

Telemedicine in veterinary practice

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ABSTRACT

Veterinary surgeons have a long tradition of consulting one another about problem cases and many have unwittingly practised telemedicine when discussing cases by telephone or by sending laboratory reports by telefax. Specific veterinary telemedicine applications have been in use since the early 1980s, but little research has been undertaken in this field. The Pubmed and CAB International databases were searched for the following Boolean logic-linked keywords; veterinary AND telemedicine, veterinary AND telecare, animal AND telemedicine, animal AND telecare and veterinary AND e-mail and an additional search was made of the worldwide web, using Google Scholar. This returned 25 papers which were reviewed. Of these only 2 report research. Sixteen papers had no references and 1 author was associated with 13 papers. Several themes emerge in the papers reviewed. These include remarks about the use of telemedicine, the benefits that can and are derived from the use of telemedicine, areas of practice in which telemedicine is being used, ethical and legal issues around the practice of telemedicine, image standards required for telemedicine, the equipment that is required for the practice of telemedicine, advice on ways in which digital images can be obtained and educational aspects of telemedicine. These are discussed. Veterinary practice has lagged behind its human counterpart in producing research on the validity and efficacy of telemedicine. This is an important field which requires further research.

Key words: animal, e-mail, telecare, telemedicine, videoconferencing.

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INTRODUCTION

Veterinary surgeons have a strong tradition of consulting one another about problem cases^{3,16}. The increasing use of computers, e-mail, cellular telephones, digital cameras and the falling costs of information communication technologies offer new ways in which practitioners can communicate and share information with colleagues, electronically. Electronic sharing of information constitutes veterinary telemedicine, which is defined as the use of electronic information and communication technologies to assist practitioners in providing clinical care when separated by a distance³³. Telemedicine is not new and many, if not all veterinarians, have practiced telemedicine without having appreciated that using a telephone or fax to discuss a case or send a laboratory report, constitutes telemedicine.

Veterinary telemedicine can probably trace its origins back to the early days of the telephone or telegraph. The 1st

dedicated service was the use of a trans-telephonic electrocardiogram (ECG) transmitter to connect veterinarians across America to specialist cardiologists at the Animal Medical Centre in New York in the 1980s³³.

Advances in computing and the acceptance of the internet, provide the average person with the facility to rapidly transmit text, images, video and sound in digital format, over great distances. Telemedicine services have broadly evolved into 2 categories, synchronous telemedicine and store and forward telemedicine.

Synchronous or real-time telemedicine involves a live consultation with the consultant able to see and discuss the problem with the referrer. This usually involves some form of videoconference connection, to which can be added, visual or auditory input from specialised instruments such as electronic stethoscopes, dermoscopes, fundoscopes and the transmission of diagnostic tests like radiographs, ECGs or laboratory reports. Store and forward telemedicine, as its name implies, involves forwarding information which has already been stored in an electronic format, to a consultant who reviews the case in his or her own time. A

3rd form of telemedicine is evolving. This is a variant of synchronous and store and forward telemedicine, in which data, such as radiographs, histopathology slides and ECGs are sent electronically and the referrer and the consultant discuss interpretation of the data over the telephone. Despite the use of veterinary telemedicine, Leung noted in 1999 that there were no studies evaluating the use of veterinary telemedicine in veterinary practice¹⁶.

Human telemedicine is developing in South Africa. Teleradiology has a relatively long history, with CT scanners linked to academic hospitals⁷ and more recently with the development of e-mail services⁸. Teleneurology¹³, teleophthalmology⁶, telepathology⁴ and teledermatology are all established services in some centres. The National Department of Health has identified telemedicine as a way of providing specialist services to rural areas and rolled out phase 1 of an ambitious National Telemedicine Project in 1999 and 2000. Several pilot projects were commenced, looking at the introduction of teleradiology, teleophthalmology and teleultrasonography¹⁰. These have been followed by separate initiatives in KwaZulu-Natal, Limpopo, Mpumalanga, the Eastern Cape and the Western Cape. In KwaZulu-Natal, there are functioning projects in teledermatology, teleophthalmology, tele-plastic surgery, teleradiology, teleorthopaedics, tele-paediatric surgery supplemented by a wide range of tele-education programmes.

In veterinary practice, a Digital Veterinary Diagnostic teleconsultancy service has been established. The service allows large amounts of laboratory data to be submitted by fax, e-mail or via the D-V-D website³². The livestock and health and production group of the South African Veterinary Association runs an e-mail discussion group called Ruralvet (ruralvet@yahoo.com), which allows practitioners to seek advice or share their experience with their colleagues. There are plans to expand this with a veterinarian network website¹. These appear to be the only organised attempts at developing veterinary telemedicine in South Africa.

The aim of this paper is to look at the

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Table 1: Year of publication, the number of papers published, the journals in which the papers were published (number of papers in journal) and the country of the primary author's institution.

Year	No. of papers*	Journal	Country
1996	1	<i>Seminars Veterinary Medicine and Surgery</i>	USA
1998	1	<i>Journal of the American Veterinary Medical Association</i>	USA
1999	3	<i>Journal of Telemedicine and Telecare</i>	Canada
		<i>Canadian Veterinary Journal</i>	Canada
		<i>Compendium Small Animals/Exotics</i>	USA
2000	3	<i>In Practice</i> (2)	UK (2)
		<i>Creativity and Innovation Management</i>	Japan
2001	15	<i>Clinical Techniques in Small Animal Practice</i> (12)	USA (14)
		<i>Veterinary Clinics of North America: Equine Practice</i> (3)	UK (1)
2002	1	<i>Journal of Veterinary Emergency and Critical Care</i>	USA
2005	1	<i>The Veterinary Record</i>	USA
Total	25	11	

*Refs 2, 3, 5, 9, 11, 12, 14–31, 33.

current status of veterinary telemedicine and to present ways in which telemedicine may be expanded in veterinary practice in South Africa.

METHODS

Full-length, peer-reviewed journal papers were obtained for review by searching the electronic databases PubMed and CAB International. Searches were made on the following Boolean linked keywords; veterinary AND telemedicine, veterinary AND telecare, animal AND telemedicine, animal AND telecare and veterinary AND e-mail. The results of all the searches were combined and duplicates excluded. An additional search of the world wide web was made on Google Scholar. Where appropriate, references cited in papers were obtained and studied. Abstracts of papers presented at conferences were not included.

RESULTS

The database searches returned 23 papers and the web search, another 2. The papers were published in 11 journals. The 1st paper was published in 1996, with no papers published in 1997, 2003 and 2004. The number of papers published and the journals in which they were published are shown in Table 1.

Only 2 of the 25 papers can be classified as research studies^{9,14}. The other 23 papers either presented evidence of the usefulness of telemedicine or gave technical information and advice on how to capture and transmit data. Sixteen papers had no references. One person was associated with 13 papers, 12 of which were as 1st author, and another person wrote 2 papers. Nineteen papers emanated from the United States, 3 from the United Kingdom, 2 from Canada and 1 from Japan.

DISCUSSION

Leung observed in 1999 that there had been no studies or evaluations of veterinary telemedicine, comparable to those in human telemedicine¹⁶, and the situation has changed little since then. In the absence of scientific evidence on the use of telemedicine in veterinary practice, several themes emerge in the papers reviewed. These include remarks about the use of telemedicine, the benefits that can and are derived from the use of telemedicine, areas of practice in which telemedicine is being used, ethical and legal issues around the practice of telemedicine, image standards required for telemedicine, the equipment that is required for the practice of telemedicine, advice on ways in which digital images can be obtained and educational aspects of telemedicine.

Use of telemedicine

Telemedicine use is more likely to occur in practices that have already embraced computers and the internet. In 2000, Boydell commented that 'there is a surprisingly large number of veterinary practices in the UK that do not use computers in their general management², whereas in the US, 10 % of veterinary clinics did not yet have computer systems by 2001²⁰. Despite the use of computers, uptake of telemedicine in the US was low in 2001, with about 900 telemedicine users or 6 % of the 15 000 practices. In some areas, however, usage was high, with 60 % of practices in the Portland Vancouver metropolitan area sending their radiographs to specialist radiologists for reporting^{20,22}.

Benefits of telemedicine

The benefits of veterinary telemedicine

are assumed to be similar to those given in human telemedicine. These include providing a better service to patients in both urban and rural areas^{16,29}, by offering specialist services at a distance²⁰, increasing access to specialists²⁰, supporting isolated doctors²⁰ and reducing cost and saving time by not having to travel to another centre after referral³⁰. It should also be able to be used to overcome shortages of veterinarians in some areas, deliver education^{3,16,25,33} and facilitate research.

A marked difference between the benefits cited for human and veterinary telemedicine is the emphasis on the potential of veterinary telemedicine to improve practice income and limit personal liability²⁹. This may be a reflection of the largely North American bias of the papers or the lack of state-funded veterinary practice.

Areas of practice in which telemedicine is used

While tele-ECG^{2,16,25,33} has been around since the 1980s, teleultrasonography^{2,3,21,29,30}, teleradiology^{2,22,27,30,33} and telecytology^{11,33} appear to be the most commonly practised forms of veterinary telemedicine.

Teleultrasonography can be performed both synchronously and by store and forward telemedicine. Many veterinary radiologists believe the interpretation of still images is less accurate than interpretation of real-time examination and the need for adequate training is stressed³. While it is useful to have a specialist reviewing the examination and providing the diagnosis, the procedure requires a competent practitioner performing the ultrasound examination²⁹. One practice reports that teleultrasound

examinations are sent to their facility daily²¹. There are no studies comparing the accuracy of remote teleultrasonography with radiologists performing the ultrasonography. Similarly, no comparison has been done between a general practitioner's diagnosis on site with a radiologist's diagnosis at a distance. A human study of 80 patients in 1999 showed the diagnostic accuracy of general practitioners on-site and remote radiologists was 92 % and 94 %, respectively³⁴.

Teleradiology is another area where teleservices are easily rendered. As previously mentioned, in 2001, 60 % of veterinary practices in the Portland Vancouver metropolitan area had their radiographs read by specialist radiologists²². Arguing in support of digital radiography and teleradiology, Papageorges states that there is a 20–30 % error rate in the interpretation of radiographs by non-specialists and that there is an up to 50 % radiograph retake rate in veterinary practice^{27,30}. The error rate can be reduced by specialist interpretation. There are various ways in which radiographs can be obtained in digital format. These include very expensive digital X-ray units that use phosphor plates²² and large dedicated radiograph scanners that convert a standard radiograph plate into a digital image²⁷. Acceptable images can also be obtained with readily available and relatively cheap digital cameras²². To optimise digital photographic images captured for teleradiology, issues such as resolution, bit depth, dynamic range, file format and compression need to be addressed²⁷. These are all relatively simple matters to resolve.

Image standards have been defined by the American College of Radiologists for human teleradiology. They recommend a minimum resolution of an image of 2000 × 2000 pixels by 12 bit for radiographs and 500 × 500 pixels by 8 bit for ultrasound images. No standards have been defined for veterinary radiology. Papageorges's recommendation of 640 × 480 pixels by 8 bit for veterinary radiology is easily obtainable with comparatively cheap digital cameras²⁷.

Telecytology can also be practiced using store and forward telemedicine, with images captured using a digital camera attached to the microscope eyepiece with a suitable adaptor. Issues revolve around selection of the area to be photographed, focus, magnification and the number of images that must be taken to provide a representative sample¹¹. Recent advances in human telepathology provide for concentrating on areas of an image³⁶. With the addition of a video

camera to the microscope images can be seen in real-time, but with a loss of resolution.

Synchronous and store and forward teleradiology are widely practiced in human telemedicine and teleradiology and should also be suitable for veterinary practice³³. When filming skin lesions for onward transmission by e-mail, it is suggested that the macro feature, which allows close-up focussing should be considered. Care should also be taken to ensure that the colours of the photograph are a true representation²⁵.

There are various ways in which telemedicine is used in cardiology. The Cardiopet, transtelephonic ECG service was the earliest example^{16,33}. Tele-ECGs can also be transmitted live², recorded as a video clip, digital photographs can be taken of the printout and sent by e-mail or printouts can be faxed. Echocardiography can also be transmitted over distances^{25,33} and heart or breath sounds derived from dedicated stethoscopes can be transmitted live or can be recorded for later transmission²⁵.

Standard digital photography is useful in teleophthalmology of the surface of the eye. While pictures of the anterior chamber can be obtained with a digital camera and a slit lamp in humans³⁵, dedicated ophthalmoscopes are required for anterior and posterior chamber work in animals^{2,25}.

Teleendoscopy can be achieved through the attachment of digital still or video cameras to endoscopes^{2,25,30}. Tele-neurology has been facilitated by transmitting EEGs electronically and also by evaluating video footage of an animal's gait and then discussing the video over the telephone³.

Video-conference based telepsychiatry is a rapidly developing form of human telemedicine. Dodman has shown the efficacy of remote consultations in the management of aggressive behaviour in dogs. In this study owners completed a behaviour assessment form which was submitted to the behaviourist and advice and treatment options were mailed back to the owners who were asked to share the information with their veterinarian. Owners were also asked to maintain telephone contact with the behaviourist for 2 months. Results obtained were similar to those achieved with direct consultation with the owner and the dog⁹. It has also been suggested that video-conferencing can be used to interview owners and see their animals²⁵.

Ethical and legal issues

Four papers discuss the ethical and legal issues of veterinary telemedicine, the

most recent of which was published in 2001^{2,12,16,19}. As 3 of the papers are from North America, the issue of trans-state practice and the need to be licensed to practice in the state or province in which the referral originates, is a focus. This is not a problem in the South African context but may well arise with cross-border practice. There are currently no appropriate laws or guidelines for the practice of human or veterinary telemedicine in South Africa.

The need to obtain informed consent for a telemedicine consultation is stressed. This allows for the maintenance of patient/client/practitioner confidentiality^{12,16}. Another problem related to confidentiality is that of data protection. There is the possibility of 'hackers' accessing data stored on hard drives or e-mails being intercepted and read. Although not fool proof, technological safeguards such as encryption and message authentication should be used for data transmission¹².

Two interesting viewpoints emerge regarding the use of telemedicine and the standard of care. Proponents of telemedicine suggest that telemedicine will improve the standard of care and lower the risk of liability. An extreme view is, that in future, the failure to teleconsult a specialist or forward tests and diagnostic images for a 2nd opinion, may itself be deemed to be negligent^{12,19}. Opponents argue that the use of telemedicine will raise the expectation of clients and increase the risk of malpractice claims.

Ethical concerns have been raised about the storage and confidentiality of patient electronic records and data and these need further debate. Further concerns over prescription are usually covered by existing guidelines and policies on telephonic, faxed and posted prescriptions.

Electronic discussion groups

There are a number of international electronic discussion groups, both web and e-mail based, in which veterinarians can discuss problem cases with their colleagues. These groups, such as Ruralvet in South Africa, can be considered to be sources of electronic 2nd opinions and a form of telemedicine. They also highlight the absence of specialist support in certain fields in some countries and regions and the need for this support.

Education

It is well documented in human telemedicine that teleconsultation is a learning experience for the referring practitioner. After several teleconsultations elicit the same diagnosis and treatment options, the referring doctor learns how to

recognise the condition and knows the treatment options. Videoconferencing is a very effective tool for providing lectures, with full interactivity, and also allows practitioners to participate in 'grand rounds' at a distance.

The future

While exotic advances in telemedicine, like telerobotic surgery across continents, capture the focus of the world's media, simple advances in cellular telephony and the convergence of the cell phone and the hand-held computer will probably have a greater impact for the practicing veterinarian. Already cell phones can take and send photographs, video footage, e-mails, access the web, and record and send sound files. Hand-held computers can store information and provide programmes for data management and editing. As bandwidth improves and the technology matures, the cell phone/hand-held computer will provide many practitioners and clients with access to a wider range of veterinary support and services.

CONCLUSIONS

Telemedicine is not a technology, a separate branch of medicine, a new branch of medicine, the preserve of computer nerds, new, or a mature discipline. It is an evolving field. Telemedicine will in time become an integral part of the practice of certain aspects of veterinary medicine. It is not a matter of if, but when. For those enthusiasts who lead the way, it is necessary to adopt some of the sound principles of IT change management that have been established over the years. The 1st and most fundamental principle is to use technology to solve a problem, and not for the sake of using technology. In some instances a pencil and a piece of paper is still more appropriate than a state of the art laptop or PDA. In our African setting, it is often more appropriate to use the lowest level of technology that will do the job, rather than expensive leading-edge technology. In human telemedicine, change has been driven by groups of enthusiasts with others following as they see the benefits to themselves and their patients.

Veterinary practice has lagged behind its human counterpart in producing research on the validity and efficacy of telemedicine. This is an important field which requires further research. The

students of today have been brought up in the digital age, and easily embrace technological change and advance. Their technological acumen needs to be harnessed. The potential usefulness of veterinary telemedicine and its constraints need to be included in their education, so that they can fashion the future and take their older teachers with them.

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