local animal needs. In smaller counties with only one appointed veterinarian,

he/she has to be able to care for various production animals, horses, cats, dogs and even more exotic pets. When possible, a large animal and a small animal veterinarian are appointed for the county. The county appoints the county veterinarians in accordance to the Finnish Law of Medical Services for Animals 16 § [15]. There are approx. 2,100 licensed veterinarians in Finland, 30 % work as county veterinarians and others mostly work at private practices or clinics [16]. In Finland there are both small animal and equine private clinics. The University of Helsinki has the only production animal clinic. Apart from pets and production animals, a county veterinarian is also responsible for animal welfare and wildlife care within the county. The county veterinarian might also be a "hygienist veterinarian", meaning that he/she monitors the county's food production and overall health situation when it comes to food products.

Equine medicine veterinarians specialize in treating hoofed animals, which in Finland is primarily horses. These veterinarians treat and/or inspect all kind of horses: leisure, harness sport, equestrian sport and horses going to slaughter. Today, horses are increasingly seen as companion animals and used as sport animals. Thus also equine medicine has developed further than bovine or swine medicine. A bovine animal is seldom treated to the extent of horses. A bovine's worth is more likely to be attached to the value of the meat, milk and/or breeding. A horse's value is connected to the horse's quality as a racehorse, dressage horse etc.

According to EU regulations and Finnish food legislation, all animals slaughtered in EU for human consumption need to have proof of identity and a logbook stating what medications and feed the animal has received during its lifetime [17]. Some medications that are used on horses are considered dangerous for humans. If the horse has been treated with these medicines during its lifetime, the meat cannot be used for human food consumption. Since horses can be sold many times during their lifespan, the medical history that, in most cases, is in paper format does not necessarily move along with the horse.

Veterinarians today usually have their own patients' records on file and are required to do so for a minimum of three years, according to Finnish laws [18]. The problem is to find all medical information of a horse. Veterinarians, who informed that their specialty is equine medicine, could have medical information about the horse that is relevant for e.g. slaughter (2009 there were 25 equine medicine veterinarians). County veterinarians might also have treated it and if the horse has been imported from another country, it is virtually impossible to be 100 % sure that all medical data is intact [19]. Horses

competing internationally must have a paper-based medical logbook that includes the horse's medical history according to FEI (Fédération Equestre Internationale) veterinary regulation, article 1026, 3§ [20]. This logbook has become mandatory after FEI started the "clean sport" program against doping. The logbook includes information on what and when the horse has received medication. E.g. some horses have to be mildly tranquilized for shoeing. If trace elements of this tranquilizer remain in the horse's blood, beyond the pharmaceutical company's safe date, then a positive doping test may result.

According to Suomen Hippos (the Finnish Trotting and Breeding Association), there were approx. 73 000 horses in Finland in 2010 [21]. This amount includes all horses that were registered in Finland; harness sport, leisure horses and equestrian sport horses. This figure might be misleading if a horse has been imported from another EU country and it has the importing country's passport, then it does not necessarily have to be registered into Hippos. Horses are primarily identified by their national and/or international passport(s). Beginning July 1, 2009, all foals born in Finland and all horses imported to Finland must have a microchip for identification. They must also have a national passport since this is still officially used for identification at racetracks, equestrian competitions and border control [22]. It is estimated that in Finland there were 9,100 actively competing harness racing horses and 6,900 competing equestrian sports horses in 2009 [23].

County veterinarians mostly treat production animals, while both county and private practice veterinarians treat horses. These veterinarians are specialized in large animal and/or equine medicine veterinary. Both county and private practice veterinarians might make house calls and are an essential part of this study. Record keeping is difficult when working in less than ideal environments and animal owners might lose medical information. This medical information must be presented if the animal owner desires to slaughter the animal.

2.2. Literature review

In recent literature, the digitalization of human healthcare has been much discussed [2, 3, 4, 5]. The development of mobile technology has enabled mobile phones to be used not only as personal devices but also as work tools in one's profession. In her 2005 publicized doctoral thesis, Han discusses the mobile technology usage and adaptation among Finnish physicians. In this study, once the physician started to use mobile technology (in these cases the content of the service was basically a Nokia phone that included

the whole Pharma Fennica, i.e. the Finnish medicine encyclopaedia) he/she was positively inclined towards the technology's usefulness and usage [24]. This dissertation gives a picture of the physicians' attitudes. For large animal veterinarians the mobile phone usage would be somewhat broader for them to obtain maximum benefits. A veterinarian on the move needs much more than just the list of medicine he can prescribe during house calls. A mobile device could be used by a veterinarian to enter treatment information, which physicians would not need since they usually work in offices with computers. Therefore, in this paper the research question has been taken a bit further than Han's dissertation.

In the 03-Vet project, the aim is the digitalization of animal hospitals compliant with the Information Technology (IT) standards [12]. In this project, some of the human healthcare standards have been reused and fitted to suit animal and veterinarian needs. One of the aims is to maximize data sharing with web-oriented technology. This study, at the moment of writing this paper, is limited to animal hospitals and does not study the mobile possibilities.

One of the problems that need to be addressed is the ideal way to identify the animal the veterinarian is treating. For livestock, the industry has already stipulated the need for clear identification, thus e.g. ear tags on bovines and swine. Often the identification today is RFID-based, as in the studies of Trevarthen, Trevarthen & Michael, Voulodimos, et al and Wallace et al articles [9, 10, 11, 25]. In these studies, apart from the aforementioned article from Wallace et al, the studies have been about the need for bovine identification in business management and the importance of traceability. The main issue in these studies is that via the id-tag of the bovine animal, information about the animal can be traced. Whether with RFID-tag technology a cow's milk production is monitored or a heifer's movements across the country from various owners can be monitored. Information can be traced and be used from the farm to the slaughterhouse to your table. Since, especially in Europe, a horse might end up as a meal for people, the same level of monitoring is needed.

Both FEI and harness racing sports have strict rules about medication usage and vaccination requirements. Accurate identification of the animal is one of the key features that are needed to gain trustworthy information. Inserting a microchip identifies horses, but often the standards of various microchip companies vary, so the veterinarian needs more than one reader to be able to identify the horses. These microchips only contain the horse's life number. There is a need to develop horse identification in the direction discussed in the Voulodimos et al and Trevarthen articles [9, 10,

11]. In Wallace et al, the study involved temperature measurements done in horses with RFID tags. This study shows other issues that could be raised with id-tags and veterinary monitoring. One of the problems that were discussed in this study is the much-debated issue raised by many who oppose inserted microchips: Can a microchip implantation cause foreign body reactions or tumour formations? In our research these aspects are not discussed. The ideas how a microchip can be used in veterinarian work and the digitalization of a horse's healthcare information as discussed in Wallace et al article is an excellent basis for this research.

The article by Lin and Heffernan on HPAI (Highly Pathogenic Avian Influenza) surveillance is one of the few that study veterinarian work and animal health information with mobile technology [26]. The mobile system in their research is used to get information on outbreaks of HPAI. The system has many basic applications that could be used by a veterinarian's mobile service. Information is input via the mobile phone into a database. In our case the study is taken somewhat further. The information that would be essential to send via the mobile phone is larger and the information has to be restricted to predetermined users and have high security levels. In aspects of food safety, the Lin and Heffernan study is on the same path as this research; real-time information leads to faster responses to a potential problem. But in the mobile application they study, anybody can report their suspicion of HPAI via the mobile phone and it is the only information that can be sent in this service. .

The importance in food safety and monitoring animals with proper identification has also been discussed in many papers [8, 27, 28, 29]. Although this paper does not study identification of animals per se, some of the same issues and important factors are parallel to the problems discussed in the above-mentioned articles. Medication and possible transferable disease information for production animals and horses have to be traceable throughout the animal's life. Equally, the veterinarian treatment of horses has to be traced in doping suspicion cases. Unlike a sport horse's human equivalent, the horse is chipped and monitored throughout their life, which would be a violation of privacy for a human athlete. As mentioned in Chapter 2.1, a horse's value is dependent on the privacy of the animal's health information and thus it is important that access to this information be restricted.

2.3. Conceptualization

This research is tangent with many other areas in the literature review. Figure 1 is a visual representation

of this. A veterinarian's core business is naturally the healthcare of the animal, but also non core-business tasks, such as paperwork need to be done. This work, which is not directly related to the core business, has not been studied before but is addressed in this paper. Similarities to this research had to be found in other tangential areas.

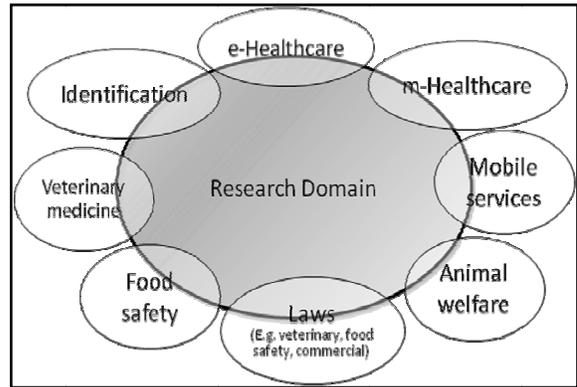


Figure 1. Research area.

To understand the bottlenecks in a veterinarian's daily routines this paper will illuminate a veterinarian's daily routines and especially the time spent on the non-core business tasks. As in Han's dissertation, it is imperative that we understand the veterinarians' attitudes towards mobile technology and current usage of various mobile applications [24]. This will further illustrate what kind of applications could be built for them. The ideal platform and how tech-savvy the veterinarians in reality are needs to be studied.

3. Empirical study

To gather information on veterinarian's daily routines, use of mobile devices and attitude towards new technological innovations, a survey was conducted in Finland. Prior to forming the survey, we recorded interviews and discussions with a county veterinarian and veterinarians working at three different horse clinics. The horse clinic veterinarians also did house call work. These preliminary interviews were important for the research since we needed a picture of what tasks a veterinarian performs at a clinic and during house calls. We accompanied some of the veterinarians during their workday to get a better feel of their daily tasks. With this knowledge we then composed a survey, taking into account what information we needed and the previous feedback we had gotten from the veterinarians. This type of iterative research gave us the opportunity to better understand the veterinarians' work and to explore ways it could be enhanced through mobile technology. The survey was

exploratory since we knew little about a veterinarian's day. This type of research had previously not been done in Finland. After the personal interviews and observations, we conducted an online survey with 32 questions. Our survey was done with Webropol, an online survey and analysis software. An Internet survey was chosen, as there are many advantages to it as is stated in Shiu et al (2009) and Dillman (2007) works [30, 31]. We were able to track down most of the e-mail addresses of the veterinarians. A link to the Webropol survey was included to the cover e-mail letter. This contact method is recommended in Shiu et. al and Kaplowitz et.al to obtain interest in respondents [30, 32].

The survey's questions were divided into three parts.

1. County and private veterinarian's routines, tasks and treatments at a clinic and during house calls.

2. Use of non-clinical technology at work; current technology use and skills plus mobile phone features in use

3. Attitudes towards technology; willingness to use new IS and mobile technologies

The cover letter e-mail contained a short description of the research and a link to the Webropol survey. It took approx. 10 minutes to answer the questions and the survey could be done in Finnish, Swedish, or English. From the Finnish Food Safety Authority, Evira, a list of all the veterinarians that were working in Finland in 2009 could be found [19]. The veterinarians listed as practicing equine medicine or working at a horse clinic and all county veterinarians were included to the survey. Since not all veterinarians had informed Evira of their e-mail addresses or they were incorrect, e-mail information had to be double checked from county websites. This way some of the non-response errors could be omitted. Some veterinarians had several e-mail addresses, in these cases the e-mail was sent to all the addresses.

3.2. Data Analysis

In total, the survey link was sent to 543 veterinarians, of which 146 veterinarians' e-mail addresses were not valid or could not be found. The veterinarians, whose e-mail addresses could not be found, were located in various areas of Finland. The represented percentile regionally of these non-partaking veterinarians had approximately the same variance in between the different areas of Finland, as did the veterinarians who took part of the survey. Of the 397 veterinarians, who received the e-mail, 161 veterinarians took part in the survey, resulting in a response rate of 40.55%. The survey link was sent to 383 (70.5%) women veterinarians and 160 men

(29.5%). This ratio between men and women is veterinarians. This ratio somewhat differs from the ratio that the Finnish Veterinary Association listed in their annual report 2010, women 73 % and men 27 % [33]. Of the respondents, 72,7 % was women and 27,3 % men.

Of the respondents, 47.8 % were under 40 years old and the largest group was in the 30-39 years old age category. In table 1 the gender and age differences in the question of Internet use on the mobile phone are presented

Table 1. Mobile phone and Internet Veterinarians' Internet usage on their mobile phones.

Age	Gender	Yes	No	No answer	Total
20-29	Man	0	3	0	3
	Woman	4	16	0	20
30-39	Man	3	4	0	7
	Woman	19	27	1	47
40-49	Man	3	7	0	10
	Woman	5	21	0	26
50-59	Man	2	12	0	14
	Woman	2	13	1	16
60-69	Man	1	9	0	10
	Woman	1	6	0	7
No answer				1	1
Total		40	118	3	161

We wanted to know whether there is a large difference between men and women's use of Internet on their mobile phones. From Table 1 we can see that 27.2 % of the women use Internet on their mobile phones, whereas only 20.5 % of men use Internet on their mobile phones. Approx. 30 % of men and 35% of women who are under 40 years old use Internet on their mobile phones. But it is intriguing that none of the men in the age category 20-29 years old use Internet on their mobile phones, although when the survey was done, Internet usage on mobile phones was already relatively cheap in Finland and many phones offered this feature.

Table 2, on the other hand, gives a picture of what functions veterinarians are already using on their mobile phone. We were interested in information on the mobile features they currently use or have tried on their mobile phones. In this table, the respondents are only from the group "large animal veterinarians", i.e. Equine and production animal veterinarians. 137 of the 161 respondents are large animal veterinarians and 100 of them are county veterinarians. Many of these veterinarians are general practitioners.

Table 2. Mobile phone functions that veterinarians use or have tried

Equine and production animal veterinarians usage of their existing mobile phones' functions.				
		Use	Tried	Total
Calling	Man	18	0	74
	Woman	56	0	
SMS	Man	20	0	76
	Woman	56	0	
MMS	Man	4	6	48
	Woman	23	15	
Calendar	Man	6	4	53
	Woman	21	22	
E-mail	Man	3	4	33
	Woman	11	15	
GPS	Man	1	3	18
	Woman	5	9	
Camera	Man	11	5	69
	Woman	42	11	
Notes	Man	6	1	33
	Woman	16	10	

Calling and sending SMS were the most common services that veterinarians use on their mobile phones. In table 2, women use more actively their mobile phone functions than men. Men only use the notes and SMS functions on their mobile phone more than women do. On the other hand, women use the Camera, GPS and MMS functions more than men. Overall, it seems that notes, e-mail and GPS functions are the least used of the mobile phones functions.

Tables 3, Table 4 and Figure 2 are more specifically about house call routines. These tables and figure only contain answers from respondents who are either production animal or equine medicine veterinarians and make house calls. 137 veterinarians fit these requirements, of which 100 are women and 37 men.

We were especially interested in the large animal veterinarians' record keeping during house calls. We specifically wanted to know how many have manual computer or mobile recordkeeping. Table 3 presents how veterinarians' keep records for three different house call actions. These actions are: patient information, treatment information and driven distance information. In the survey, there was various record keeping options that were chosen as being the most likely methods according to the veterinarians who were interviewed prior to the survey.

Table 3. House call routines

Equine and production animal veterinarians record keeping during house calls.						
	Patients		Treatments		Driven distance	
Manually	74	54.0%	73	53.3%	68	49.6%
Laptop	67	48.9%	68	49.6%	45	32.8%
Mobile phone	1	0.7%	1	0.7%	0	0.0%
Assistant	4	2.9%	4	2.9%	3	2.2%
Memorize	2	1.5%	2	1.5%	2	1.5%

It seems that the large animal veterinarians who make house calls are divided into two almost equally sized groups; those who keep patient and treatment records manually and those who keep records electronically on a laptop. Distance records were primarily kept manually. Half of all the women used a laptop for patient and treatment recording. Interestingly, younger veterinarians (under 40 years old) did not use a laptop as frequently as the older ones did. Fewer than 40 % of the young veterinarians used a laptop for patient and treatment records. According to our survey, mobile phones are rarely used as a record keeping option.

One of the research questions was to find out what the veterinarians routines and bottlenecks are at work. In table 4, the attitudes toward some of the non core-business routines and possible technological innovations that could support the veterinarian's work are presented.

Table 4. Daily routines and attitudes toward them.

The equine medicine and production animal veterinarians' attitudes towards various non-core business tasks and methods.					
	Definitely agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Definitely disagree
I feel I spend too much time doing paperwork	43 31.4%	66 48.2%	18 13.1%	8 5.8%	0 0.0%
It's common that paperwork gets postponed and thus accumulates	59 43.1%	53 38.7%	6 4.4%	11 8.0%	7 5.1%
I feel that I could improve the way I keep medical records during house calls	19 13.9%	57 41.6%	24 17.5%	27 19.7%	10 7.3%
I would use a mobile device (mobile phone, PDA etc.) if it improved my work performance	22 16.1%	50 36.5%	24 22.6%	27 12.4%	10 10.9%
I would use a system that automatically measures the distance I travel.	28 20.4%	39 28.5%	23 16.8%	25 18.2%	21 15.3%
I would use a system that would hasten my billing procedure	57 41.6%	54 39.4%	15 10.9%	5 3.6%	5 3.6%

As is presented in Table 4, many of the veterinarians felt that they use too much of their time doing paperwork and that it often gets postponed. Over 50% of the veterinarians use 20% or more of their time doing paperwork. 75% use more than 20% of their time driving. Billing procedures seem to be one of the major actions that veterinarians wish could be done with more smoothly.

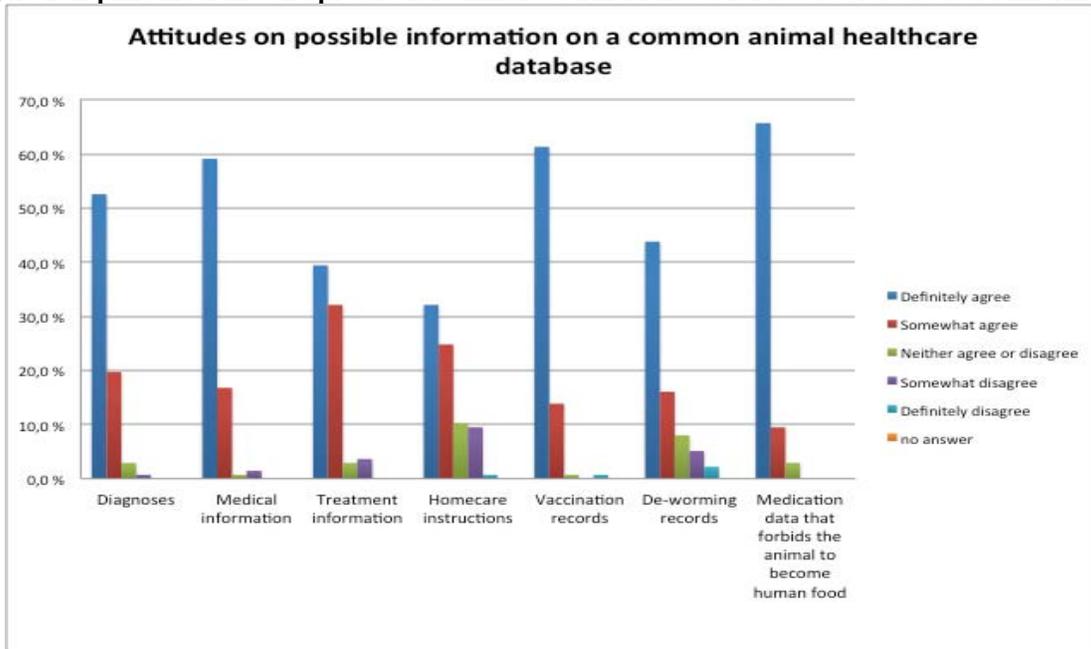
Figure 2 represents the veterinarians' attitudes towards a patient database. A database with various IS and mobile services could be used to help a veterinarian in their daily routines. Today such services do not exist, although in Finland there are databases for both cattle and swine (www.naseva.fi and www.sikava.fi). These databases have information about the animals or group of animals ID's and

medical treatments. Owners are allowed to enter data into these databases and the agricultural ministry provides tutorials and guides to animal owners.

Over 75% of the veterinarians would prefer a database where all animal information could be inserted. Of the responders who opposed a common database, they most often stated that patient information should not be shared (approximately 32% of the database opposing respondents). 24.5% of the opponents stated that they do not believe such a database would be beneficial for them. Security issues were the third most common reason that veterinarians did not want a common database (13,5%).

With this survey we wanted to get a better insight on what veterinarians could see as being useful information on an animal healthcare database. In Figure 2, these results are presented.

Figure 2. Equine medicine and production animal veterinarians' attitudes towards database information



4. Discussion & Conclusion

Overall, women seemed to use and have a more open mind towards various mobile phone functions. Laptops are also coming to be a normal device to have during house calls, but still manual record keeping is equally popular (Table 3). As was expected veterinarians felt that they use too much time on paperwork. At the same time they were rather positively inclined towards having some sort of mobile or other digital system to help them with the non-core business time consuming problems, such as billing, paperwork and distance calculation (Table 4).

The veterinarians were given options of information that could be stored on a database if it existed. Many either agreed or somewhat agreed that diagnostic data, medical data, vaccination data and information that the animal is not suitable to enter the human food chain, would be considered useful. Treatment information, homecare instructions and deworming data also had a more positive feedback then negative.

All the information gathered from the survey points towards the need for assistance in one of the most common veterinary occupational bottleneck, i.e. paperwork. Since the veterinarians were rather positive towards new technology, a mobile phone application and Internet service that is connected to a national database could have potential. To get the approval of

these services main users, veterinarians, it would be imperative that the system is built with their help. This bottom-up approach would allow fast iterations when developing the services and thus the criteria's of the veterinarians would be met. The system has to be flexible to meet the various veterinarians' needs and the needs of other stakeholders, such as the animal owners, slaughterhouses and the government.

From previous studies the importance of proper and accurate animal identification has been established and would be one of the core information in a IS support system for veterinarians. As in the 03-Vet project, common standards would have to be established and these standards should be easily transferable to other countries' veterinary systems and practices [12]. As in the many of both Michael's and Trevarthen's studies, management is one of the key features that is to be gained from a IS support system [5, 9, 10, 13]. Veterinarians would get better patient management and animal owners would get accurate and up to date essential farm management information. In addition, the healthcare, food safety and disease control units would gain vital real-time information enabling them to react fast.

4.2. Further research

A horse is the only animal in the world that can be used for food, leisure activities, Olympic sports and

professional sports. This poses many challenges to a medical database supported by mobile and Internet services. The central figure, the horse, however is the same, despite its career in the human world. The surrounding stakeholders, on the other hand, have varying various needs.

Further research should be done to determine other usage areas, such as other horse sports, small animal veterinarians, other countries and other animals. Even the possibility of a medical database with supporting IS and mobile systems could be used, as a model for the digitalization of human healthcare should be explored.

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