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THE REALITY OF MEDICAL WORK -

THE CASE FOR A NEW PERSPECTIVE ON TELEMEDICINE

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Abstract

This paper considers the nature of medical work and how new telemedicine technologies can be developed to support that work. Telemedicine developers attempt to increase communication and collaboration between medical practitioners and between patients and medics, with the goal being to make medical care and information more easily accessible. However, the focus of telemedicine systems appears to have so far been technology centred, and the work they are trying to support is often ignored. We argue that to develop appropriate telemedicine technologies, it is important to understand the nature of medical work, and to examine the manner in which medical practice *actually* occurs. Only then will we be in a position to design appropriate telemedicine technologies to support these activities. Unless designers have an insight into the work itself, new technologies will continue to fail to support what telemedicine effectively aims to promote - collaboration and access to distributed knowledge.

Keywords

Co-operation, Communication, Medical Work, Telemedicine.

Introduction

Hospitals and medical centres are heavy consumers of information - doctors, nurses and other medical professionals receive, digest and act on information in diagnosis and treatment. It is then perhaps strange that they make very little use of information technology in going about their work. These centres are not technology shy - the use of complicated equipment permeates these settings, from radiographic equipment to cardiac monitoring systems. More conventional technologies such as

word processors and patient data storage facilities are used, although largely in an administrative capacity. Beyond this, there is little evidence of communications and collaboration technology more sophisticated than the ubiquitous bleeper and telephone being used in typical settings. Why then are even the most basic communication technologies apparently resisted?

Collaborative and groupware technology, now finding its foothold so quickly in industry is not being accepted so rapidly in medical work, and in our experience telemedicine has failed to be used other than in small scale and research settings. We suggest that this failure of technology take-up has resulted from a lack of real understanding of what medical work itself involves. Rather than suggest that this is primarily a problem that can be directly resolved by technical innovations, we argue that understanding the work and problems faced by medical professionals is a far more effective way of supporting both the development and deployment of technology than the current 'technology-centred' approach applied today.

Medicine and telemedicine

If we are to argue that the take-up of telemedicine has been slow because it addresses areas of work that are of secondary or minor importance to the people that it is intended to be used by, perhaps we need to discuss what we mean by telemedicine itself. The term 'telemedicine' is most commonly used to describe information and (tele)communications systems that are used in medical work and allow people to work together over time and space (Craig 1999; Watts and Monk, in press). It is also sometimes used as a 'buzz word' to describe the general use of technology within medical settings. Increasingly, it has come to mean collaboration technology used in a medical setting and work in the area has typically focused on areas such as training, remote surgery, remote consultations, patient data and file transfers, and medic-to-medic conferencing. Some of these are summarised below in table 1.

The main technologies currently in use in specific areas include, but are not limited to, the following[1]:

[1] Complied largely from the UK National Database of Telemedicine.

Virtual Reality Environments	*Training students* (Young 1999) - using data-gloves and head seats so that they can simulate surgical procedures. *Treatment of phobias* (Riva 1998) what is seen is not 'real' but a representation of what is seen in the world - allowing people to become gradually exposed to their problems in a secure and safe environment.
Augmented Reality	*Image guided surgery* (Grimson *et al* 1999) - an image is projected onto a patient's body to guide a surgeon in performing an operation. It assists by providing an accurately mapped internal visualisation of the patient's organs for precise surgery.
Robotics	*Surgery at a distance* (e.g. ROBODOC developed by 'Integrated Surgical Systems') - where a surgeon operates or programs a robotic arm that actually performs surgical procedures. This can be done from the same room, be pre-programmed, or controlled remotely.
Video Conferencing	*Teleconsultations* - video link between two or more medics and/or their patient. Video-conferencing technology transmits both pictures and sound. It is useful in cases where another medic needs to see a patient, or where medics need to collaborate or view and confer over visual materials simultaneously. An advanced development allows a stethoscope to transmit a persons heartbeat to a remote medic.
Store and Forward	*Teleradiology* - often associated with sending digitised X-rays over a network. The x-rays may have been taken at a specific time and stored to be forwarded on later.
Live Video Feed	*Teleultrasound* - where ultrasounds are streamed in real time over a video link to specialists based at different sites.

Table 1. current telemedicine technologies and their application in medical work.

What Table 1 demonstrates - supported by an extensive survey of the available literature - is that despite the wide ranging areas of medical practice in existence, the use of telemedicine is generally confined to a few limited domains of application. Despite their undoubted importance, medical work is not limited to networking and training medical personnel, providing information for remote patients, assessing remote patients needs and symptoms, and transferring images and notes. Their everyday work is often more mundane, grounded in seeing patients face-to-face, speaking to a range of other

specialists and support staff within the hospital, locating and entering patient data, providing treatment regimes and performing surgery. Whilst perhaps not as exciting on first inspection as the areas currently supported by telemedicine, these are the workaday activities that medical professionals are involved in for a large part of their time. These are perhaps the areas that telemedicine can make the greatest improvement to the quality and provision of medical care, because they take up such a large proportion of medical workers' time; they are also areas that may require a very different approach to telemedicine technology to those currently being developed.

Telemedicine, as we have shown, has focused on small group, synchronous, face-to-face computer mediated communication and on document transfers between distant locations - and solutions have, in many cases, used commercially available and largely unmodified technologies originally intended to support work in office-based scenarios. However, as we have learnt from studies in CSCW (computer supported co-operative work) and more generally in information systems theory, the particularities of the setting are critical in determining the appropriateness of technology that is introduced into it. The simple deployment of a videoconferencing system (for example) into a medical setting may not be an appropriate technology for its intended users because it does not meet their informational requirements, and it may not even be appropriate for the type of work they have to perform. To develop and implement appropriate telemedicine technologies, we need to better understand *practice* and the use of information in the everyday work of medical professionals. This allows us to understand more of 'what really goes on' in medical work and will provide a more considered and systematic basis for developments in the design of systems that support a medics (or a medical system's) ability to attend to, process, store and correctly use the enormous amount of information that they must encounter on a daily basis.

To demonstrate the complexities involved in 'information rich' medical work and its surrounding environment, we need to look more closely at what medical work actually involves.

Medical Settings

The hospital is a large and dynamic organisation with a highly structured workforce with specialist skills. It is perhaps the most diverse setting in which telemedicine technologies can be deployed, and one in which they could potentially make the greatest impact because of its critical role in healthcare. People in the hospital perform a range of different kinds of work activities, many of which are interrelated. It is also ne with which many of us are at least personally familiar. Current media interests and prurience mean that we are all aware of at least some aspects of medical work. Whether or not the our initial impressions of hospital work accurately represent these situations, the work of medical personnel in a hospital setting is certainly complex (Cicourel 1990). It is hard to map out exact processes because of the hand-crafted nature of a standard patient-treatment trajectory,

because an individual patient's illness will dictate the type of medical work that is applicable to them (Strauss *et al* 1985).

The notion of having a one-on-one consultation with a medic who is then the only person that the patient will see is not a typical scenario, because medical settings represent pools of resources (Cicourel 1990), where collaboration between staff of all levels and all backgrounds is necessary, encouraged and indeed an essential part of the medical process. In any one situation there may be nurses, physicians, radiographers, pathologists, porters, medical residents, administration staff and many others attending to the needs of just one patient. Alongside these people, tools are used; these include artefacts such as the medical record (which may include x-rays, blood reports and request forms for further tests), pumps, drips and a whole host of other artefacts and details that accompany the patient and assist in forming the big picture of the 'medical body' (Berg and Bowker 1997). It is the input from these other resources that allows the hospital staff to explore probabilities, rule out situations and determine an accurate diagnosis from the many possible pathologies.

Let us take a (hypothetical and heavily simplified) example to illustrate how a patient enters and moves through a medical - in this case a hospital - system:

A young boy complaining of severe stomach pains is brought to the accident and emergency department of a local hospital by an ambulance crew. His personal details have been noted by the paramedics in the ambulance (the start of his 'medical record' in this instance), and upon arrival the crew members hand over the patients personal details to the nurse/doctor on duty. In doing so, they effectively hand over responsibility of the patient (Symon *et al* 1996) to those in the hospital. From here, a triage nurse takes further details from the boy and his parents about his condition and when the pain first started. The nurse then assesses the patient's immediate need to see a doctor and places him in a queuing system.

When the doctor arrives, she takes note of what has been recorded in the boy's record so far and may repeat certain questions and examinations in order to confirm details and evaluate if she can gain any further information (Cicourel 1990). Following this, the doctor has an idea of the cause of the illness, but is not too sure and so, in order to rule out any uncertainty, orders a series of tests. These include a blood test, a computed tomography (CT) scan of the abdomen, and a few others. She has also found out that the boy was brought in several days ago with a similar complaint and asks that his old medical records and x-rays to be brought up from the stores. She writes all of this down in the boy's medical record and fills in some forms for the tests, indicating her evaluation of the situation and the tests she thinks are relevant. Following this, she hands the forms to the nurse and requests that the tests be completed - responsibility of the patient is handed back to the nurse. The doctor leaves and requests that she be contacted when the test results arrive.

The nurse then evaluates the forms and calls for a porter to take the boy to have a CT scan. The porters' office finds a porter and sends him to pick up the boy. The porter arrives and the nurse hands him the form. The porter then takes the boy to the radiology department. The request forms are given to a radiographer who interprets them and the boy has his x-rays taken. The x-ray films are checked to ensure they have been taken correctly and the radiographer adds a possible diagnosis in a note to say he has seen them and cannot see anything abnormal. The porter is called back and the boy, with his x-ray films on his lap is wheeled back to the Accident and Emergency (A&E) department. He is now back in the care of the nurses there.

The doctor is called and looks at the x-rays which do not show anything of particular interest. As she waits for the results of other tests, she recommends that the boy be admitted to a general children's ward and be seen by a doctor the following morning when all of the lab test results arrive, fairly confident that it is nothing serious. She then fills out some more forms to request an admission to the ward and updates the ongoing medical record whilst waiting for a bed to be made available. When one is available, the A&E nurse calls the porter to take the boy, and all of his records so far, up to the ward. The boy is wheeled up to the ward and his care and responsibility is handed over to the nurse on the ward.

The nurse makes the boy comfortable in his new surroundings and makes sure his records are kept by his bed so that when the doctor from the next shift arrives in the morning he will know where to find them. The boy is now in the care of the medical team on that ward and will be assigned to specialists accordingly. The new medical team and the doctor in charge will now find out more about the patient from what he and his parents tell them, but they will also gain a more varied picture from the notes and details contained in the medical record. These may include small notes from the A&E doctor indicating the boys state of mind, his evolving symptoms and other things thought to be of importance.

The first question that such a scenario brings to mind for us is the lack of support that traditional telemedicine technologies provide for the situation described. The second question that it raises is one of design: how can we transform the media of communication or the information from the setting into an electronic, or virtual, counterpart that manages to capture the richness evident in its use here?

The description above is far from complete and the complex interactions within it are simplified here; we have not noted other activities that take place off the trajectory (Strauss 1985) of the boy and his illness. There are other patients in the hospital, equipment may fail, a nurse may be taken ill and infections may be spreading across wards. It is nevertheless, clearly a very intricate situation where tasks may have some structure but information is gathered and used 'on the fly'. Although the medical

personnel have different goals and responsibilities (Hajdukiewicz *et al* 1998) they are 'virtually' collaborating to work on the patient - not directly, but through the artefacts in the setting. These context dependent factors of the work are skilfully used by the medial workers to inform the diagnostic and treatment process. One activity allows another to take place and this in turn allows another yet the extent of the collaboration is clear - work is distributed over the various people involved, and the structure of the environment in which the activity takes place is a critical feature of their performance.

If we are to set about designing appropriate technology, it is important that we understand how interactions between people and artefacts occur and how medical professionals pick up on clues from each other and the patients they are treating. For instance, in the case above where the boy is wheeled back with his x-rays on his lap, the nurse he then sees assumes that the x-rays he has on his lap are his. Although this may appear to be a trivial example, it is these implicitly recognised cues that make the work process possible without the need for constant instruction or interruption. Implicit details of work such as these need to be observed at first hand and analysed to expose the variety of work practices underpinning medical work. Through doing so, we can actively contribute to the development of technology that fits the work, instead of having to make the work fit the technology (Karinch 1994; Watts & Monk, in press). If we fail to do this, users of the technology will either be forced to adopt non-optimal work strategies that are determined by the technology and not the patient, or as we have more often seen, they will reject the technology wholesale.

The example given above is a walkthrough of what might possibly happen given a medical situation, but medics collaborate (both implicitly and explicitly) on a variety of different activities and using an array of different mechanisms. These include the use of forms, brief meetings in corridors, via the use of charts, residents reporting for consultations, fax messages, formal weekly meetings, telephone conversations, nurse briefings, and brief messages to name but a few (cf. Cicourel 1990). Although some of these activities may seem familiar and ordinary, these request forms and hospital charts are extremely important in providing a type of 'virtual' communication between people. It is virtual in the sense that both medics are not co-present, yet the information they provide is readily available and can be interpreted without words and gestures. Synchronous, face-to-face communication is not always necessary, and may indeed be less effective at conveying information between people; symbolic representations can be more effective for this.

For instance, the medical record, as we have seen above, is a common artefact (Robinson 1993) that is amended by a number of people who use it as a tool for collaboration. The details included may have come from various sources and the record may comprise of a blood pressure and weight chart, electrocardiogram (ECG) records, blood test results, consultant reports, a GP's letter, and many other things. Each part of the record is of importance to different people and each may use the information in a different way. Each person may also make notes in the record that act as a signal for different

member groups of medical personnel and they can then take cues from this of how to proceed with a particular treatment. The medical record is clearly an important tool for providing information about the patient to other medics, where it acts as a representation of the patient at a given moment in time (Berg and Bowker 1997), as well as a means of providing a record of tasks that have been performed. The patient is represented in and by the medical record and it is this representation of the patient - the *medical* body - that is discussed and treated. We could argue that it acts as a type of organisational memory (Walsh and Ungson 1991) within a common information space that allows for medics to collaborate and communicate at different times. As the example demonstrates, telemedicine clearly has an important part to play in circumstances such as during shiftwork handovers, where time, and not space (or distance) is the critical issue. Current telemedicine technologies neglect this important aspect of work.

A Return to the Body

Telemedicine gives us the opportunity to practice medicine in a different way. What then can advances in telemedicine bring to the medic who is faced with the forms of work we outlined towards the beginning of this paper? In the case of a general hospital ward, where medical personnel are separated more by time we must consider where can we apply this technology to aid collaboration. We will continue to use the example of the medical record here as it is a tool that allows collaboration to occur and, even though it also acts as an individually used tool for evidence, confirmation and trace, it is one that is used extensively in that role. One of the methods that could be used in telemedicine is virtual, or augmented[2] reality (VR/ AR).

VR and AR technologies allow us to visualise information in a novel manner - they allow us to manipulate and interact with three dimensional information. In the case of medicine this has the potential of allowing us to unite the *medical* body with the *physical* body, connecting all of the activities that have been divorced from the physical body into separately accessible artefacts. By presenting the information represented in these artefacts and the body together, they can be combined to form a more complete representation of the patient, both abstracted and material. This could be done in several ways, from an electronic medical card (even a barcode) attached to the physical body so that the patient's information can be accessed their physical body goes, to a computer generated virtual representation of the physical body that has accompanying representations of the patient's *medical* body transposed onto them.

The possibilities for this and other areas of medical practice are diverse, but the root of the problem remains the same. Medical work often relies upon collaboration, and any technology has to be able to

support that collaboration in a manner that does not distract from the accompanying work process. No matter what technology is used to represent and treat the medical body, we must always return to the reality of the physical body, and the technology developed must take this into account.

Discussion

If we are to develop telemedicine applications to facilitate communication and collaboration in medical settings, then we must first study the factors that presently influence communication, co-ordination and collaboration. One must consider how medics work together, and the artefacts (i.e. the representations of the patient's data) and communication channels that they use in treatment. Observational studies of medics at work would allow us to observe how events take place in medical settings and the methods medical workers use in treatment. We are currently actively seeking opportunities where we can do large-scale fieldwork to investigate this question.

Workplace studies give us a rich and detailed description about how knowledge is distributed between people and in the work environment. It would also enable us to see how that knowledge is gathered to assist in treating the patient as a whole entity and not just a series of parts, and how people use this knowledge to interpret actions, speech and gestures in a manner that allows the them to be used as clues when assessing the patient. Perhaps medical personnel need to participate more in the design process (Kyng 1991, Bannon 1993) so that the technology is created for them and the manner in which they work. Although certain practices may vary across departments and medical organisations, it is important to strike the right balance between technology that is compatible with the work at hand and technology that is compatible with existing technology.

The future of telemedicine technology is bright but the consideration of issues such as those outlined above is also especially important if we are to develop and integrate these communications technologies with more complex applications that will allow for the next generation of medial technologies (see Karinch 1994) - precise robotic surgery, electronic diagnosis, smart card record systems and home care and monitoring.

Conclusion

Developers of telemedicine technologies we need to pay more attention to the nature of medical work before making collaborative medical practice 'virtual', be it with virtual reality techniques or any other form of communications technology. Telemedicine technology is constantly evolving and its attempt to aid collaboration and enable the distribution of knowledge can only be encouraged. However, if by

[2] AR technologies use a variety of techniques that allow the interposition of virtual objects and real world

adding technology we complicate the work processes, then we hinder the medical workers' ability to collaborate and communicate effectively. This could hinder the care given to patients. For example, in an intensive care unit, a medic may interpret the bleeps being emitted from a cardiac monitor as a sign that a patient is deteriorating and pull out some paper from the patient's medical record to compare earlier ECG tests results with what is now on the monitor. These could then be pulled out of the file and taken across the ward and handed over to a consultant. If however, the medic had a fully electronic medical record, how easy would it be for them to carry out the same activity as quickly and without having to switch between screens or settings? It is important to know how crucial such actions are, to and for the medical workers in question.

Telemedicine undoubtedly has the potential to facilitate the provision of medical care, but medical work itself is so complex and intertwined that we must actively consider how we can ensure that the technology continues to aid co-operation and communication between medical communities.

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