ESTONIAN ENTREPRENEURSHIP UNIVERSITY OF
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Web design and digital graphics curriculum

Ott Tooming

VETERINARY MEDICINE COLLABORATION PLATFORM FOR CONSULTATIONS

Thesis

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ABSTRACT

Veterinary medicine is a rapidly evolving field that faces major operational hurdles in managing patient care. From keeping up to date with medical conditions to handling effective communication between the veterinary doctors for the purposes of diagnostic consultations. This necessitates the practical management of patient medical records and the workflows around them. Migrations to electronic health records have made these operations more powerful, but major advancements are potentially available by bringing additional inclusive collaborative efforts into the veterinary diagnostic proceedings. Current electronic health records result in numerous difficulties in making patient-related material available to consulting veterinary practitioners.

This study handles the task of conduction a survey among Estonian veterinary doctors about the current state of diagnostic consultations among veterinarians and the planned platform that would include the integration of patient management system with collaborative diagnostics for health records. Based on this feedback and evaluations a functional prototype is implemented. Through it, a potential collaborative patient record management service is being appraised for its functionality and benefits in delivering value to the veterinary practice. These considerations are viewed through the lens of optimal development architecture and design methodologies while considering requirements set by veterinary medicine.

This study concludes that a collaborative platform integrated with a patient management system is an engaging proposition for veterinary practitioners in Estonia. It would be expected to positively impact the animal healthcare sector with improved quality of care for patients and efficiency increases in business operations. These benefits are realized through improved capabilities to dispense patient records with consulting veterinarians, making the patient diagnostic process more collaborative and inclusive to the principles of evidence-based medicine.

RESÜMEE

Veterinaarmeditsiin on kiiresti arenev valdkond, mida mõjutavad märkimisväärsed operatiivsed tõkked patsiendi ravi määramisel. Seda nii läbi vajaduse hoida end kursis uuenevate meditsiiniliste teadmistega kui ka läbi vajaduse leida efektiivseid viise kommunikatsiooniks vetrerinaararstide vahel, et realiseerida diagnostiliste konsultatsioonide efektiivne käitlemine. See eeldab patsiendi tervisekontrolli andmete ja nende ümber olevate töövoogude praktilist haldamist. Üleminek elektroonilistele tervisekontrolli kaartidele on muutnud need toimingud produktiivsemaks, kuid potentsiaalsed suured edusammud on veel kättesaadavad, kui viia veterinaarmeditsiini diagnostikaprotseduuridesse täiendavad koostöömeetmete võimalused. Hetkel olemasolevate elektrooniliste tervisekontrolli kaartide tõttu on patsientidega seotud materjalide kättesaadavaks tegemine konsulteeritavatele veterinaararstidele ulatuslikult raskendatud.

Konkreetse uuringu eesmärgiks on viia läbi küsitlus eesti veterinaararstide seas, et saada suurem teadlikkus veterinaarmeditsiini diagnostiliste konsultatsioonide protsesside üle ja kavandatava platvormi kohta, mis hõlmaks konsultatsioone koostöövõimekusega integreeriva patsiendihaldussüsteemi planeerimist. Vastava tagasiside ja kaalutluse põhjal ehitatakse funktsionaalne prototüüp. Selle kaudu hinnatakse potentsiaalse teenuse funktsionaalsust ning võimalikku kasu loomakliinikutele. Vastavat tööd rakendatakse läbi parimate tehniliste lahenduste, disaini metoodikate fookuse ja jälgides veterinaarmeditsiini nõudeid**.**

Uuringust järeldub, et patsientide haldussüsteemiga integreeritud koostööplatvorm on eesti veterinaararstidele kaasahaarav idee. Võimaldades positiivselt mõjutada loomade tervishoiu sektorit tõhusama patsiendi ravi ja äritegevuse efektiivsuse laienemise kaudu. Need eelised realiseeritakse tänu parematele võimalustele väljastada patsientide andmeid veterinaararstidega konsulteerimise kaudu. Muutes patsiendi diagnoosimisprotsessi koostöö hõlpsamaks, kaasavamaks ning rohkem toetuvamaks tõenduspõhise meditsiini põhimõtetele.

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ABBREVIATIONS

EHR stands for electronic health records. See also EMR. Interchangeable with EMR in veterinary medicine.

EMR stands for the electronic medical record. It is a digital version of a patient chart that contains medical information about the patient. This may include a history of medical conditions and treatments, general patient information and relevant information from the owners.

EVMR stands for the electronic veterinary medical record. See also EMR. Used to differentiate itself from EMR usage in human medicine.

INTRODUCTION

Building a veterinary medicine collaboration platform for consultations deals with the systematic problem of increasing costs and rising complexities in the animal healthcare field. “As the popularity of companion animals and the amount spent on them continues to climb, both anecdotal reports from pet owners and statistical releases from the U.S. government suggested that the cost of veterinary care is climbing faster than all consumer prices” (Purdue University, 2016, 2). In the current situation for the industry, the medical consultation with an outside source is both time-intensive and logistically prohibitive due to the need for managing various different source systems in disseminating diagnostics reports. These solutions are in the form of legacy paper card-based documentation conventions to off the shelf electronic patient management systems. Neither of which are optimal for transmitting, synchronizing and collating large amounts of input data in a timely manner as required by the rapid casework of the profession.

This report is handling the immediate task of patient record management in-depth as this is the venue through which the industry is interfacing most frequently in managing patient diagnosis. It is by introducing collaborative consultations capability to established conventional designs in animal medical history management and the potential benefits arising from this capability that will be the subject of this research. Combining patient record management with an *ad hoc* consultation capability will enable the healthcare professional to manage their diagnostic requirements in an organized and centralized fashion with a single source of truth.

The end solution is targeted to veterinary clinics and other applicable institutions like the veterinary education establishment in order to introduce benefits to both the patients and the veterinary professionals in the form of a conceivable reduced time to diagnosis and higher revenue generation through increased patient capacity. In the fast-moving pace of handling daily case works, this will enable users to focus more on the patient care and application of the possible treatments. While spending less time to manage documentation that is relevant for any conceivable consultation in the future and standardize the record-keeping in a coherent manner.

1.1. Background to the veterinary medicine

While the industry is making consistent gains in the adoption of electronic health records and discarding established uses of paper documentation as means of keeping patient's medical information, there is still a significant number of practices that keep using old legacy methods. “Of 82 practices for which medical record type was reported, 14 (17.1%) used EVMRs only and 16 (19.5%) used paper records only. The remaining 52 (63.4%) used both types of record systems” (Krone L.M., Brown C.M. & Lindenmayer J.M., 2014, 6). This is providing an ample target for new disruptive and experimenting solutions to enter into the market as the existing off the shelf solutions have not saturated the business segment. Meanwhile, from a risk standpoint, the old habits are prohibiting the switch to digital systems and hampering the demand to reduce paper-based documentation. Many reasons for this are found in the lack of applicable solutions to fully satisfy in-house patient record management needs and the lack of clarity in the benefits of existing solutions in the market. This presents great room for innovation as a trigger for further migration to digital healthcare solutions with business value multiplier benefits. Handling collaboration in this situation as a differentiating factor opens up an avenue for potential market disruption as put forward by Christensen, C. (1995): “The technological changes that damage established companies are usually not radically new or difficult from a technological point of view. They do, however, have two important characteristics: First, they typically present a different package of performance attributes—ones that, at least at the outset, are not valued by existing customers. Second, the performance attributes that existing customers do value improve at such a rapid rate that the new technology can later invade those established markets” (3).

The matter of constant dynamic changes and persistent adaptability of medical knowledge is a great source of required upkeep for veterinary professionals. New medical conditions are discovered routinely and changing best practices for patient care is a fact of life in the field. Necessitating that the retraining efforts to be persistent and efficient. This effort is hampered in the current state by the lack of access to a compendium of patient records that hold the key to field-tested patient care procedures and treatment protocols as they are locked and without accessible shared availability. Information from these private clinic sources are valuable in real-life knowledge and would be invaluable to both young professionals as well as more experienced experts in keeping up with the changing real-world conditions. Interaction between handling different cases is a great source of comparison between the

effectiveness of different procedures and could hold promising new insights into relevant diagnostic cases in both ongoing procedures and research work.

In relation to specialization in the field, general practice veterinarians are generally more common in the industry than specialist doctors. While the number of veterinarians pursuing postgraduate diplomate training in a recognized veterinary specialty area is increasing, this is still represented by a minority of all practitioners. “More than 11,000 veterinarians have been awarded diplomate status in the U.S., or 12 percent of the profession” (University of California, 2015, 12). Also in contrast to human medicine, where there is a great division of labor in regard to different organ systems or care requirements between medical and surgical needs, this is largely encompassed into a single field for veterinarians. This creates a lot more pressure for maintaining high levels of professionalism in the field as the day to day requirements will be highly demanding from the physician. It may be the need to administer both routine vaccination and handle animal grooming for a family pet to going on and completing a major surgery on the same afternoon.

Segregation in the field is most commonly related to the split between large and small animal care. This division is due to the specialization track selection requirement in getting a medical degree. “The first two years of the curriculum are a core for all students and feature a comparative approach. /…/ The next block provides foundational material common to years one and two. /…/ For the third and fourth years, all students take a comparative track and select one of two tracks: small animal or large animal” (University of California, 2015, 25). For patient record management this creates a unique set of possibilities and different requirements as demanded by the industry segments. Large animal care is largely done for the agricultural sector in raising livestock and handling their specific requirements. Meaning that it is most closely related to preventing disease outbreaks and handling large volumes of subjects. Small animal care is delegated with more in-depth considerations relevant to specific patients and must handle customer demands with privacy and delicate consideration in mind. Both of these bring with each other unique demands, as described beforehand, to any electronic patient record management system and needs to be acknowledged in software requirements. This is to maintain goodwill with users, comply with legal requirements and provide continuing business value.

1.2. Statement of the problem

Electronic health records are rapidly driving the market to discard the use of old paper-based document handling, while considerable legacy use is still prevalent. “Paper records have several limitations, including but not limited to accessibility problems, inadequate organization of information, incompleteness and fragmentation of information, redundancy, security problems, difficulties in reusing data, and legibility issues” (World Health Organization, 2017, 19). An example of a paper-based patient healthcare record is demonstrated in Figure 4 Paper-based patient card. These shifts in the market are mostly driven by clinic management and related to immediate business needs as opposed to medical considerations. Requirements that are commonly related to reducing storage and organizing requirements for patient records, handling time management for employees and various other administrative duties. “EVMRs appeared to be used more frequently for practice management and economic purposes (scheduling, billing, automating reminders, and providing cost estimates for clients, reviewing veterinarian performance, and marketing) at practices in the present study than they were used to track and improve patient and population health” (Krone L.M., Brown C.M. & Lindenmayer J.M. 2014, 10). While considerable effort has been allotted to improving these solutions they have also been driven by the localized and balkanized nature of their efforts, due to seeing themselves as primarily delivering value to the business and not considering wide-ranging diagnostics possibilities. This has caused the patient management systems to segment themselves between handling small animal clinic duties where only a small number of users are considered or specializing more on institutional use cases, whereas in a university a large size of the faculty is of significant consideration.

With the current status in the market, the prevailing methods and solutions available to the general field do not adequately enable the full potential for collaboration in the patient diagnostics process. While there are a plethora of solutions on the market offering patient management systems, they are limited to feed information gathered from patient care to a walled garden, restricted to a specific clinic and do not tap into the collaborative potential of the field. This is mainly due to the positioning of the established software to satisfy the problem of clinic management and maintaining patient records as a secondary consideration to main business demands. Enterprise requirements can not be discarded when evaluating patient management systems from the side of presentable business utility benefits.

Nevertheless handling software requirements from this narrow scope is ultimately prohibitive from the standpoint of lost value to the practice. Management demands in itself limit the scope through which to consider the main goals of the software in the veterinary setting, this is to help patients and deliver the most effective treatment possible in a timely manner.

Relegated to the none prioritized status, in currently established patient record management systems, the main work done in handling consultations is in a lot of cases a substantial amount of manual work. Some of the veterinary proceedings that are resulting from encumbered document handling processes are related to the managing of patient records. In often cases these need to be written down to paper before being digitized, if possible, communicated through various communication channels like email and information networks and then the updates fed back into the established system. Using an established electronic healthcare manager will enable the process to skip digitalization and handling of paper records, but offer little in the terms of connectivity to other veterinary professionals who are not working in the same clinic. Leaving the doctors to their own devices and interpretations, lacking potentially crucial input from outside consultations due to their lack of accessible connectivity. This problem has been noted as a possible improvement by the work of Krone L.M., Brown C.M., Lindenmayer J.M., (2014): “Beyond the use of EVMRs to track and improve the health of individual clinic patients or populations, it should be possible one day to link independent, stand-alone veterinary medical practices that use different EVMR software. This would allow the veterinary medical profession to monitor and track patient health over wider geographic areas than the catchment areas of their individual practices” (10).

1.3. Record keeping

Patient records are handled in the field of veterinary medicine to keep a history of medical procedures. These records must include justification for patient care and should contain information pertaining to differential diagnosis. Their main purpose is to serve as a means of communication between colleagues and other veterinarians to whom the case may be referred. The problems arise from the current situation where established software is indifferent or not focused on the needs of referring the patient, which usually involves

handing out printed copies of records or sending emails with applicable documentation in a static document format, e.g. PDF[1]. This creates a problem within itself, where all further additions are lost from patient records, if not fed back into the system manually by the responsible physician.

For both clinical and legal reason, they provide documentary evidence of the patient's ownership status, health status, care, and treatment. This is of primary value to the management of any practice as it is used to keep track of their patient flows and retain customers as repeat visitors. Passing on patient records as a common property is mired with considerable legal restrictions and confidentiality obligations and needs to be managed by a release form. This being a limiting factor to any consultation system that needs to overstep the boundary between different institutions and physical actors managing those records.

Documents related to patients are also the basis for review, study, and evaluation of veterinary care rendered to the patient by the practice. There is an already established practice in enabling scientific research to be accomplished, but this is handled individually in a case by case matter and most routinely after the treatment has been completed. While being a well-sourced repository with a wealth of knowledge it is of little timely effect to the patients coming in each day for their routine procedures. Most imperatively it is the source of emulation for this research to generate a similar procedure in an expedient manner for any event that consultation is deemed to be a requirement.

1.4. The current state of diagnostics

Although the various steps for any diagnostic process in the field of veterinary medicine differ for each clinic, with varying degree, the most common initial investigation steps are as follows:

- Taking a comprehensive history from the client
- The doctor conducting a physical examination of the patient
- Reviewing medical records from previous examinations or treatments
- Performing additional diagnostics that are deemed beneficial to the patient

[1] Portable Document Format

In the following diagram, it is shown how a common patient examination might take place and where a medical record is positioned in this process.

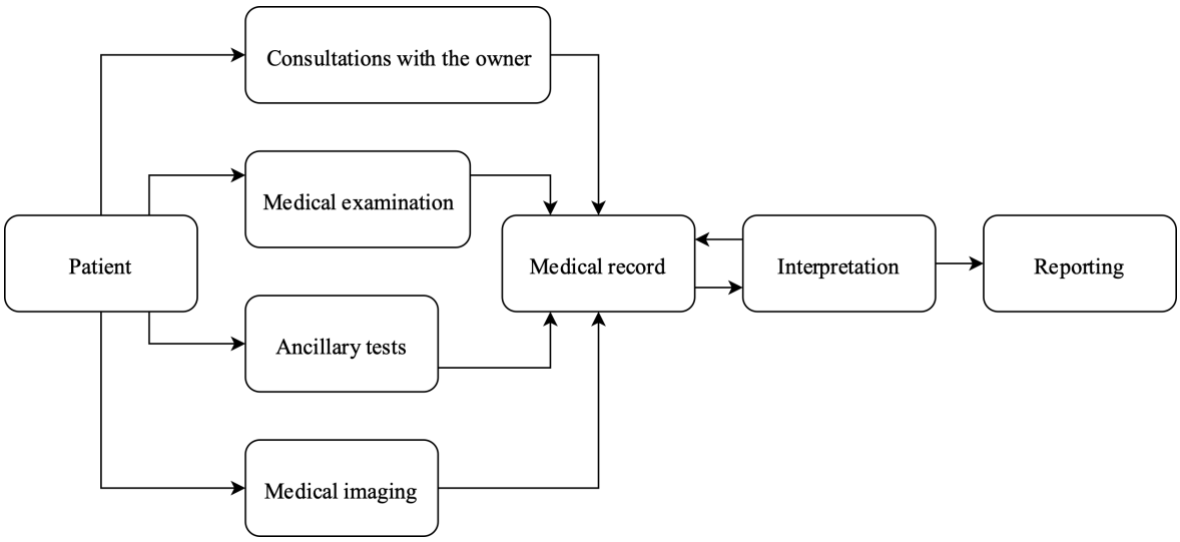

Diagram 1 Schematic diagram showing the diagnostic process

When the patient is in the review or the examination process of the diagnostics and there is a question of ambiguity or uncertainty in the existing procedures completed or applying relevant medical care to the patient, then it is common to consult with colleagues and/or with applicable medical literature. As defined by the American Animal Hospital Association the consultation process is a communication between an attending veterinarian and a consulting veterinarian concerning the diagnosis and/or care of a patient (AHAA, 2013). Consultations with colleagues or with outside sources are dependent on a multitude of factors, but one of the most defining ones is that of clinic size. This is due to the amount of contact a working veterinarian has with colleagues and the smaller the group the more dependent they are of outside sourcing. Also, this is amplified in case of needing a specialist for differential diagnosis as these professionals are not readily available for the vast majority of existing clinics, necessitating seeking outside support. The consultation process usually involves the exchange of information or interpretation of test results as defined in the AAHA Referral and Consultation Guidelines (AHAA, 2013). The procedure doesn't mean the transfer of care for the patient: "Diagnostic or therapeutic procedures are not performed on the patient by the consulting veterinarian, and the veterinarian-client-patient relationship remains the responsibility of the attending veterinarian" (AHAA, 2013). These proceedings are illustrated in Diagram 2 Consultation process.

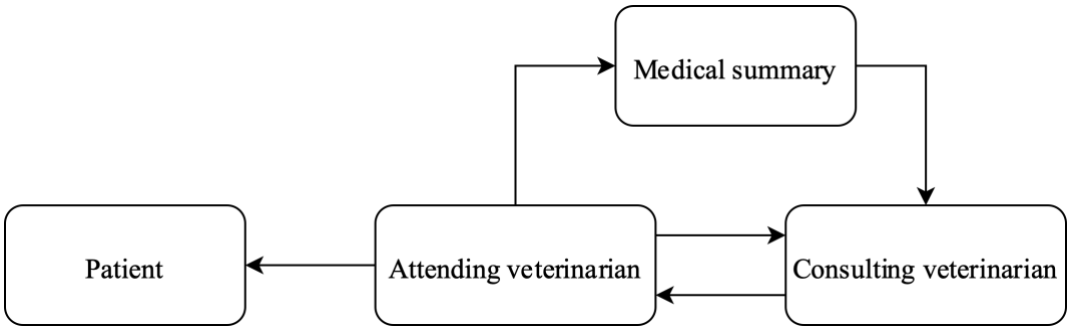

Diagram 2 Consultation process

There are a lot of different approaches for any specific procedure in veterinary medicine and therefore this often results in a situation where it is rare that any single approach taken is the absolutely correct one. With this in mind, it is not unreasonable to find that the care rendered or suggestions made by other veterinarians are supported by a reasonable school of thought and although this may not have been in accordance with the approach chosen by the responsible veterinarian it is based on a sound medical work. While seeking consults through outside source there is a reasonable expectation to have dissenting opinions in differential diagnoses and debate the treatment options. Veterinary medicine is a medical science based on conventions, rules and best practices that are dynamic and ever-changing for the improvement of the field.

2. STUDY OF THE VETERINARY FIELD IN ESTONIA

For gathering more intimate knowledge about the subject matter from real-life examples it was deemed that hands-on interviews were the most approachable method for gauging possible limitations in the current state of the field. To handle this process in a coherent manner it followed a set of questionnaire topics that are listed in Appendix 2. User interviews. These proceedings were done during the period of 5-9 February 2019 and conducted in veterinary clinics both in Tallinn and Tartu. The names of the participants have been anonymized for professional considerations and herefore referenced in the pattern of interview participants. The pool of interview participants included veterinary technicians and doctors alike and resulted in 5 interviews. Three of these were made in Tartu and two were completed in Tallinn. The end result of these proceedings is analyzed followingly.

2.1. Research interviews

The common thread for all participants was the lack of affection for any information technology solutions. They were deemed relevant and necessary for the functional workings of the modern veterinary clinic but were not seen as a desirable factor to be interacted with. The cause for this was the lack of immediate benefit for medical procedures in progress. Having patient records or interacting in general with the clinic information system was seen as more of an administrative duty than of medical relevance. Commenting this was Interview participant nr. 1: “Not so affectionate for information technology as it is mostly only adding overhead” (interview, February 6, 2019). This lackluster enthusiasm was mitigated only when referencing past patient records where the benefits of having ease of access to rendered medical care were of considerable convenience.

Most of the participants referenced a lack of access to more specialized medical equipment in their clinic and the need to outsource these procedures should they arise. As mentioned by Interview participant nr. 2: “/…/ every clinic doesn’t have an ultrasound, magnetic resonance imaging and other equipment” (interview, February 6, 2019). This causes a problem of timely access to necessary diagnostic overview. Other causes for consultations were related to difficult caseloads or having exhausted all methods of treatments. The

solutions proposed to mitigate the problems by the interview participants were all related to asking reference hospitals or acquaintances for consultations. This was to gather insight if any contact has had a similar case that could offer timely insight without sending the patient to get outsourced diagnostics. Friends with veterinary education and coursemates from the university were at the top of references to consult.

The communication channels for these proceedings were reported to be most commonly email, other text-based messenger services as in Facebook Messenger and community forums or channels like private Facebook groups dedicated to veterinary medical professionals. Most urgent matters needing consultations, for example, patients in critical condition and need of immediate medical treatment, would have necessitated the need for more direct contact to be made in the form of a telephone call. Otherwise, this kind of urgency was not deemed applicable or desirable due to the disruptive nature of the communication method.

The frequency of these consultations varied greatly but consistently ranked in the order of 1-2 times a time relevant to different patients. As put by Interview participant nr. 2: “We would need to contact once a day or so for consults. Sometimes no urgent or difficult cases so less” (interview, February 6, 2019). The sentiment expressed was reflective that more consultations would be made if the process was less taxing and time-consuming. At the moment transcribing and forwarding medical documents with current processes was deemed as too cumbersome and at this rate no more than crucial matters would be deemed worthy of the effort.

The end sentiment from the interview process was a cautious agreement that colocation of patient records and collaboration functionality is of medical value to the veterinary field by reducing logistical efforts for diagnostics. A considerable factor for value rendered would be the dissemination of electronic patient records that would not be redundantly duplicated. Some of the perceived benefits must also have to be considered to been created by the migration to electronic patient record management software as this was not available to all participants in the interview process. As reported by the Interview participant nr. 1: “Anything moving away from pen and paper is welcomed. So you don’t have to drag along a bunch of paper cards after the day is over and you need to type out a patient history you didn’t have time during the hectic day” (interview, February 6, 2019). Limitations were seen

mainly in the form of lacking the critical mass for consultations to have the potential to reach applicable specialists and offer constructive feedback.

2.2. Survey of veterinary specialists

To gather a greater understanding of the communication patterns veterinary specialists are handling in their daily routine a survey was conducted between February 7-9, 2019. The questionnaire that was sent out is available in Appendix 3. Survey of veterinary specialists. The target demographics for this was 85 veterinary clinics in Estonia and their staff by the method of direct email targeting. In addition to that, the survey was posted to private veterinary support groups on Facebook and other forums that are populated by the members of the veterinary field. The private Facebook veterinary doctors group lists 433 members as the total number of active users. In total, the survey yielded 72 responses.

In general, the veterinary community is not averse to innovative technological solutions being introduced as could have been interpreted by the results of chapter 2.1 Research interviews, where interview participants reported greater dissatisfaction with new information technology implementations. The survey participants reported great enthusiasm for new market solutions to improve their respective field as seen in Chart 1 How do you agree with the statement: „The field of veterinary medicine should keep up with technological progress?“. These results indicate that possible adoption rates could be seen in a positive trend for any collaboration effort to reach critical penetration in the field.

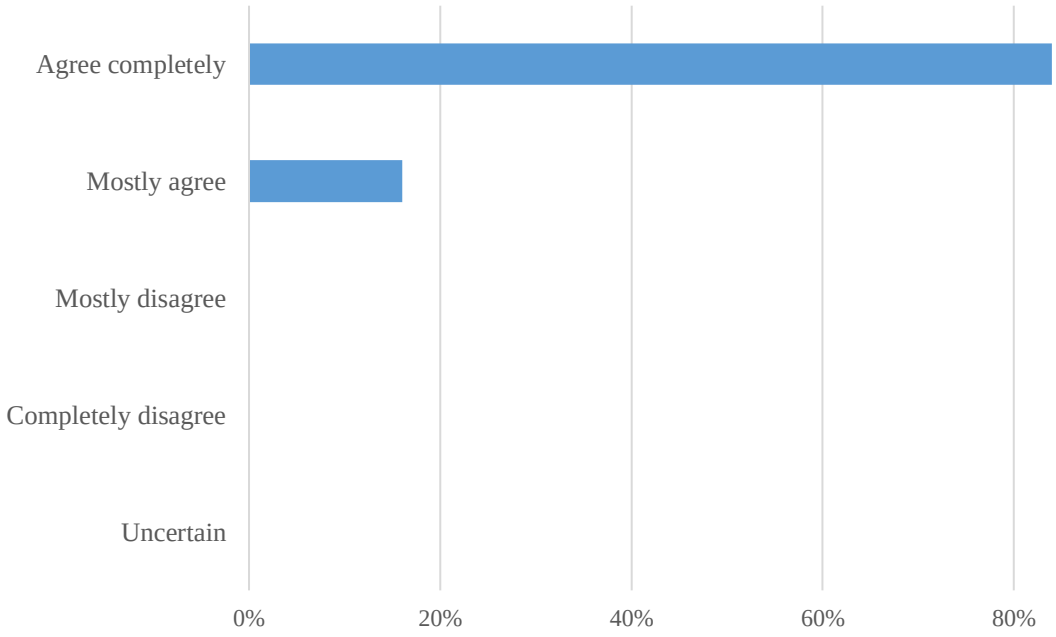

Chart 1 How do you agree with the statement: „The field of veterinary medicine should keep up with technological progress?“

To get a better understanding of the communication patterns of veterinary doctors in their daily proceedings it was necessary to gather the frequency at which they initiated a professional dialog. These results are made available in Chart 2 The situations where there is a need to consult with other veterinarians occurs? In general, it was gathered that request for consultation was a routine practice for 56% of the survey participants and a common occurrence for the other 44% of respondents. This hints at the potential for more integrated solutions in the field and also at the divisive gap between frequent users of outsourced consultations and more self-reliant doctors.

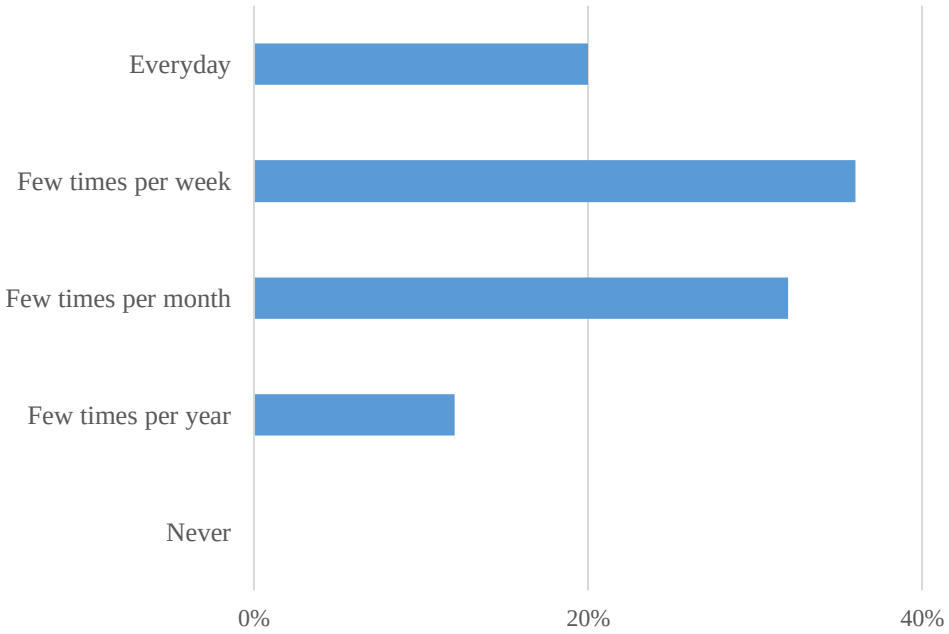

Chart 2 The situations where there is a need to consult with other veterinarians occurs?

With a plethora of communication channels available in the contemporary market, the veterinary community is reflected to be conservative in its platform choices as reflected in Chart 3 What are the communication channels that you use to consult with other veterinarians? The dominant positions are held by traditional email and phone usage with 43% of respondents pointing them out. „Other“ position didn’t get any specific mentions to what other capabilities are available to them but still polling to 2% of the total users.

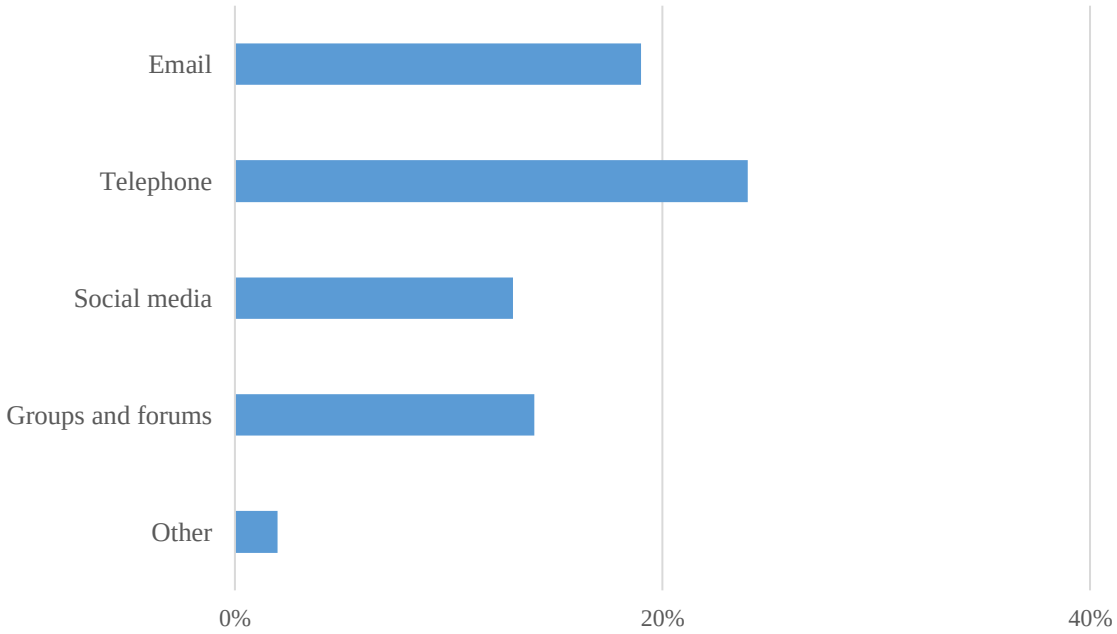

Chart 3 What are the communication channels that you use to consult with other veterinarians?

The respondents were greatly enthusiastic about the prospect of enhanced patient record management software with collaboration enhancements with 60% being interested as reported by Chart 4 To what extent would you be interested in software that enables communication between veterinarians and creates a common environment to digitally manage patient medical records? These results give an indication of a need being prevalent in the field for new approaches to consultations or alternatively there is a willing sentiment for innovative approaches. Veterinary medicine is an industry where there is considerable professional pressure for excellence and lack of tolerances for mistakes marks this feedback as an indicator that the industry is capable of handling new proposals being presented to alter existing workflows.

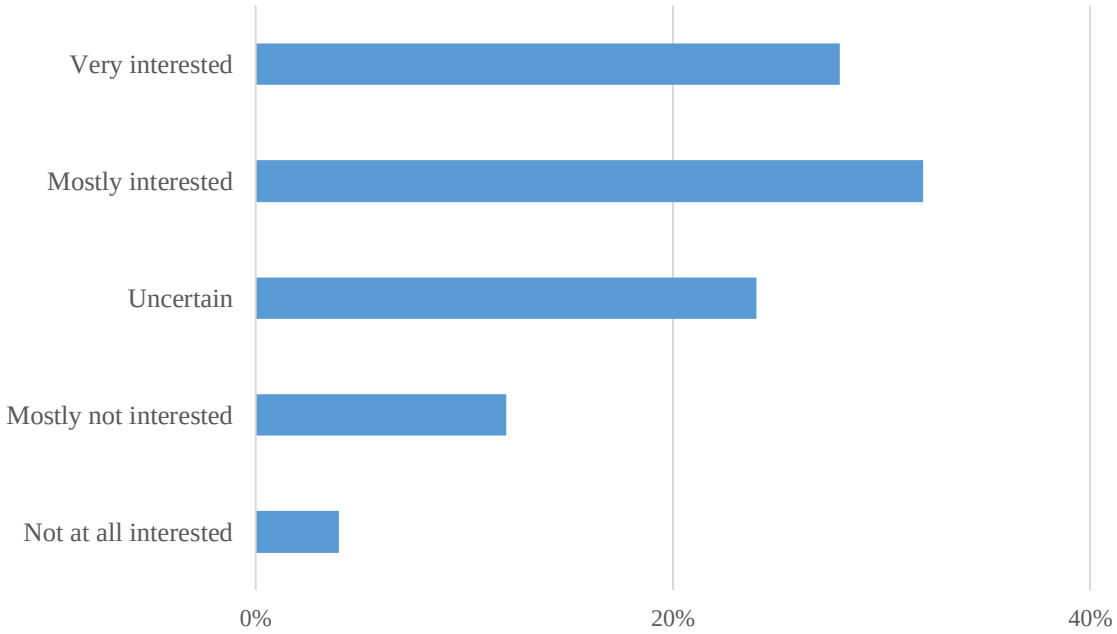

Chart 4 To what extent would you be interested in software that enables communication between veterinarians and creates a common environment to digitally manage patient medical records?

For the general concept of a collaboration platform for consultations, there was an enthusiastic response in favor of its potential. There were 64% response rate that implementing such capability would have a more positive feedback to Estonian veterinary medicine in general and enhancing veterinarian work specifically as seen from the Chart 5 Do you find that such service would be capable of enhancing the work of Estonian veterinarians and making it more efficient while improving the field of Estonian veterinary medicine in general?

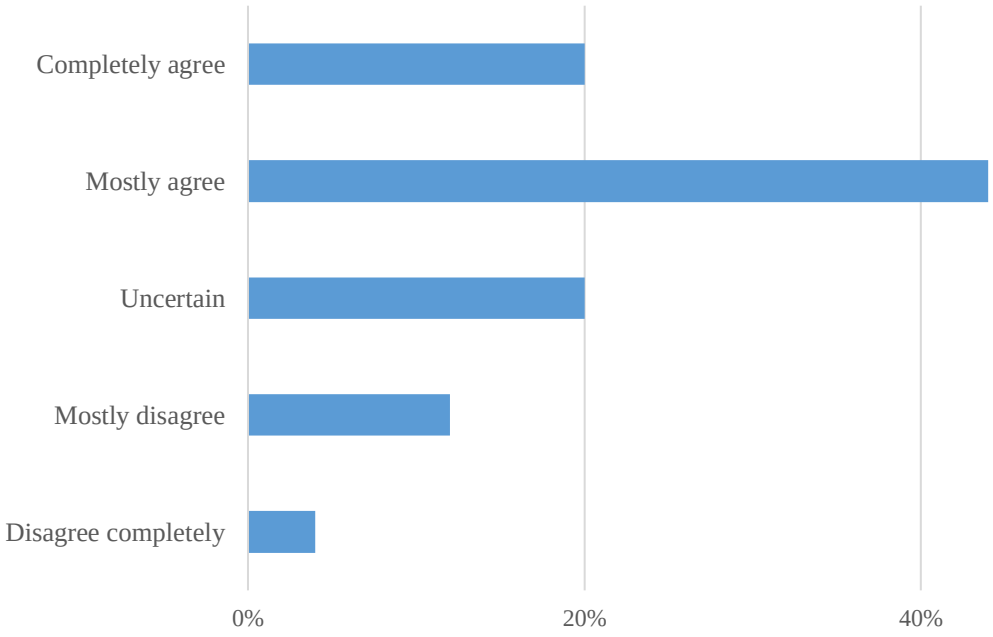

Chart 5 Do you find that such service would be capable of enhancing the work of Estonian veterinarians and making it more efficient while improving the field of Estonian veterinary medicine in general?

2.3. Conclusion of the response by the Estonian veterinary community

As seen by the enthusiastic response of the veterinary community in Estonia to the proposed consultations platform in chapter 2.2 Survey of veterinary specialists and more cautious agreement of benefits in 2.1 Research interviews it is in the capability of the veterinary field to approach new service implementations with a constructive approach. The respondents were ready to try new solutions and agreed in general with the proposed solution being an improvement to their daily routine in handling consultations.

3. POTENTIAL BENEFITS

Dedicated support for collaborative efforts that are systematized in a patient record management software is largely dependant on its realization by the more general drive in the industry segment to adopt electronic healthcare systems and discarding the old paper documentation implementations. “Some of the main benefits of EHR systems that have been identified include reducing medical errors, improving quality of care, conserving physician time, sharing patient information among healthcare practitioners, and workflow efficiency” (Minal T., Diane C. D. 2006, 3). The changes differentiating proposed solutions from existing solutions on the market for EHR’s[2] are intimately linked to the benefits delivered to both the veterinary clinic practice and the patients themselves by the most concise diagnostic results made possible by outsourcing patient records for cooperative input from veterinarians all over the world. “Data sharing is a fundamental component of collaboration for any discipline to initiate learning, offer validation and to go forward without duplicating effort” (Karin R. S., 2014, 17). These recommendations from miscellaneous inputs will result in providing precise and most up to date health records that are available, with the most informed medical care possible delivered to the patient. The greatest common factor separating this approach from legacy conventional software available is related to delivering a strengthened quality of care given to patients and a reduction in medical errors through improved timely access to records.

More specifically the differentiation from traditional patient record management software is tied to increased benefits in access to specialized consults and the accessibility of the record sharing in relation to the capability of feeding back any new information relevant to the diagnostics. Without having to manually introduce all or portions of the data handed over by other outside sources like email or information messenger services. All while directly linking applicable veterinarians to their original data sources and creating an environment where veterinary specialists are free to concentrate on their patients and not be needlessly encumbered with managing their communication channels.

Main drivers of the added value generated by a collaborative patient record management software are therefore most sharply defined by the following factors:

[2] Electronic health record

- Improved clinical decision making and disease management.
- Decreased duplication of effort into managing patient records as previous casework can be shared between veterinarians.
- Integrated access to patient records by invitation. No need to send out documents.
- Privacy improvements as confidential information is only shared in a user-defined manner and shared access can be terminated.
- Research access for greater insight into patient care and treatment possibilities.

3.1. Quality of care improvements for patients

Clients coming into an animal clinic for treatment of any level of severity in condition are expecting the utmost care to be rendered to their animals, irrespective of the veterinarian attending their case. This expectation is largely dependant on the immediate skill of the attending physician and varies widely dependant on the personnel available at the specific moment. It is a common misconception that this can be mitigated by demanding to see a senior doctor who is believed to be more attuned by the harsh realities of day to day differential diagnosis. The inverse may be the case and more recent graduates may have more up to date medical knowledge and skills that are needed. Handling this problem at the legal level are requirements for re-certifications as pointed out by the European Board of Veterinary Certification (2019): “Continuing education has been compulsory in Estonia since around the mid-2000s. Veterinarians have to be relicensed to practice on a 5-yearly basis and for this have to provide evidence of the continuing education that has been followed in the preceding period. If insufficient continuing education is followed then veterinarians may only be re-certified for 1 year instead of 5 years.” The industry is moving at breakneck speed with respect to new procedures and methodologies coming into play and not keeping up with these changes will lead to subpar clinical care in the long term. “Significant changes in the educational requirements for veterinary medicine have occurred over the years, with additional changes anticipated as the profession evolves to meet society’s needs in the 21st century. Influencing these changes have been major advances in veterinary science and technology; growing societal expectations regarding the quality and efficacy of veterinary services /…/” (University of California, 2015, 2).

One of the methods to reduce this discrepancy in skill and experience would be to bring access to more widespread adoption of proposed collaboration efforts as a way to level the quality of care rendered. Recent graduates are already ahead of this curve by attaining cooperation patters before graduating, due to the plethora of available communication channels and the value proposition of being quick to diagnostic results. Attaining widespread adoption in this regard could bring critical peer review to shed light on any outdated methodologies and procedures to help patients get the most up to date care. This is in accordance with the commonly accepted position that more modern treatment options are less invasive or deliver with themselves more effective outcomes and reflected in the application of similar collaboration efforts in zoological societies with the adoption of Zoological Information Management System. "Almost 1000 zoos and aquariums in nearly 90 countries use a web-based program called the Zoological Information Management System (ZIMS) /…/ ZIMS allows staff members at these institutions to create husbandry and medical records for all of their animals and to share these records /…/" (Allen, S. 2017).

Veterinarians of all experience and skill levels will get access to collaborative input from enhanced patient record tools that enable them to validate their hypothesis and conclusions reached during the diagnostic process. Leveling the discrepancy in skill level and bringing possible new insights into the treatments that are available, no matter the experience status of the veterinarian doctor handling the treatment. "The use of EMRs holds great promise for monitoring and improving the health of individual human and animal patients as well as human and animal populations. Independent veterinary medical practices have the potential to contribute to the veterinary medical profession's understanding of the natural history of and risk factors for diseases in animals, the effectiveness of treatments and procedures, and the prevention of modifiable diseases among animals and humans" (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 12).

3.2. Productivity and efficiency increase

While handling patient history and diagnosis a substantial time and effort are given for reviewing and reconciling found treatment possibilities. This comes to be considered in the end by a qualified judgment call by the attending veterinarian, all the while running into the risk of carrying out a misdiagnosed procedure. It is common to use an opinion of a colleague

who has encountered a similar situation and consults with them about the situation, but as a large number of animal clinics are staffed by a limited number of veterinarians, this may be of considerably limited capability. “Of the 83 practices for which size information was provided, 21 (25.3%) were small (≤ 2 veterinarians), 41 (49.4%) were medium-sized (3 or 4 veterinarians), and 21 (25.3%) were large (≥ 5 veterinarians). The median number of veterinarians in a practice was 2 (range, 1 to 40). Eighty-one of 83 (97.6%) practices employed between 1 and 7 veterinarians” (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 6). Also in consideration is the growing specialization nature of the field and the possible lack of in practice medical expertise about rare and potentially obscure conditions.

When considering outside consultations the clinics are tapping into the collective experience pool that may suggest new avenues to approach to specific cases or outright diagnosis as this has been an existing situation the other party had dealt with in the recent past.

3.3. Cost reduction and enhanced revenue generation

Clinics and other veterinary institutions are largely dependent on their funding by the incoming flow of patients. The revenue that is generated through services rendered is heavily skewed toward being based on treatment procedures. “Just over half of the total market (aggregate revenue) is for the treatment of animals. This is the largest single type of service in each country. About 20 percent of the total market is for surgery – this proportion varies little between the countries” (Federation of Veterinarians in Europe, 2015, 37). This results in incentivizing the businesses to attend to as many animals as possible for better economic performance. Negative outcomes of these are due to overloading veterinarian with the excessive workload while maintaining pressure to keep a tight schedule with as little of a buffer as possible. From a business sense, it is cost-effective to release a patient as quickly as possible with the allocated treatments. These constraints are severely restricting any time allotments that the veterinarian doctor has available for research. “Studies of information usage in the veterinary profession have indicated that time to access and appraise the literature are important constraints on the practice of evidence-based veterinary medicine” (Everitt S., 2011, 48). Bridging this gap is to connect an electronic decision support mechanism for veterinarians directly through an EHR for collaborative access to all relevant data that is available for possible treatments.

Handling of time-intensive patients is cost-prohibitive for a clinic and puts a considerable amount of pressure on the attending veterinarian to keep up with the schedule. Factors that come to determine such occurrences may be outside of the capability to handle in an allotted amount of time, necessitating extensive research and approaching through different alternative treatments. Another consideration is the client relationship management that is often time strained due to repeat visits required by uncertain diagnosis or rendering of ineffective care. This frustrates the clients and has the potential to create a considerable amount of churn for the business, reducing revenue. “Most practices reported that they had 10-minute appointments. The next most common was 15 minutes appointments /…/” (Gray, C. A., Cripps, P. J. 2005). This is the window through which medical care is based on, with additional animal observations taking up further allotments of time. Taking into consideration the complexities involved in veterinary medicine, the scheduled consultation with the patient owner may not be enough for getting a complete overview from the limited set of data.

“/…/ more than 60 percent replied that they entered clinical notes both during and after the consultation, 17-8 percent entered notes during the consultation and 19-2 percent entered them after consultations had finished” (Gray, C. A., Cripps, P. J. 2005). If the physician is more adapt to digital content management, then in the current status of the field it is common to consult outsourced diagnosis help through information networks available when an applicable situation has arisen. This reduces the time to deliver a possible medical solution as it is gathering data from specialists who are possibly more involved with the condition. While using these information sources is a productivity enhancement factor they are not dedicated to this time-sensitive task and lead to mismatches in information centralization that could be avoided by a dedicated system.

4. SYSTEM DESIGN

The design process involved in the creation of a high fidelity design prototype using Figma service and was created primarily to serve both the user requirements mapping evaluations as well as a blueprint for the development goals. The goal of this exploration was to expedite the evaluations for optimal results to system architecture and validate the implementation in the eyes of preliminary test users. Enabling the objectives to be continuously adjusted for input and improvement. “Having a defined set of requirements allows you to parcel out responsibility for the work more efficiently. Seeing the entire scope mapped out enables you to see connections between individual requirements that might not otherwise be apparent” (Garrett, J. J., 2011, 60). The end result of these deliberations and design iterations was the implementation of a working prototype concept as described in chapter 6 Prototype implementation. The process from evaluation to prototype implementation is illustrated in Diagram 3 Prototype implementation process.

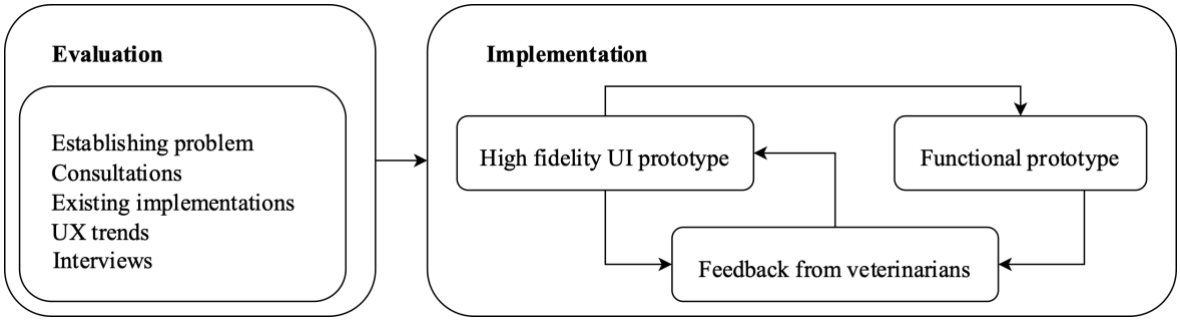

Diagram 3 Prototype implementation process

4.1. User requirements

A patient record management system holds all the different documents and information that a clinic needs for its daily operation. “Electronic medical records improve communication among members of medical teams, which facilitates the implementation of care guidelines and decision-support tools to improve patient safety and reduce medical errors” (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 3). These include work routine inscriptions,

prevailing norms and habits, written manuals, patient medical history, institutional and organizational arrangements, and procedures. All of this is handled and standardized in an organizational way that is most commonly used to prioritize clinic business management arrangements first. “If veterinary medical practices use EVMRs primarily for business rather than health reasons, veterinarians are likely missing opportunities to apply best practices to their patient populations /…/” (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 10). This is in contrast with medical requirements necessitating a more intimate approach to patient care requirements that handle efficient veterinary communication and dialog. All of these organizational needs may amount to a substantial amount of data that is fed into the electronic healthcare system but is of insignificant immediate benefit to the doctor handling its patients. This data flow can easily be overwhelming and commonly it is used in a manner that is nothing more than an afterthought to the routine medical work and is handled not as a pathway to improve patient care as it could be with different focus applied. “Members of both the human and veterinary medical professions have acknowledged that medical records have the potential to be considerably more useful than the limited ways in which they are currently applied” (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 10).

Different types of information that might be included in a patient record entry:

- Personal information related to various baseline data. E.g. species, breed, date of birth, sex, weight, allergies, prevalent existing conditions, *etc*.
- Diagnostic results that might include images related to radiography, ultrasound video or still capture, report to an analysis done on blood and other samples from the patient.
- Commentary related to patient behavior, owner observations and other empirical data relevant to the specific case.

The handling of this data is substantially made more difficult in the aspect that all of this needs to be handled using privacy and confidentiality in mind as expected by the legal requirements in place to protect the personal rights of the animal owners.

For any meaningful level of successful adoption of an electronic healthcare system, there needs to be a perceivable improvement of usability and user satisfaction. The application needs to foster a user's acceptance of its benefits and cultivate a positive attitude around its implementation ecosystem. The system would in an ideal setting be able to reveal deeply

buried content and handle medical mistakes with suspension, interruption or a warning. Interacting with outside actors in a collaborative setting is one of these settings that can intervene in a positive manner for the benefit of all the parties involved in patient care. "/…/ data suggest that with increasing adoption of EMR and EVMR systems, improved software system availability, and ease of use, it will be possible to exploit medical records more effectively to improve patient safety and health outcomes" (Krone L.M., Brown C.M., Lindenmayer J.M., 2014, 10).

4.2. Design considerations

For the purposes of making the system accessible to all veterinary professionals, it is imperative to consider intuitive handling as a key requirement for the system. So that it would have attainable adaptability to both proficient users of patient record management systems as well as less computer literate personnel. Simplicity, intuitiveness and unobtrusive data entry capability are the key concepts that need to be handled in an efficient matter for all relevant parties. Usability is always among the most prioritized goals for the continued use of an electronic healthcare system as it is critical in improving patient safety and quality of care. "A critical component of safe and effective use of health IT is usability—'the effectiveness, efficiency, and satisfaction with which the intended users can achieve their tasks in the intended context of product use'" (Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., 2013, 1).

This is due to complex systems inhibiting the proper and valid use of patient records, therefore causing a large number of possible vulnerable endpoints where data entry, as well as other actions, are handled in a less than adequate manner. Results of this are found to have repercussions down the line for the patient care, where a wrong treatment plan or a medical procedure may be prescribed as a result of the wrong data being present in the system. "/…/ clinicians need to use usable, efficient health IT that enhances patient safety and the quality of care. Some experts suggest that improving the usability of EHR may be critical to the continued successful diffusion of the technology" (Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., 2013, 3). Lack of entries due to being troublesome with respect to data entry is itself a potent adversary for any doctor as they have

to retrace the steps taken in patient care and waste valuable time by reordering of tests, among various tasks.

Lack of usability considerations with respect to collaboration on existing solutions available at the market is creating a plethora of potentially dangerous workarounds, distrust for the accuracy of patient records and inhibits the provision of care for the patients. The intention is that with greater emphasis on approachable user-centered design, the pitfalls of complexity and data fragmentation can be avoided. Inter-user meaningful operations are at the core of this approach, enabling systematized action through a collaborative effort. With this in mind, the most advantageous avenue available to implement this approach effectively is through a component-based UI[3] design system and is illustrated in Diagram 4 Component-based design system. "/…/ important component for EHR design and effective use is the application of standard user interface guidelines ('style guides') that provide guidance on color, controls, screen layout, and application flow to developers and users who are customizing an application" (Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., 2013, 4). This is coupled through additional software architecture considerations to also enable rapid development iterations by reducing the need to build redundant interface elements with overlapping logic behaviors.

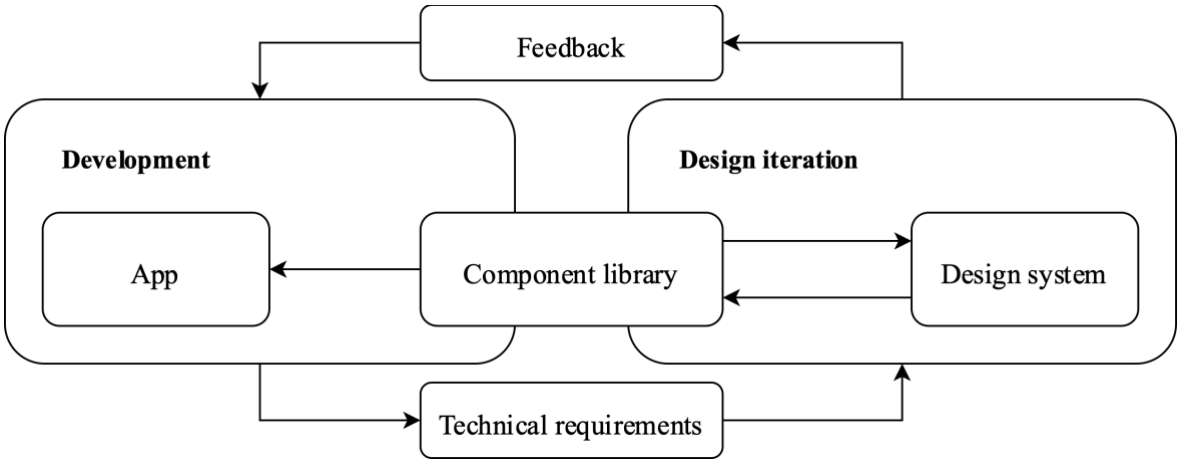

Diagram 4 Component-based design system

[3] User interface

Elementary user interface components implemented using atomic design are a key dedication in this project and are to deliver dedicated common interaction modality. The example for this is illustrated in Figure 1 Storybook with a component. From these expressions, it is derived larger modular organisms and templates for user interactions. For conveying ease of access, it is deemed that the most optimal path to deliver accessible collaboration between different access level users is by enabling access through user-customizable conditional requirements, but leave the interaction with the applicable views to match their own patient records. Therefore it is not desirable to create any barriers between different records, but leave the visual flow unchanged and not differentiate between alternative sources of healthcare resources. Making the users feel that the various sources of the data they are reviewing are identical with its usability considerations to the user-interface flows they are already accustomed to. "/…/ screen layout, controls such as buttons, dialog boxes, entry modules, and other interface artifacts should be designed to have consistent visual and functional attributes across all component modules of a complex system" (Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., 2013, 4).

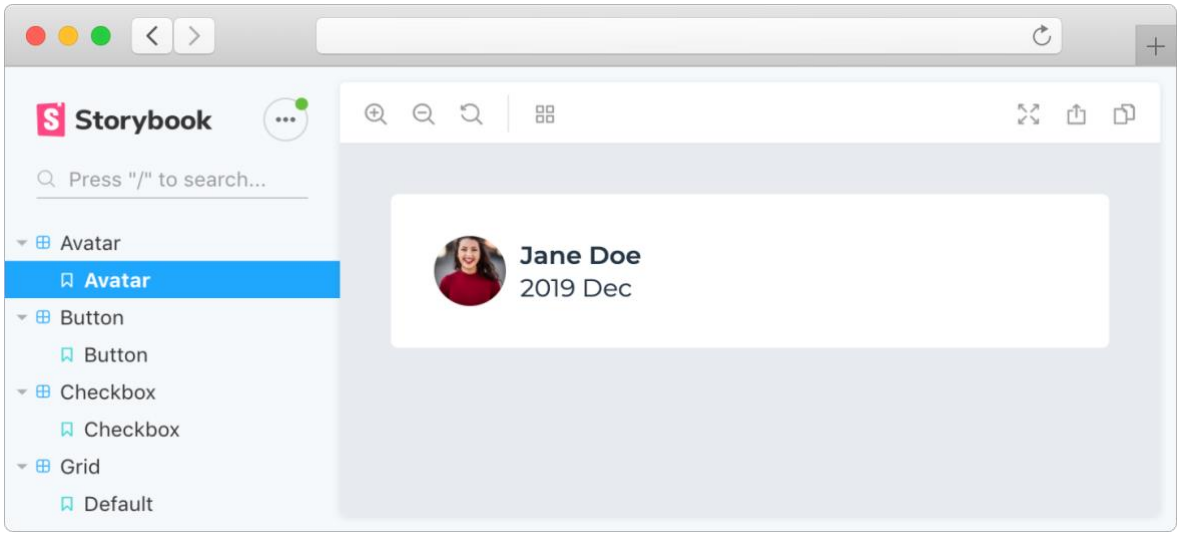

Figure 1 Storybook with a component

5. SOFTWARE ARCHITECTURE

For the technical implementation of the consultations collaboration platform, it was decided to handle the software architecture using a microservices approach. “Microservices are a modern service-oriented architecture (SOA) related software development approach where application logic is divided and implemented as separate functional domains, instead of implementing all application logic in a single monolithic application” (Touronen, V., 2019, 1). This approach was deemed to be the most applicable to meet the needs of rapid business domain requirement changes that are of considerable difficulty in nature considering the subject matter. These intricacies are evidently present due to the complexity and high exigency of the field of veterinary medicine. The benefits that are available due to this approach are most immediately available in the form of loose coupling of data, separated execution of the business logic and ready availability of the database layer. Coupled together with the considerations that resulted in the microservices being adopted from the expertise side were related to the potential availability of developers who would be available to work on the software and handle the development in an agile manner. “According to grey literature and the expert interviews, the GraphQL language ecosystem seems to bring excellent developer experience for microservice architectures. A small learning and development investment has to be done on the part of backend developers, which can be justified with more relaxed API design requirements upfront” (Touronen, V., 2019, 49). Building separate services for different server and client-side requirements enables the segregation of user interface development responsibility from the server-side requirements and enable greater input from various developer specializations.

A sample diagram has been exposed in Diagram 5 Microservice architecture to illustrate the basic concept of service segregation and dependent components.

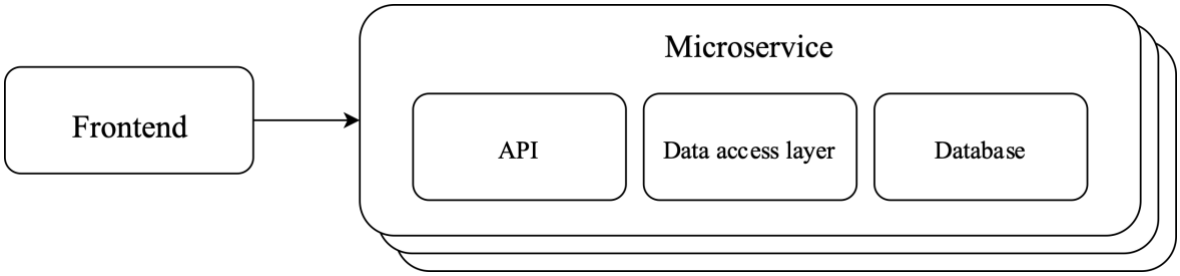

Diagram 5 Microservice architecture

Each iteration in development must be easy to deliver and understand, so it should be relatively small and approachable. “Because one microservice’s scope is limited to a small set of functions, they are more easy to test in isolation” (Touronen, V., 2019, 4). This is to enable for each cycle to handle their requirements autonomously and deploy the changes without input from unrelated sources. Handling each concern in a separated service enables greatly improved maintainability as each instance is restricted to a relatively small footprint and is therefore straightforward to understand. All while maintaining the adaptability for change and modification in an accessible manner. It also empowers software developers working on the project to reject long-term commitment to any specific technology stack and gives them the freedom to start a new service from the ground up. While not committing considerable resources in needing to rewrite the existing monolith from the start. This only requires the project to include another service for any user-facing enhancement. “/…/ an application with microservices will have separation of concerns by nature. Also, each service in an application can be developed with a different set of tools, such as databases, programming languages, monitoring, testing and build pipelines” (Touronen, V., 2019, 3).

5.1. Database abstraction layer

Database access is at the core of any persistent application logic and making a decision for a direct or abstracted approach for the connectivity in a server architecture is of considerable long term implications. “By adopting ORM technology, developers can focus on the high-level business logic without worrying about the underlying database access details and without having to write error-prone database boilerplate code” (Chen T., Shang W., Jiang Z., Hassan A., Nasser M. & Flora P. 2016, 1). Primarily the considerations consist of developer experience, ease of business logic development and data handling capabilities as main focal points. Direct database calls using plain SQL queries were not applicable to the requirements of this project due to their inherent complexity in maintainability and lack of accessible developer tooling. When developing application servers with well-organized database access and tooling then this should not take primacy from business domain requirements. Complexities in implementation can not be entirely eliminated but adequate considerations should be given into abstractions that give developers maximum interaction with business logic demands. “The DAL's API is consumed by the application server,

allowing API developers to simply think about what data they need instead of worrying about how to securely and performantly retrieve it from the database" (Prisma, 2019).

An example of a DAL position in service architecture is shown with Diagram 6 Data access layer.

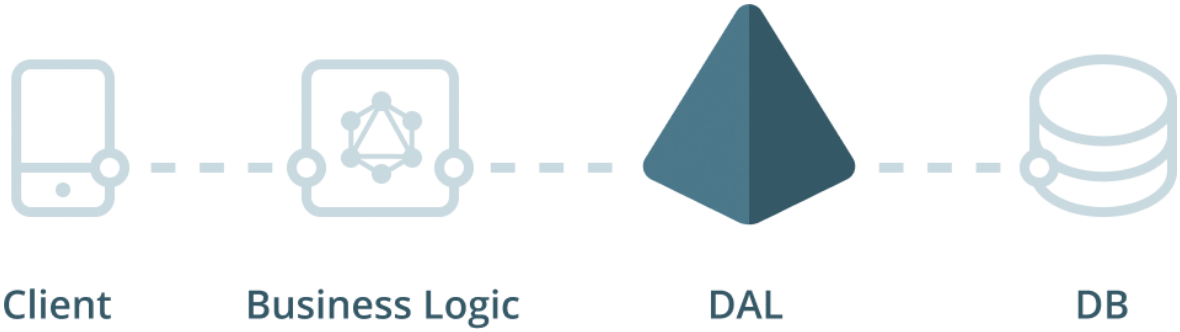

Diagram 6 Data access layer
Source: Prisma, 2019

To consider what is the platform requirements in implementing collaboration with patient records then security abstraction, possible multiple database access sharing, query performance, optimization and schema migrations are at the forefront of main concerns. Also without diminishing the severity of attention demanded from the developer learning curve in data layer composition design and development. Through adequate abstractions, it was the goal to bring straightforward development into the forefront and enable the project to iterate rapidly on meeting changing business demands.

For meeting the unified data layer design goal in this project it was decided to implement a dedicated data access layer using Prisma. An ORM[4] likeness software by a Berlin-based software development company of the same name. They position themselves as a unified data layer infrastructure component provider with the goal of making database access less complicated by unlocking best practices in modern data infrastructure. Delivering these benefits is made available by providing strongly typed database access and a layered architecture with respect to the application server. "Using a DAL ensures a clear separation

[4] Object-relational mapping

of concerns and therefore improves maintainability and reusability of your code. Having some sort of database abstraction (be it a simple ORM library or a standalone infrastructure component) is best practice for smaller sized applications as well as for applications running at scale. It ensures the application server can talk to your database(s) in a secure and performant way" (Prisma, 2019).

In the following Diagram 7 Prisma database connection, it is demonstrated how a Prisma Server creates a bridge between itself and the underlying database.

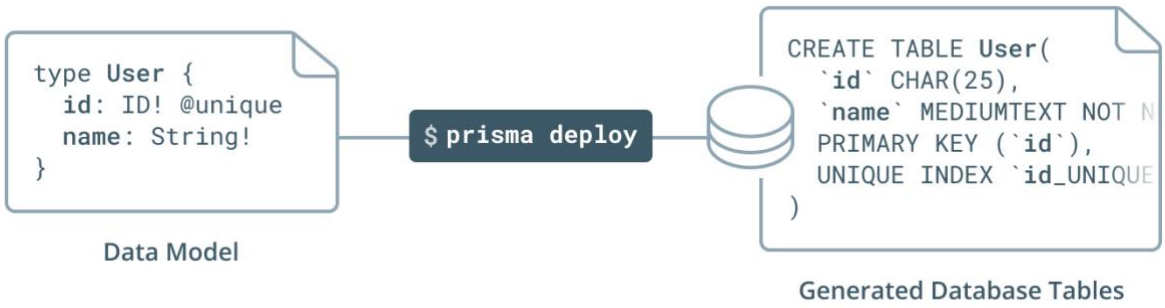

Diagram 7 Prisma database connection

Source: Prisma, 2019

In the following Code sample 1 Prisma datamodel it is demonstrated a partial source of the Prisma datamodel layer for this project. It defines the models for the application and is the foundation through which a schema is generated for a Prisma Client API[5]. This also brings with it an added benefit of being the source of truth for performing database migrations in a declarative manner and code auto-generation through which to read, write and stream data to the database. For Prisma Server, the datamodel schema is marked using the GraphQL Schema Definition Language (SDL).

[5] Application programming interface

```
enum PostType {
  MEDICAL_RECORD
  FORUM_POST
}

type Post {
  id: ID! @unique
  createdAt: DateTime!
  updatedAt: DateTime!
  published: Boolean! @default(value: "false")
  type: PostType! @default(value: MEDICAL_RECORD)
  title: String!
  content: String
  author: User!
  patient: Patient
  histories: [History!]!
  messages: [Message!]!
}
```

Code sample 1 Prisma datamodel

5.2. Client-side development

Implementing a design system into a living front-end user interface is accomplished by utilizing the React.js framework. The considerations that resulted in its adoption are predominantly due to its declarative programming paradigm and more generally due to React's handling of functional programming as an encapsulation of domain and UI logic specific concerns using the component pattern. The domain-specific language implementation of this is accomplished using JSX[6] and it delivers XML[7] structured

[6] JavaScript XML
[7] Extensible Markup Language

JavaScript functions that output their render calls into standard HTML[8] structure. This implementation detail is powerful in its accessibility for developer experience as it does not necessitate the acquirement of a dedicated templating system outside of using standard JavaScript methods. By delivering an encapsulated path to control business domain requirements and eschewing imperative control over standards-based DOM[9] it is capable of efficient and rapid development iterations to validate the business case for collaboration platform integration in veterinary medicine consultations. “The abstraction provides simplicity in development of web and allows the developers to focus on the business logic of the application rather than internal implementation details” (Mukhiya, S. & Hung, H. 2018, 10).

In the following diagram Diagram 8 JSX to HTML it is exposed how React transforms high-level JSX description components into low-level HTML data that can be rendered into the web page.

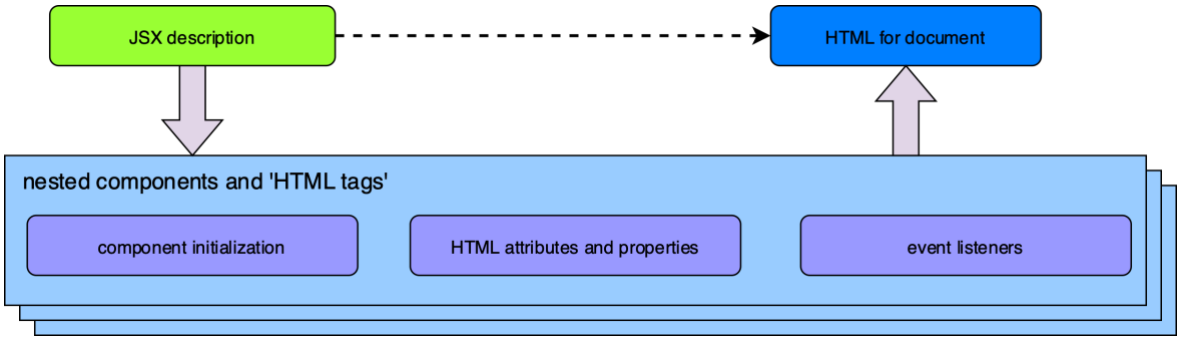

Diagram 8 JSX to HTML

Source: Under the hood: React, 2019

To maintain high visual consistency and painless user approachability between all the distinct user flows a component-based framework enables for work on common structures to be unhampered by different teams or developers and reach for input in a manner most suitable for progressive enhancement. Atomic base component blocks for user interface delivered through a single page application can be served in a manner that is not blocking

8 Hypertext Markup Language
9 Document Object Model

integrations with database or business logic development. This separations of concerns means that the codebase is colocated based on logic relations rather than other arbitrary considerations. Enabling simple maintainability and extensibility for future modifications and additions. “Single-page architecture follows a flexible structure where each component has a single responsibility. In addition to that, it separates the presentational component, container component, states, and business logic separately. This makes easier to maintain the application” (Mukhiya, S. & Hung, H. 2018, 10).

Designer input is segregated to a UI component explorer service provided by Storybook that handles both the visual review feedback and as a kitchen sink for documenting all of the different variations and distinct capabilities of the diverse set of components. The example view is presented in Figure 1 Storybook with a component. This maintains a single source of truth for component consistency and enables design considerations to be handled in a separate manner from business logic implementations. Therefore maintaining iteration speed for all parties involved. The design process and its interaction with application development are illustrated in Diagram 4 Component-based design system.

```
import * as React from 'react';
import Button from '../Button/Button.common';
import { ButtonProps } from '../Button/Button.common';

/**
 * Contains only attributes that are available to button element,
 * and not generic HTMLAttributes.
 * Prevents any Omit usage from removing standard HTMLAttributes
 */
export type ButtonElement = Omit<
  React.ButtonHTMLAttributes<HTMLButtonElement>,
  keyof React.HTMLAttributes<HTMLButtonElement>
>;

/**
 * Remove button element attributes to only support generic anchor.
 */
export type PartialButtonProps = Omit<ButtonProps, keyof ButtonElement>;

export type LinkProps = PartialButtonProps;

const Link: React.FC<LinkProps> = ({
  variant = 'link',
  as = 'a',
  ...restProps
}) => {
  return <Button {...restProps} as={as} variant={variant} />;
};

export default Link;
```

Code sample 2 Link user interface component

6. PROTOTYPE IMPLEMENTATION

As handling the full domain-specific requirements for a viable electronic healthcare record system is not practical in the scope of this project, the prototype implementation of the veterinary consultations collaboration platform is built only for validating the business value specifics of the proposal. Therefore core specifics of the system were evaluated on the premise of greatest relevancy to end-users when handling medical history.

The specific views that were built in the prototype phase are visualized in a flow chart represented by Diagram 9 Sitemap and are listed as follows:

- Landing page
- Login page
- Patient list view
- Patient details view
- Medical conditions list view
- Medical condition detail view

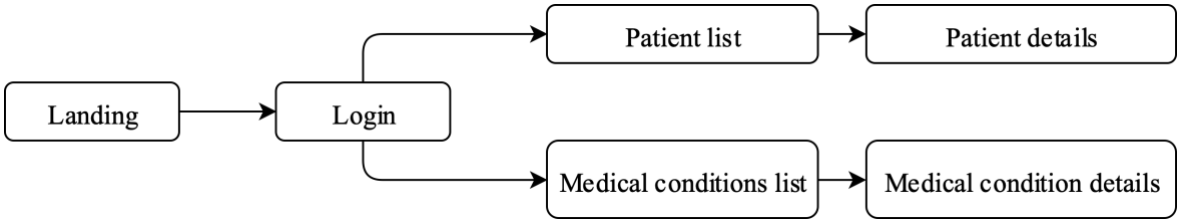

Diagram 9 Sitemap

6.1. Health record access

To handle patient records a list view of all the available patient entries was created. Illustrated from Figure 2 Patient record list view. This serves as an entry point to access the system from a user's point of view. In this situation, the system displays for each patient entry the name of the doctor that is responsible for the patient and the most recent medical

entry related to the medical history. Also on the right are the most common treatments and ailments that have been relevant to this patient. This is to enable the user to make the most immediate connection to the patient.

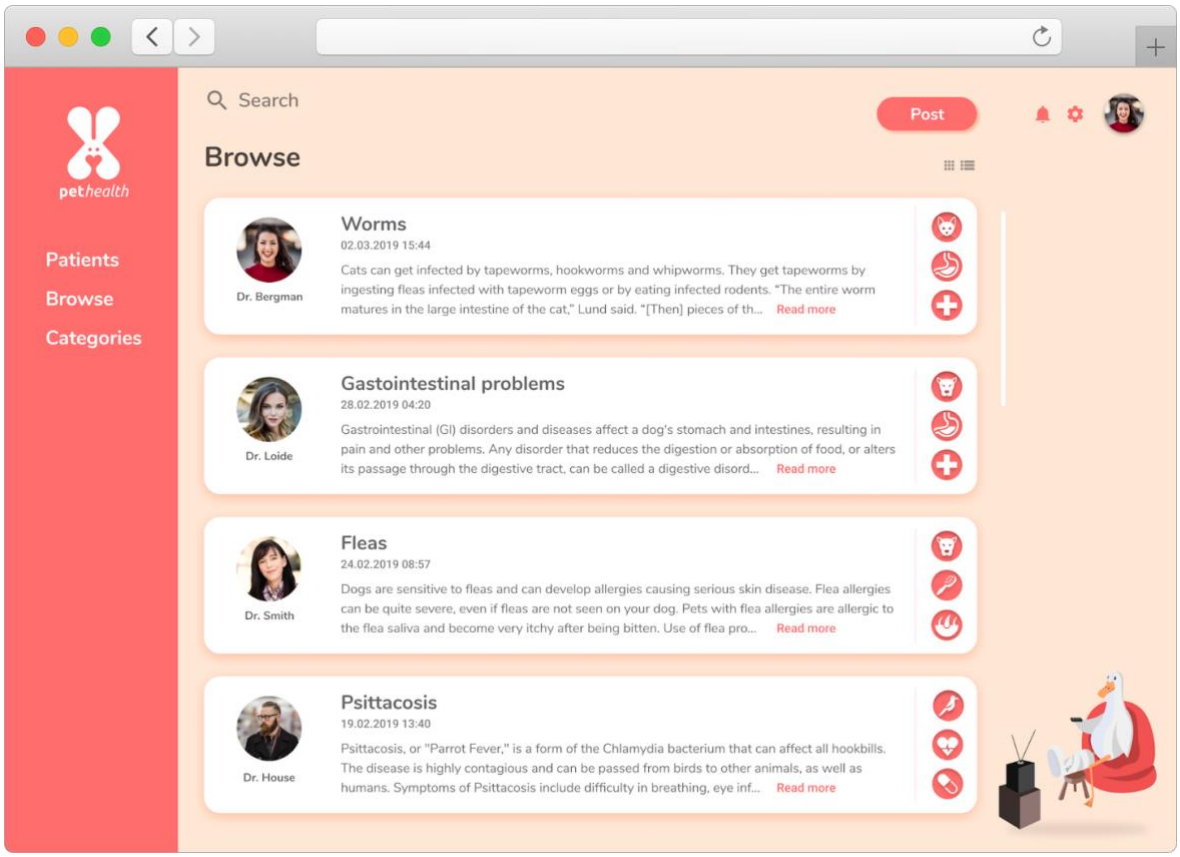

Figure 2 Patient record list view

An alternative listing for medical categories has also been implemented in the prototype as seen in Figure 5 Medical categories. This serves as a focal point to collate all discussion and medically relevant information pertinent to the condition, species or another categorization that would be applicable for medical deliberation. Differentiating itself from a health record tied to a specific patient.

6.2. Medical condition review

The patient view was divided as a three-column view separating each of the most immediate concerns that must be visible to the veterinary doctor handling the treatment of the patient. Illustrated from Figure 3 Individual patient record view. As the most immediate concern is

to establish patient information, the first column deals with the personal details. These are related to the name, age, breed and etc of the animal. Following this, the most detailed interaction will take place in the middle column as this lists all the patient medical history entries. For the doctor responsible for the treatment of the patient this is the most focused target of their attention in most of the dealings with the patient. The last column is where a messageboard is populated with discussions about the condition of the patient. This enables collaborative effort and input from other doctors.

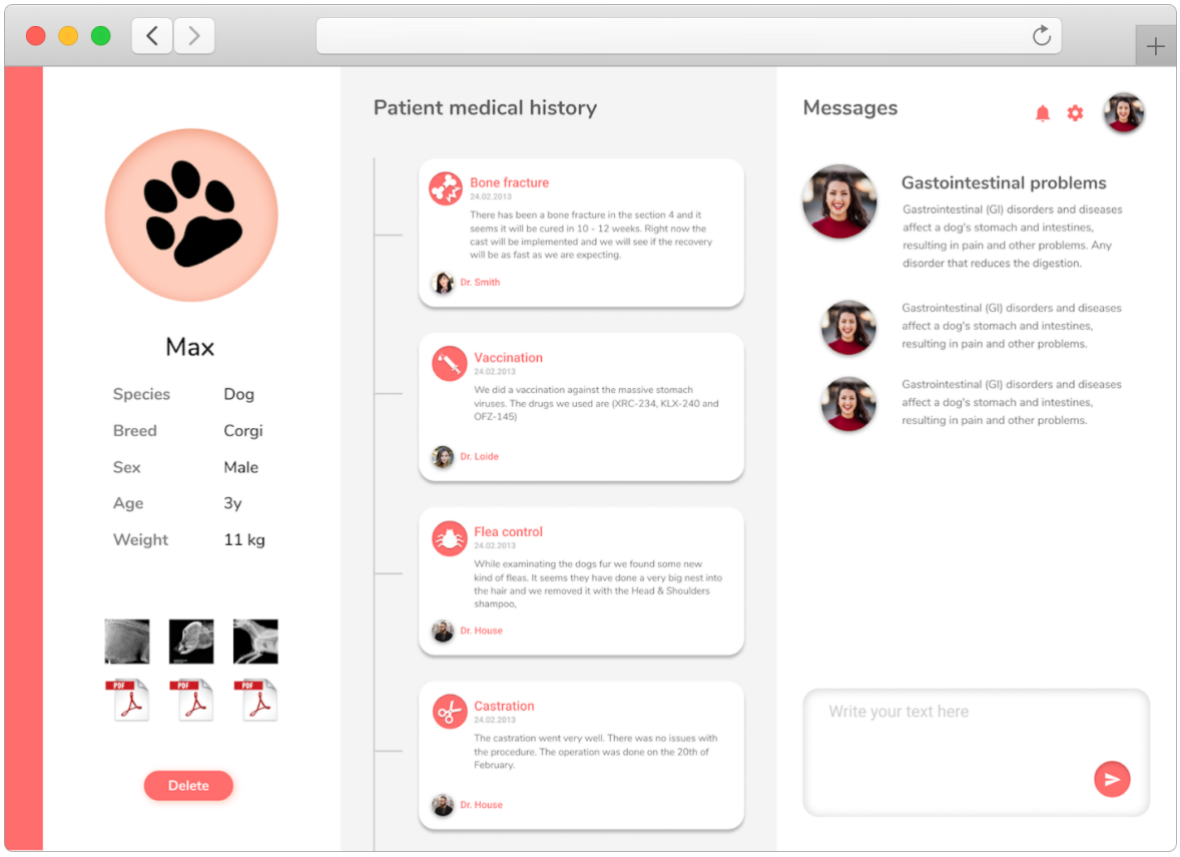

Figure 3 Individual patient record view

An alternative detail view for medical categories was created to collate any relevant information that is not limited to the specific patient case as seen in Figure 6 Medical category detail view. This differentiates itself from a regular patient detail view by being limited to two separate columns, eschewing the details column and maintaining focus on medical history relevant to the category and applicable discussions.

7. CHALLENGES FOR SYSTEMATIC ADOPTION

The benefits of any collaboration effort must be balanced by adequate security consideration and data privacy. Although practical implementations in this regard were not under the scope of this project they were of considerable theoretical overhead as any viable service in this regard needs to handle these matters with utmost delicacy. Also to consider are factors of scale in the collaborative aspect of the implementation. Lacking a sufficient amount of intercommunication volume to bring out possible treatments or suggestions in a medical consultation would render the service incapable of reaching its full potential.

7.1. Deficiency of scale

Lack of access to timely diagnostics consultation is of considerable limitation in the early stage of this service where user participation is expected to be on the lower side. Veterinary medicine is a highly time-sensitive field that depends on rapid diagnostics for best outcomes to patient treatment. Without a scalable community of users, it will render any potential benefits derived from the platform moot and irrelevant.

To overcome this situation the most applicable solution would be to introduce the platform specifics beforehand its release to the greater demographics and enrolls wide enough demographic outreach as possible with the final product.

7.2. Security considerations

To handle with utmost care patient record confidentiality a rights management approach was deemed to be the most promising. This implementation is based on DRM[10] where users can only access their data based on the policy stated by the license accompanied by the encrypted patient record. Ensuring that the data is always in encrypted form and thus inaccessible by outside actors as put forward by Jafari M., & Reihaneh S., & Sheppard N. P. (2011, 3). The

[10] Digital rights management

DRM approach provides a persistent access control where the patient record and relevant medical data can be shared with relevant parties while retaining control over its licensing to their owners. “This contrasts with traditional access control systems in which there is no control on the use of data when access is granted” (Jafari M., & Reihaneh S., & Sheppard N. P. 2011, 4). It is accomplished by utilizing public-key cryptography and authentication service that would be implemented on the service side of this proposed project. This enables the medical professionals to delegate control over their records to other colleagues while being certain that they can revoke the access with confidence.

8. FEEDBACK

The interview process for review and feedback on the prototype implementation was conducted on March 2, 2019, in Tallinn and included 3 interviews with the partial set of participants involved in chapter 2.1 Research interviews. They were conducted to gather greater insight into the potential viability of veterinary collaboration platform to facilitate enhanced diagnostic consultations. For demonstration purposes, they were introduced to the functional prototype and constructed with finding an optimal workflow that would match their preferences and previous experiences. These exercises were constructed to gauge the intuitiveness of the assembled implementation in relation to existing know-how from veterinary specialists in working with electronic healthcare systems.

In general, the interview participants reported great enthusiasm for the service implementation with the split column segregation of Figure 3 Individual patient record view being the most intriguing detail. For the Interview participant nr. 3: “It’s a simple yet effective way to communicate, like Facebook Messenger. And all the data is accessible for me” (interview, March 2, 2019). Reducing the need to switch from the platform to accommodate the sharing of medical history was pointed out as being beneficial in diminishing the cognitive load for veterinary practitioners and keeping all the referenced documentation in a single source of truth. As mentioned by the Interview participant nr. 3: “Keeping tabs on medical imaging assets and diagnostic printouts that I have sent out is tiresome, it’s more convenient to invite someone to the patient record to look it over themselves than to send them out manually” (interview, March 2, 2019).

It was noted by all interview participants that the current prototype system doesn’t have privacy and data separation handled in their implementation details and that this made it harder to gauge in an objective manner how the service would be limited in full functionality. This notwithstanding the communication with different patient records was intuitive and well received. Notable positive feedback was directed at the card-based medical history abstraction that separated different procedures in an easily referenced manner while listing responsible doctors for the procedure and with a simple visual iconographic representation for the ailment.

CONCLUSION

This project evaluates and studies the information-sharing potential in the field of veterinary medicine. In specifics, it is evaluated how to integrate collaboration in diagnostic consults and patient management systems. The end focus is a review of the potential benefits of the aforementioned service, its relevance for the industry and implementation of a prototype service to serve as a test base for evaluation of the concept.

The implemented prototype concentrates on user-centered design and is made to be intuitive and uncomplicated to use for any veterinary professional migrating from a paper card-based organizational method or from an existing electronic patient management software. This has been accomplished in a minimally viable fashion for this project and validated among the representatives of the Estonian veterinary medicine community. The results from this were received in an emphatic manner and with an agreement that a service that would integrate patient record management with collaborative aspects to facilitate diagnostic consultations would be of benefit to the field of veterinary medicine.

Results also indicate that the current utilization of electronic healthcare records is underutilized in their potential for improving clinic operations and facilitating dialogue among veterinary doctors for best care practices. Medical literature on the subject matter is confirming that current software implementations available in animal healthcare are concentrated on providing administrative value to their clients as a first priority and relegating medical consideration to the afterthought of their plans. Efforts to strengthen the position of EVMR should be prioritized among the veterinary medical patient management system providers to include more advanced sharing of patient records as well as bringing more inclusive collaboration into consideration where applicable.

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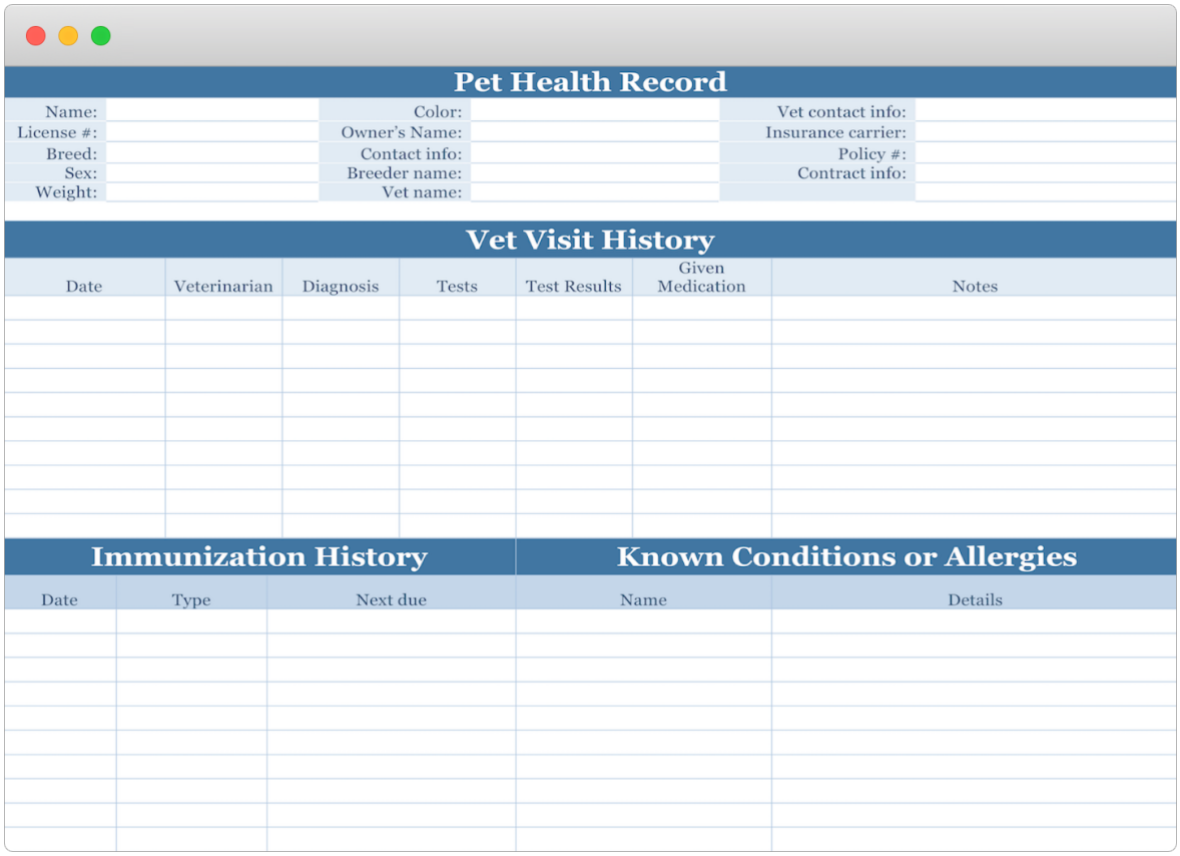
APPENDIX

Appendix 1. Paper-based veterinary medicine health record



Pet Health Record

Name:		Color:		Vet contact info:	
License #:		Owner's Name:		Insurance carrier:	
Breed:		Contact info:		Policy #:	
Sex:		Breeder name:		Contract info:	
Weight:		Vet name:			

Vet Visit History

Date	Veterinarian	Diagnosis	Tests	Test Results	Given Medication	Notes

Immunization History

Date	Type	Next due

Known Conditions or Allergies

Name	Details

Figure 4 Paper-based patient card

Appendix 2. User interviews

1. If and what are the biggest problems in the field of veterinary medicine?
2. Have you and how do you have dealt with these problems?
3. How do you rate the adaptability of new technologies in the field?
4. How do you rate the dissemination of information among the veterinary profession?
5. How often does the need for outside consultation arise?
6. What causes the need for a consultation?

7. What communication channels do you use for communication with other veterinary professionals?

Appendix 3. Survey of veterinary specialists

1. How do you agree with the statement: „The field of veterinary medicine should keep up with technological progress?“
    a. Agree completely
    b. Mostly agree
    c. Mostly disagree
    d. Completely disagree
    e. Uncertain
2. If and what are the biggest problems that veterinarians face at work? We ask for you to consider technological aspects and problems that are faced with document management.
3. If you answered „Yes“ to the previous question, then how have you been dealing with these problems?
4. How do you evaluate information sharing between veterinarians?
    a. Information is shared a lot and often
    b. Information is shared only when necessary
    c. In some cases, the information is not shared at all
    d. Information is shared predominantly or only with aquaintances
    e. Information is shared with all the colleagues in the field
5. The situations where there is a need to consult with other veterinarians occurs?
    a. Everyday
    b. A couple of times during the week
    c. A couple of times during the month
    d. A couple of times during the year
    e. Never
6. What causes the need for consultation with other veterinarians? If you answered „Never“ to the previous question then please skip this question.

7. What are the communication channels that you use to consult with other veterinarians?
    a. Email
    b. Telephone
    c. Social media
    d. Internet groups and forums
    e. Other (please specify)
8. To what extent would you be interested in software that enables communication between veterinarians and creates a common environment to digitally manage patient medical records?
    a. Very interested
    b. Mostly interested
    c. Uncertain
    d. Mostly not interested
    e. Not at all interested
9. How much would you be willing to pay for this service?
    a. 4-6€
    b. 7-9€
    c. 10-12€
    d. 13-15€
    e. 15-...€
    f. Is not important
    g. Would not be willing to pay
10. Do you find that such a service would be capable of enhancing the work of Estonian veterinarians and making it more efficient while improving the field of Estonian veterinary medicine in general?
    a. Completely agree
    b. Mostly agree
    c. Uncertain
    d. Mostly disagree
    e. Disagree completely

Appendix 4. Medical categories

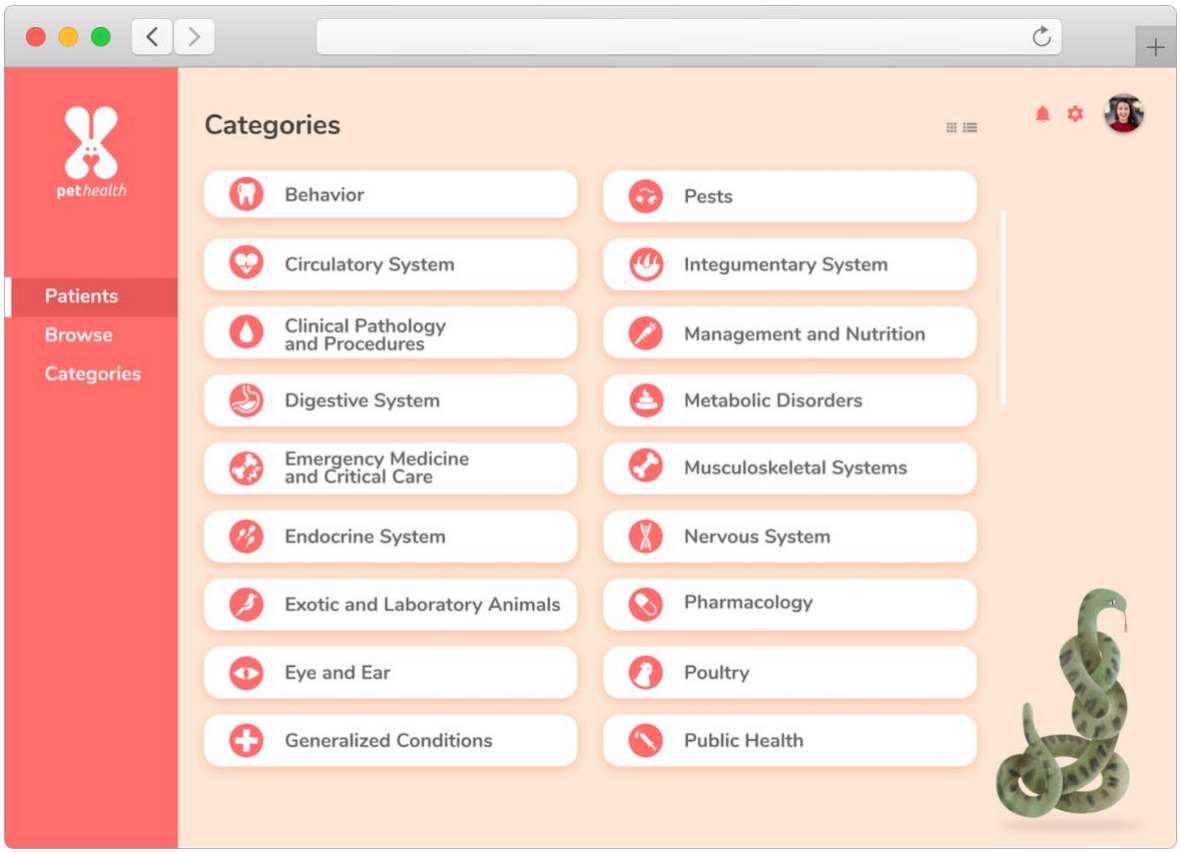


Figure 5 Medical categories

Appendix 5. Medical category detail view

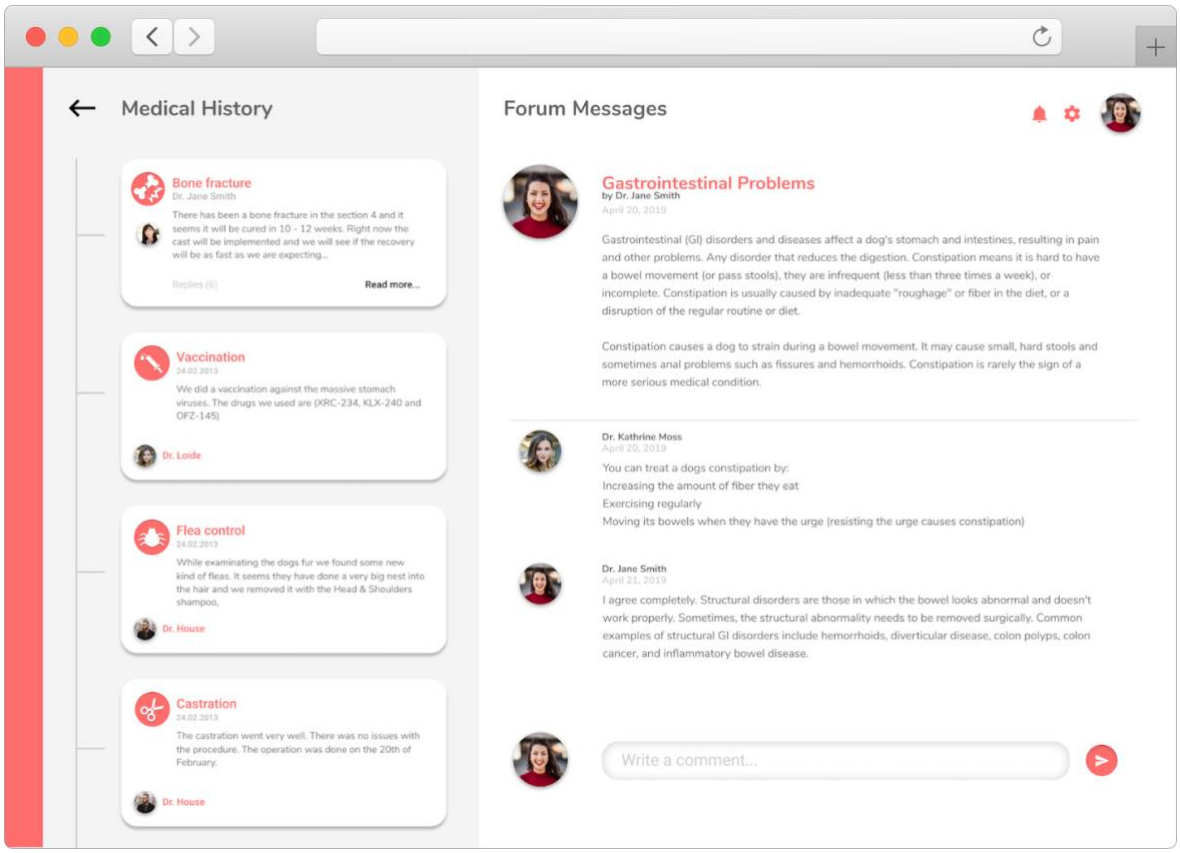


Figure 6 Medical category detail view