TELEHEALTH SYSTEMS: CONSIDERING KNOWLEDGE MANAGEMENT AND ICT ISSUES

A. Dwivedi[1], R.K. Bali[2], A.E. James[1], R.N.G. Naguib[2]

[1]Data and Knowledge Engineering Research Group (DKERG), School of Mathematical and Information Sciences, Coventry University, UK

[2]BIOCORE, School of Mathematical and Information Sciences, Coventry University, UK

Abstract - **In this paper we examine the factors necessary for telehealth implementations in healthcare organisations. We focus on the transfer of medical information using Information and Communication Technologies (ICT). The paper identifies current applications of telehealth and telemedicine. It contends that we are using such applications in a static manner, whilst futuristic systems would be dynamic in nature and would support the transfer of context-based information. This could make web-based multimedia patient administration systems the norm for healthcare institutions. Such a scenario is likely to lead to a situation where healthcare institutions would be flooded with large amounts of clinical data. The introduction of the Knowledge Management (KM) paradigm would enable healthcare institutions to face the challenge of transforming large amounts of medical data into relevant clinical information. A KM solution would allow healthcare institutions to give clinical data context, so as to allow knowledge derivation for more effective clinical diagnoses. It would also provide a mechanism for the effective transfer of the acquired knowledge so as to aid telecare workers, as and when required**.

Keywords - **Telemedicine, healthcare, contextual recycling, electronic health records**

I. INTRODUCTION

Telehealth refers to an assortment of healthcare associated activities such as the development of healthcare systems, professional healthcare education for the public and community healthcare systems [1,2], whilst telemedicine is a method of healthcare delivery where advanced video communications technologies are used to bridge the geographical gap that exists between the licensed caregivers and/or the care receiver, so as to provide medical diagnosis and treatment [2-5].

Telehealth has a much broader scope in comparison to telemedicine, as telehealth relates to the bigger issues in healthcare administration and regulation, whilst telemedicine is concerned with the clinical aspects of healthcare delivery [1,2]. Some authors [4,6] have further delineated between the two by positing that, in telemedicine, healthcare providers fall into the category of physicians whilst, in telehealth, the category of healthcare providers can be extended to include non-physicians, as telehealth encompasses health promotion and disease prevention.

II. THE ROLE OF TECHNOLOGY IN TELEHEALTH

Technology strongly influences the way we work and is creating opportunities and new demands for a range of different approaches to telehealth [7]. Telecommunications have evolved and have been accompanied by an evolution in attitudes to information and communications technologies [8]. Previously, only companies owned computers and it was the IT specialists, rather than ordinary users, who determined their use and application. Today's response to technological change is profoundly different. On average, around 1 in 4 European households already owns a personal computer; in some countries this rises to more than 50% and in some local communities it is even higher.

A recent study confirms this trend and predicts that, in two years time, it is expected that the use of information communication technology will increase markedly [9]. The ease with which we use them and the take-up of remote working in the European Union continues at a rapid pace. Recent estimates [10] show that approximately 6.7 million Europeans (4.5% of the workforce) were practising remote working in one form or another at the beginning of 1999.

Social, cultural, economic and regulatory factors determine how we organise our business, our work and, hence, our lives [8]. Technology-led change opens up opportunities for new working methods in three main ways: allowing existing activities to be carried out more rapidly, with more consistency and at a lower cost than could previously be achieved. Today, the explosive growth of the Internet has promoted the trend for investment in information and communication devices and the healthcare industry is an active participant in this trend [13]. It would be fair to state that advances in communications technology are dramatically changing the delivery of healthcare services [11].

Our stand is validated when we see that modern healthcare is the largest sector of the US economy [13]. However, IT expenditure in healthcare organisations, as a portion of revenues, is in the region of 2%, far below the 7-10% mark in other information-intensive industries [12].

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)	
25 Oct 2001	N/A	-	

Title and Subtitle	Contract Number
Telehealth Systems: Considering Knowledge Management and ICT Issues	
	Grant Number
	Program Element Number

Author(s)	Project Number
	Task Number
	Work Unit Number

Performing Organization Name(s) and Address(es)	Performing Organization Report Number
Data and knowledge Engineering Research Group (DKERG) School of Mathematical and Information Sciences Coventry University, UK	

Sponsoring/Monitoring Agency Name(s) and Address(es)	Sponsor/Monitor's Acronym(s)
US Army Research, Development & Standardization Group (UK) PSC 803 Box 15 FPO AE 09499-1500	
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes
Papers from 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, October 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on cd-rom.

Abstract

Subject Terms

Report Classification	Classification of this page
unclassified	unclassified

Classification of Abstract	Limitation of Abstract
unclassified	UU

Number of Pages
4

Analysts are confident that the above situation is about to undergo a sea change. Investor confidence in technology growth in healthcare is so strong that, between 1992 to 1996, there was a quintuple leap in the number of publicly traded health information technology companies. In 1998, the top 35 companies had market capitalization of over $25 billion [12]. Today, about 43% of US-based Internet users use the Web to locate healthcare related information [13]. This clearly indicates that E-healthcare and its applications (such as telemedicine) are here to stay.

III. CURRENT TELEMEDICINE TECHNOLOGIES

There are two main models in telemedicine: (1) interactive video and (2) store-and-forward [4,13]. The main difference between them is that interactive video allows real-time patient care, whilst the store-and-forward technology is asynchronous (there is a gap between transmission of data and patient care diagnosis). Today, store-and-forward technology applications in telemedicine include telepathology and teleradiology [4]. The use of email to transmit medical prescriptions by physicians to their patients is fast becoming another major application of store-and-forward technology in telemedicine [14].

Since store-and-forward technology is asynchronous (communication over telephone lines linking two computers or other peripheral devices using start and stop bits), applications based on this type of technology are being more widely used in comparison to interactive video applications, as they can easily be transmitted over a network. Modern store-and-forward technology applications, in conjunction with advances in telecommunications technologies (such as digital imaging, WAP and fibre optics) are resulting in the creation of a much larger telemedicine market [1,15].

Technologies that offer healthcare videoconferencing as a substrate are still evolving. It will be possible to send large amounts of clinical multimedia data (compressed audio and video images) on high speed lines such as broadband technologies over the internet [4]. Given the current pace of advances in internet and videoconferencing technologies, interactive telemedicine applications will feature heavily in futuristic healthcare systems.

The advantages of telemedicine include enabling direct links between the caregivers and/or care receivers thereby enabling effective medical care especially to rural populations, saving time and money for caregivers and faster diagnosis and treatment for care receivers [3,11,13,16,17]. Whilst it is clear that telemedicine is more viable compared to traditional telephonic consultations [18], in a normal patient care scenario it enables patients to have faster access to alternative specialists and, more importantly, to have access to information about their sickness [19].

However, one of the major limitations in telemedicine is that there is no adequate regulatory structure which addresses such issues as licensure, credentialing, intellectual property and MediCare payments (in the US) [11,20]. Governments have started to address these issues. The US Congress has taken a pioneering stand in this regard. In 1999, it introduced 22 pieces of legislation relating to telemedicine [20].

Telemedicine technologies, in conjunction with state-of-the-art Electronic Health Record (EHR) systems, are changing the face of healthcare. Telemedicine technologies have the potential to replace 5% of hospital stays, 5% of nursing home care, and 20% of home health visits [17], resulting in savings of time and money for both patients and doctors. Additionally, caregivers have more time to devote to clinical activities (such as medical diagnosis and treatment).

A. Impact on Health Organisations

Researchers estimate that in the period 1997-2000, 85% of healthcare organisations underwent some sort of transformation [21]. It has been proposed [22,23] that holistic health will emerge as an alternative to complement traditional medicine. As patients' houses become the homebase for delivering more and better types of care, people will expect "King Quality, Queen Value" [24]. Healthcare organisations need to be fully aware of the organisational implications of telehealth initiatives. The technology associated with telehealth schemes transcends geographical, institutional and disciplinary boundaries. Telehealth redefines organisational roles and responsibilities.

By disseminating knowledge and information, telemedicine allows healthcare professionals and patients to relate to each other. The astonishing rate of change makes strategic planning extremely difficult.

Appreciating the role of management and how it controls and monitors resource requirements needs is crucial. Having identified suitable individuals and jobs, it must be emphasized that telehealth is an additional health-delivery avenue and no healthcare provider should be forced to use the new technology. Telehealth delivery may be better suited to people who tend to exhibit such traits as a greater ability to structure their workday, more efficiently separate work and family life, or those whose jobs are more independent and proactive.

IV. KNOWLEDGE MANAGEMENT

One of the main factors behind the widespread interest in knowledge management (KM) is due to it being considered as a source of great competitive advantage [25,26]. Knowledge can either be tacit or explicit [27-29]. Explicit knowledge typically takes the form of company documents and is easily available, whilst tacit knowledge is subjective and cognitive. The ultimate objective of KM is to transform tacit knowledge into explicit knowledge to allow effective dissemination [28].

Knowledge Management and Information and Communication Technology (ICT) - as disciplines - do not have commonly accepted or de-facto definitions. However some common ground has been established which covers the following points.

KM is a multi-disciplinary paradigm which uses technology to support the acquisition, generation, codification and transfer of knowledge in the context of specific organisational processes. ICT refers to the recent advances in applications of communication technologies that have enabled access to large amounts of data and information when seeking to identify problems or solutions to specific issues.

A. Impact of KM on Telehealth.

There are many factors which may influence telehealth and telemedicine which can be reduced to three fundamental areas: technological, business and social [30]. These areas all consider the current pace of technological change. The commercial environment is undergoing a period of accelerated information technology change, which some would argue is a revolution. Developments in technology, social considerations, government fiscal policy and business aims and objectives need to be fully understood in order to fully exploit the social and economic benefits that are emerging as a result of telehealth [31]. Healthcare organisations are in a constant state of change and telehealth is both a key manifestation and enabler of this change. However, researchers and practitioners need to appreciate the implications and ramifications of such a change.

The multi-disciplinary aspect of KM research has resulted in a multitude of models and approaches, all of which look at KM from perspectives similar to telehealth. KM is viewed as a methodology involving the interaction between people, culture, information technology, and organisations. A different perspective discusses KM's relationships between culture, content, process, and infrastructure. Another approach reflects that a successful KM programme must bring together political, organisational, technical and cultural organisational aspects [32-35].

We would like to establish the interrelationship between KM and telehealth and telemedicine by stating that both have been brought about by the ICT revolution, and that both are bringing about fundamental changes which are redefining the work place of contemporary organisations. Another common point is that both KM and telehealth and telemedicine are concerned with dissemination of information in a manner which ensures that information is available when required.

We believe that the difference between KM applications and telehealth and telemedicine applications lie in the application of ICT. As compared to KM, ICT in telehealth and telemedicine is in its relative infancy. Unfortunately, the contemporary focus is only on how best to disseminate the information - which could be fatal for the future of telehealth and telemedicine (i.e., current use is static). Rather than creating or disseminating contextual knowledge, telehealth and telemedicine applications are being used to disseminate data and or information. Futuristic telehealth and telemedicine schemes would have to support the transfer of information with context (i.e., such schemes would have to become dynamic in nature).

One of the big drawbacks of telemedicine is that most systems force the caregiver specialist to look at medical issues in isolation, whereas more detailed information (such as the patient's medical history) might help in arriving at a better informed medical diagnosis [4]. Initial web-based multimedia patient records systems have been developed, which give remote access to the telecare providers [4]. We believe that in the future, web-based multimedia patient administration systems will become the norm for telehealth and telemedicine. A similar concept has been put forward by the NHS (National Health Service) in the UK, where healthcare institutions are being asked to adopt an Electronic Patient Record (EPR) system at six varying levels of implementation [36].

Healthcare institutions would have a framework which would help to assess how to best identify and create knowledge from internal and external organisational experiences and how best to disseminate it on an organisation-wide basis in a manner which ensures that the acquired knowledge is available for preventive and operative medical diagnosis and treatment when required. This would call for the contextual recycling of knowledge which has been acquired from the adoption of telehealth and telemedicine trials. KM can assist telehealth and telemedicine to become viable by giving healthcare information *context*, so that other healthcare providers can use telehealth and telemedicine to extract knowledge and not information.

For this to happen, futuristic telehealth and telemedicine systems would have to shift their emphasis to deal with the intangibles of knowledge, institutions and culture and that the KM paradigm is aptly suited for this role. This is due to the fact that one of the important reasons behind the emergence of the KM concept is that, even though our access to data and information has increased exponentially, our capability to acquire knowledge (by giving the information context) has not become an industry wide reality. This also holds true for the healthcare industry.

V. CONCLUSIONS

Our major contention is that KM can help telehealth and telemedicine. In the future, such systems would see increased interest in knowledge recycling of the collaborative learning process acquired from previous telehealth and telemedicine practices. KM can help telehealth and telemedicine paradigms in order to make tacit knowledge explicit and re-purposed via technology. The KM experience can be passed on to the telehealth and telemedicine paradigms, allowing them to avoid going through the similar difficulties that KM had to undergo.

Organisational aspects, such as KM initiatives, should be incorporated within the telehealth and telemedicine revolution but there needs to be a balance; one cannot exist without the other. We believe that a KM framework can be the missing link between ICT for telecare schemes and for healthcare providers.

Web-based multimedia patient administration systems, handling large amounts of data, would become the norm for healthcare institutions. Telehealth and telemedicine systems will become dynamic in nature, calling for context-based information.

We believe that the KM paradigm can offer solutions to healthcare institutions, allowing them to face the challenge of transforming large amounts of medical data into relevant clinical information by integrating information using workflow, context management and collaboration tools, and give healthcare a mechanism for effectively transferring the acquired knowledge, as and when required.

REFERENCES

[1] D.E.L. Johnson, "Telehealth expands unrealized dream", *Health Care Strategic Management*, Vol. 18, Issue: 6, 2000, pp. 2-3.

[2] European Health Telematics Observatory, "Draft International Convention on Telemedicine and Telehealth", Medicine and Law committee of the International Bar Association, http //www.ehto.org/ legal /draftconvention.doc, 1999.

[3] B.L. Charles, "Telemedicine can lower costs and improve access", *Journal of the Healthcare Financial Management Association*, Vol. 54, Issue: 4, 2000, pp. 66-69.

[4] G. Nairn, "Technology pulls together medicine's diagnostic tools: telemedicine", *Financial Times*, London, Feb 21, 2001, pp. 9.

[5] D. Garets and D. Hanna, "Emerging managed care technologies", Health Management Technology, Vol. 19, Issue. 11, 1998, pp. 28-32.

[6] S. Noring, "Telemedicine and telehealth: principles, policies, performance, and pitfalls", *American Journal of Public Health*, Vol: 90, Issue: 8, 2000, pp. 1322.

[7] D. Feldman and T. Gainey, "Patterns of telecommuting and their consequences: framing the research agenda", *Human Resource Management Review*, Vol.7, No.4, 1997, pp.369-388.

[8] C. Stanworth, "Telework and the information age", *New Technology, Work and Employment*, Vol. 13, No.1, Mar 1998, pp.51-62.

[9] M. Marien, "IT: you ain't seen nothin yet" in T Forester ed. *Computers in the Human Context*, Basil Blackwell, Oxford, 1989, pp. 7-41.

[10] European Telework Organization, "Status report on European telework", *New Methods of Work*, 1999.

[11] A.K. Schooley, "Allowing FDA regulation of communications software used in telemedicine: a potentially fatal misdiagnosis", *Federal Communications Law Journal*, Vol. 50, Issue: 3, 1998, pp. 731-751.

[12] D.W, Moran, " Health information policy: on preparing for the next war" , *Health Affair*, Vol. 17, Issue: 6, 1998, pp. 9-22.

[13] W. Kazman and A. A Westerheim, "Telemedicine leverages power of clinical information", *Health Management Technology*, Vol 20, No. 9, 1999, pp. 8-10.

[14] M.C. Convey, " Telemedicine concerns healthcare risk mgrs" *National Underwriter*, Vol. 104, Issue: 46, 2000, pp : 8

[15] B. Beavan and J. Frederick, "Telemedicine raises some points to ponder", *Defense Counsel Journal*, Vol. 67, Issue: 3, 2000, pp. 400-403.

[16] T.L. Huston, and J.L. Huston, "Is telemedicine a practical reality?", *Association for Computing Machinery, Communications of the ACM*, Vol. 43, Issue: 6, 2000, pp. 91-95.

[17] D.J. Fishman, "Telemedicine: bringing the specialist to the patient", *Nursing Management*, Vol. 28, Issue: 7, 1997, pp. 30-32

[18] L.A. Sandberg, "The pediatric promise", *Health Management Technology*, Vol. 22, Issue: 2, 2001, pp. 46-47.

[19] R. Blair, "Slice of life", *Health Management Technology*, Vol. 22, Issue: 2, 2001, pp. 4.

[20] S.A. Edelstein, "Careful telemedicine planning limits costly liability exposure ", *Journal of the Healthcare Financial Management Association*, Vol. 53, Issue: 12, 1999, pp. 63-69.

[21] J. Sherer, "The human side of change", *Healthcare Executive*, Vol.12, No.4, 1995, pp.8-14 .

[22] A.H. Church, W. Siegal, M. Javitch, J. Waclawski, and W.W. Burke, "Managing organizational change: what you don't know might hurt you", *Career Development International*, Vol.1, No.2, 1996, pp. 25-30.

[23] N.K. Dervitsiotis, "The challenge of managing organizational change: exploring the relationship of re-engineering, developing learning organizations and total quality management", *Total Quality Management*, Vol.9, No.1, 1998, pp.109-22, .

[24] C.E.Nelson, E.C., Batalden, P.B., Mohr, J.J., "Building a quality future", *Frontiers of Health Services Management*, Vol.15, No.1, 1998, pp 3.

[25] I. Nonaka. 'The Knowledge-Creating Company', *Harvard Business Review*, Vol. 69, Issue: 6, 1991, pp. 96-104.

[26] K.M. Wiig, "Knowledge management : the central focus for intelligent-acting organizations", *Schema Press*, 1994 .

[27] R.P. Beijerse, "Questions in knowledge management: defining and conceptualising a phenomenon", *Journal of Knowledge Management*, Vol 3 Issue 2, 1999, pp. 94-110.

[28] B. Gupta , L.S. Iyer and J.E. Aronson, , "Knowledge management: practices and challenges", *Industrial Management and Data Systems*, Vol 100, Issue 1,2000, pp. 17-21.

[29] M. Hansen, N. Nohria, and T. Tierney , "What's your strategy for managing knowledge?", *Harvard Business Review*, Vol. 77, Issue. 2, pp. 106-116.

[30] R.K Bali, "Organizational and social impacts of telehealth: a cause for concern", *Proc of the IEEE Int Conf on Information Technology Applications in Biomedicine (ITAB-ITIS)*, Arlington, USA, 2000, pp.54-59.

[31] R.K Bali and R.N.G. Naguib, "Towards gestalt telehealth: considering social, ethical and cultural issues", [CD-ROM] *IEEE Canadian Conference on Electrical and Computer Engineering*, Toronto, Canada, 2001.

[32] R.K Bali, "Towards a qualitative informed model for EPR implementation: considering organizational culture", *Proc of the IEEE Int Conf on Information Technology Applications in Biomedicine (ITAB-ITIS)* Arlington, USA, 2000, pp.353-358.

[33] B. Puccinelli, "Strategies for sharing knowledge", *Inform*, Vol. 12, Issue: 9, 1998, pp. 40-41

[34] L.P. Chait; "Creating a successful knowledge management system", *The Journal Of Business Strategy*, Vol. 20, Issue: 2, 1999, pp. 23-26.

[35] C. Havens and E. Knapp, "Easing Into Knowledge Management", *Strategy and Leadership*, Vol. 27, Issue: 2, 1999, pp. 4-9.

[36] NHS, "Overview of benefits from electronic patient records", http // www.nhsia.nhs.uk/ strategy/ full/2.htm, 1998.