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Telemedicine: A new rise of hope to animal health care sector-A Review

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ABSTRACT

Telemedicine in recent years has become a dominant issue in the health care community due to the advances in technology that can provide patients with faster, cheaper and easier health care services. Telemedicine is not one specific technology but a means for providing health services at a distance using information and communications technology, medical and computer science. Telemedicine hinges on transfer of text, reports, voice, images and videos between geographically separated locations. Success relates to the efficiency and effectiveness of the transfer of required information. Evidence of technology is advancing in all aspects of our life and veterinary science is no different. Veterinary telemedicine era has also come and delegation of key skills to an emerging and evolving veterinary profession appears essential to the objectives of veterinary telemedicine.

Key words: Animal health care, Information and communications technology, Veterinary telemedicine.

Telemedicine is the use of medical information exchanged from one site to another for health, diagnosis, consultation, treatment and transfer of medical data of the patient (Meher *et al.,* 2008). The term "telemedicine" was first coined in the 1970s by an American, Thomas Bird , means "healing at a distance" (from Greek "tele" and Latin "medicus") (Strehle and Shabde 2006). Telemedicine may be as simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and video conferencing equipment to conduct a real time consultation between medical specialists in two different locations (Sharma and Rajput 2009).

It is now believed that telemedicine is going to be an essential component of modern healthcare system. It helps in decreasing the load over the existing healthcare system which is already suffering from problems like lack of required number of physicians, lack of expertise in specific medical branches and high cost as well as limited reach in the rural areas to approach a medical specialist for treatment. In such conditions telemedicine helps in facilitating healthcare over long distances and thus bridging the gap (Bashshur and Lovett 1977; Mort *et al.,* 2003; Doolittle *et al.,* 2005). Electronic sharing of information constitutes veterinary telemedicine, which is defined as the use of electronic information and communication technologies to assist veterinary practitioners in providing clinical care when separated by a distance (Robertson, 1999). Veterinary telemedicine trace its origins back to the early days of the telephone or telegraph. The first dedicated service was the use of a transtelephonic electrocardiogram (ECG) transmitter to connect veterinarians across America to cardiologists at the Animal Medical Centre in New York in the 1980s (Robertson, 1999). Despite the use of veterinary telemedicine, it had been noted that there were no studies evaluating its efficiency and utility in veterinary practice (Leung, 1999). Veterinary practice has lagged behind its human counterpart in producing research on the validity and efficacy of telemedicine (Mars and Auer, 2006) and thus is an important field requiring further detailed research.

Need of initiative of telemedicine in veterinary practice:

The veterinary and animal husbandry are highly specialized area involving management and health care of varied species of animals, disease diagnosis, treatment and prevention of the diseases, quality assessment of meat and food including milk and milk products, quarantine procedures, animal welfare, feed formulation and testing, dissemination of technologies, besides teaching, training, innovation, generation and transfer of knowledge or technologies for end users as well as for administrators. The role of veterinarians has, thus, become versatile as a clinician, educator, researcher, extension educator, research administrator, consultant, policy maker and advisor demanding much more workforce in scarcity of time as well as resources. In India there are approximately 9527 veterinary hospitals/polyclinics, 20,897 veterinary dispensaries, 24482 veterinary aid centers and 67,048 artificial insemination centers offering quality veterinary services. But there is a huge gap, the requirement

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of 67,000 veterinarians is fulfilled only by the available 34,500 veterinarians. Against the requirement of 7500 veterinary and animal science specialists for teaching and research, only 3050 are available to manage universities and colleges (Planning commission working body report, 2014). Shortage of work force and inadequacy of veterinary infrastructure arouses the need of telemedicine as future of animal health care services in India.

Technology of telemedicine: Telemedicine is a confluence of communication technology, information technology, biomedical engineering and medical science. Technology ranges from the basic telephone service to broadband internet that allows physicians, nurses and other allied health professionals to provide healthcare at a remote locations (Breen and Matusitz, 2007). Three things are necessary to achieve communication: a sender, receiver and a medium which will transmits information from a sender to a receiver. The telemedicine system consists of customized hardware and software at both the patient and specialist doctor ends, with some of the diagnostic equipments like ECG, X-ray, microscope/camera etc., provided at the patient end. Communication is made through a Very Small Aperture Terminal (VSAT) system and controlled by the network hub station of Indian Space Research Organization (ISRO) (Wootton, 2001). Through a telemedicine system, medical images and other information relative to the patients could be sent to the specialist doctors, either after imaging or on a real time basis through the satellite link in the form of digital data packets. These packets are received at the specialist centre, the images and other information is reconstructed so that the specialist doctor can study the data, perform diagnosis, interact with the patient, and suggest the appropriate treatment during a video conference with the patient end. Telemedicine facility thus enables the specialist doctor and the patient separated by thousands of kilometers to see each other, talk with each other, assessing the physical and psychological state of the patient and to suggest appropriate treatment. In this way, the systematic application of Information and Communication Technology (ICT) to the practice of health care rapidly expands the outreach of the health care system.

Types of telemedicine: Asynchronous telemedicine (Store and Forward) involves acquiring medical data (like medical images, biosignals etc.) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline not requiring the presence of both parties at the same time. Cases requiring specialist opinion *viz.* dermatology, radiology and pathology are accessible to asynchronous telemedicine (Bedi, 2003). In the Indian context, asynchronous telemedicine involving sending of case details and images/lab reports via e-mail to experts for a second opinion (like human medicine) is gaining a ground.

Remote Monitoring (Tele home care) allows the remote observation and care of a patient using various technological devices. Patient status can be reviewed and alarms can be set from the hospital nurse's station, depending on the specific home health device.

Real Time Telemedicine (Interactive or Synchronous telemedicine) could be as simple as a telephone call or as complex as robotic surgery requiring the presence of both parties at the same time and a communications link between them that allows a real time interaction to take place demanding video conferencing equipment as one of the most common and important technology. There are also peripheral devices, which can be attached to computers or the video conferencing equipment aiding in an interactive examination. For example, a tele-otoscope allows a remote physician to 'see' inside a patient's ear; a tele-stethoscope allows the consulting remote physician to hear the patient's heartbeat. Almost all specialties of medicine have been found to be conducive to real time consultation including psychiatry, internal medicine, cardiology and gynaecology and obstetrics (Dasgupta and Deb 2008).

Potential scope under telemedicine

1. Teledermatology: Images of skin lesions/skin parasites transferred electronically for proper diagnosis of skin infections/diseases.

2. Teleophthalmology: It includes remote screening of cases of cataract, glaucoma and diabetic retinopathy.

3. Telecardiology: Important to remotely diagnose, treat and manage cardiac diseases through echocardiograms, angiograms and, blood pressure monitoring.

4. Telepathology: It refers to process of diagnostic pathology performed on digital images viewed on a display screen rather than by conventional light microscopy with glass slides. A Telepathology image sent through electronic mail provides acceptable efficacy and a quicker turnaround time than post and can be applied to veterinary diagnostic cytology (Maiolino *et al.*, 2006).

5. Teleradiology: Teleradiology is considered as a paradigm for other applications owing to long history of use. Patient's radiographic/pathologic images and consultative texts are electronically transmitted from one medical location to another.

6. Telesurgery: A particular advantage of this type of work is that the surgeon can perform many more operations of a similar type and with lesser fatigue.

Economics of telemedicine: Economic considerations are a crucial element in the planning and execution of a telemedicine programme. Economic evaluation is a set of formal analytical techniques that provide systematic information about costs: benefit ratio of alternative options, and can thereby assist in priority setting (Drummond and Sculpher, 2005; Sculpher and Price 2003; Sassi *et al.,* 1997; Drummond *et al.*, 2005). Economic analyses can take more than one economic perspective, but the Panel on Cost Effectiveness in Health and Medicine recommends that collective perspective should be considered always (Gold *et al.*, 1996). Diversity in telemedicine applications, lack of standardized methodology, randomized control trials (RCTs) and, long term evaluation studies and absence of quality data are few commonly encountered limitations seen in telemedicine economic analyses disabling to fully evaluate and authenticate economic impact of telemedicine (Bashshur *et al.,* 2005; Whitten *et al.*, 2002; Reardon, 2005; Jennett *et al.,* 2003; Ruckdaschel *et al.,* 2006). Most of studies investigating cost effectiveness of telemedicine found that benefits are evaluated in terms of cost savings with no assessment done in terms of changes in the benefits for the patients (Whitten *et al.,* 2002; Hailey *et al.,* 2002). There is wide variation in reports on economic analysis of telemedicine. No reports are available for economic analysis of veterinary telemedicine. Many studies suggested that telemedicine seemed to be cost effective for examples: 91% of the studies showed telehomecare to be cost effective by reducing visit to hospitals, improving patient compliance, satisfaction and quality of living (Rojas and Gagnon 2008), telemedicine was found to be cost effective in management of chronic diseases (Gaikwad and Warren 2009), telemonitoring proved to be rewarding in heart failure patients by reducing travel time, hospital admissions and constant monitoring of such critical condition (Seto, 2008), home telehealth for chronic conditions was found to be cost saving (Tran *et al.*, 2008). While other reports did not showed good evidence about cost effectiveness *viz.*, the cost effectiveness of telehomecare for older people and people suffering from chronic conditions is uncertain (Barlow *et al.,* 2007), lack of consistent results regarding costs of synchronous telehealth in primary care is a limiting factor (Deshpande *et al.*, 2008), little evidence is there for the economic viability respiratory monitoring at home (Jaana *et al.,* 2009) and also cost effectiveness in diabetes care through the use of information technology is undetermined (Jackson *et al.*, 2006).

Applications and validity of veterinary telemedicine: Telemedicine is a technology that allows a veterinarian to digitalize radiographic, ultrasound and microscopic images and send them via fax or the internet to a veterinary specialist for interpretation providing service without leaving their veterinary dispensary/hospital. Veterinary cardiologists, radiologists, dentists, ophthalmologists, dermatologists, surgeons, and internal medicine specialists are now accessible by telemedicine. While tele-electrocardiography has been around since the 1980s, teleultrasonography, teleradiology and telecytology appears to be the most commonly practiced and viable forms of veterinary telemedicine (Papageorges and Hebert 2001; Papageorges and Tilley 2001; Papageorges *et al.,* 2001; Hebert *et al.,* 2001). Veterinary teleradiology was first commercially introduced in the early 1990s with limited success because of slow internet speeds and large file sizes but currently the practice of teleradiology in veterinary medicine is widespread due to the easy availability of high speed broadband internet connections, image compression softwares, economically priced Picture Archiving and Communication System (PACS) and Digital Imaging and Communications in medicine (DICOM) software (Poteet, 2008).

Cysts, obstructions, congenital heart disease, heart murmurs and abscesses are list of conditions that can be diagnosed with ultrasound via telemedicine (Gater, 2008).

Validity of remote consultation for treatment of canine separation anxiety using two types of behavioral services offered by Tufts Cummings School of Veterinary Medicine (TCSVM) was compared: (a) "PetFax," a distant conference service in which dog owners and a certified applied animal behaviorist correspond with each other via fax or email and (b) in person clinic talk, requiring owners to bring their dogs to the animal behavior clinic at TCSVM. Study stated that remote consultation was a valid way for behavioral professionals to instruct behavior modification advice to owners regarding canine separation anxiety (Cottam *et al.,* 2008). In another study on prototype telemonitoring system that utilizes wearable technology, it has been reported that it provides continuous animal health data (Smith *et al.,* 2006).

A research "proactive herd health management for disease prevention" conducted by Kansas State University to develop the technological and sociological infrastructure to support intelligence, mobile medical monitoring devices which continuously assess the health of cattle in concentrated and distributed herds was proved to be effective. A light reflectance sensor connected to a pulse oximeter circuit to acquire red and infrared photo plethysmographic data from the ear of the cow is utilized (Patil, 2009).

Obtaining heart rate by way of a single lead electrocardiographic hardware encased in a waterproofed

polyvinylchloride pipe based bolus was used with a wearable cattle health monitoring system (Warren *et al.*, 2008).

Advantages of telemedicine technology: Telemedicine is advantageous to the patients, health care professionals, and society in many different ways. Telemedicine facilitate timely access to locally unavailable services enabling delivery of health care benefits to patients suffering from serious conditions or diseases (Matusitz and Breen, 2007; Matusitz and Breen, 2007). It speeds up the medical research and innovations by allowing health care professionals to share their findings from any location (Cermack, 2006; Pazmino *et al.*, 2004). It spares burden and cost of unnecessary travel of the patients (Robinson *et al.*, 2003) thus limiting patient exposure to infections by eliminating or limiting the need of visit to a hospital for health care services. To the society telemedicine benefits through critical care monitoring when it is not possible to transfer the animals and by providing veterinarian expertise to livestock at remote locations.

Most importantly medical records are digitalized enabling universal and, permanent availability at any time of age allowing continuity in treatment and reducing the incidence of adverse events or medication errors (Leape and Berwick, 2005). Telemedicine allows local communication between scientists, researchers, field veterinarians and, private practioners allowing update with recent advancements in veterinary science at any time and learning *vice-versa*. Telemedicine could also be able to be used to overcome shortages of veterinarians in some areas, deliver education and facilitate research (Robinson *et al.*, 2003). Mobile internet applications are also helpful in telemedicine and gaining popularity making it possible that minor health problems can be solved at a distance also. Many professional groups are created on social networking sites like facebook where veterinarians are sharing and discussing their technical knowledge adding some dimensions to primitive type of telemedicine.

Barriers to promotion of telemedicine in developing countries: Large scale telemedicine systems, whether designed for human or animal monitoring environments, share implementation barriers such as cost effectiveness, interstate licensing, biocompatibility, ethical issues, market momentum, diagnostic feasibility, confidentiality, and usability (Boydell, 2000). In developing countries like India to facilitate access to many bandwidth intensive telemedicine applications, increased broadband connectivity is needed, particularly to rural and remote communities. Any technology in its primary stage needs care and support. Only the government has the resources and the power to help it survive and grow. While the internet is a marvelous medium for transmitting information between remote computers, it is notoriously susceptible to security problems hence the problems of keeping information transferred between computers away from unauthorized access must be solved. To assure the advancement of Information Technology (IT) in health care, it is necessary to have a knowledgeable staff that can support and manage purchasing and can assure that technical specifications are met. The responsibility of error occurs at any point during a health /application using telemedicine, should be made clear as multiple parties play a role in the transmission and execution of telemedicine.

State level licensure laws meant for regulating interstate telemedicine practice are not uniform from state to state hence should be taken care off. In addition, there is a lack of confidence in patients or livestock owner about the outcome of e-medicine as no technological advancement can change anything, when a person does not wants to change.

One psychological barrier is self consciousness of being on camera or on video may be of concern for some veterinarians, paraveterinarians and livestock owners demanding education about the nature and scope of telemedicine which would help change attitudes of persons.

CONCLUSION

Specific veterinary telemedicine applications have been in use since the early 1980s, but little study about its efficacy and validity has been undertaken in this field. The demanding quality health services in animal health care sector, coupled with an expected shortage of expertise, over the coming decades accentuates the need for veterinary telemedicine. Awareness among livestock owners and stack holders is essential to accept this emerging technology as a facilitator for quality healthcare delivery especially in rural areas.

Ethical and legal issues around the practice of veterinary telemedicine, image standards, the equipment that is required for the practice of telemedicine, advice on ways in which digital images can be obtained, standardization of various systems, including the system for payment and educational aspects are the regulatory issues which need to be resolved (Sarhan, 2009; Ministry of Communication and Information Technology, 2003).

Policy making bodies need to plan the implementation of policies for the use of veterinary telemedicine besides developing revenue models and creating infrastructure for meeting the need of training manpower and carrying out research and development.

In India with current bloomed IT sector, veterinary telemedicine is a technology whose golden era has arrived

and government/agricultural universities must adopt it with open arms in order to ensure that two way flow of information is facilitated between field veterinarians and subject experts, thus resulting in an enriching experience for both, also providing more quality services to animal health care sector.

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