Running Head:
Collaboration within different settings

Title:
Collaboration within different settings: a study of co-located and distributed multidisciplinary medical team meetings

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Abstract.
This paper reports our findings from a study of multidisciplinary team meetings for the treatment and ongoing management of breast cancer patients. The focus of the fieldwork was the meetings within and between a large group of multidisciplinary health professionals from two hospitals in Sydney, a large public teaching hospital and a much smaller private hospital. The paper examines the common work of the meetings and the variation within and between local practices and sites in the doing of this work, both in the local settings of each hospital and in the video-mediated setting when the local meetings are linked. Variations in the physical setup of the meetings, the presentation of the patient cases and the preparation of images used in patient discussion are identified, traced to their various sources and examined within their particular sociotechnical context. This is followed by a discussion of how local variation contributed to the particular challenges of the video-mediated meetings as

experienced by the participants and how they might be addressed. Our motivations are to contribute both to the growing case studies of multidisciplinary team meetings within healthcare settings and to the important work being done to generate conceptual and design approaches that can support the development and successful use of CSCW technologies across highly variable local settings.

Key Words:
cooperative work practices, health care, health informatics, local practices, local variation, multidiscipinary team meetings, settings for collaboration, shared images, video-mediated meetings

1. Introduction

Collaboration in the various aspects of healthcare delivery has been an ongoing focus of interest within CSCW research from its earliest days. Interrelations between work practice and technology design have been explored in health-related contexts including patient consultation (Heath and Luff 1996), configuration work (Balka et al. 2005; Balka and Wagner 2006), issues of dependability (Procter et al. 2006), intensive care (Reddy et al. 2001), the development of Health Information Systems (Berg 2001; Zuiderent et al. 2003; Schmidt et al. 2007; Balka et al. 2008) and the introduction and use of telemedicine technology into surgery (Annestad 2003), to name just a small selection. Field studies of healthcare practices have been seen as central to the development of collaborative technologies such as Health Information Systems (HIS) and telemedicine systems designed to support and enable robust communication about various aspects of health care delivery over distance. These days both HIS and telemedicine technologies are seen, internationally, as essential to the effective and economical delivery of quality health services (e.g. Hailey et al. 2002; Suchman, 2007; Smith and Gray, 2009).

In parallel, though by no means unrelated, healthcare practices have increasingly involved cooperation between different health professions across different settings and institutions. Indeed the intensity of collaboration in health-related work has been noted not just as a characteristic of the work itself but in explanation of the importance of the domain for CSCW research (e.g. Berg 2001; Schmidt et al. 2007). The delivery of healthcare involves experts from a range of professions and disciplinary specialisations, the exchange of data between different agencies and institutions, the movement of patients between service providers and carers, and many areas and activities in between, right through to the cooperation between various state and national legal, financial, training, planning and administrative bodies.

This paper reports our findings from a field study of multidisciplinary team meetings (MDTMs) for the treatment and ongoing management of breast cancer patients. The study was part of a larger project to design an enhanced collaboration platform that would support participation in these meetings by distributed groups and individuals. The focus of the fieldwork was the MDTMs between a large group of multidisciplinary health professionals from two hospitals in Sydney, a large public teaching hospital and a much smaller private hospital. There is a mix of public and private service provision between these two hospitals that means some surgeons at the larger hospital also treat some patients at the smaller hospital. MDTM discussion of these patients' ongoing treatment is done via video conferencing within and between the local meetings at each hospital.

It was clear from the early fieldwork that we were witnessing some of the 'grand' themes of CSCW research being played out in this very specific healthcare setting. These included asymmetries in resources for communication in technology mediated communication (e.g. Heath and Luff 1992; Gaver 1992; Robertson 1997, 2002; Zuiderent et al. 2003; Luff et al. 2003; Voida et al. 2008), the agency of the physical space and existing artefacts and technologies to shape how people collaborate within specific settings (e.g. Fitzpatrick et al. 1996; Harrison and Dourish 1996; Dourish 2006; Harrison and Tater 2008; Ciolfi et al. 2008) and the importance of understanding the sociotechnical and organisational contexts in which practices involving technology use are embedded (e.g. Suchman 1983; Schmidt and Bannon 1991; Gärtner and Wagner 1996; Zuiderent et al. 2003; Balka et al. 2008). Most importantly, the very specific expressions of these themes in the different settings within our study supported the recent attention in the literature to the challenges posed for ethnographic field studies and CSCW technology design by variations in local practices (e.g. Ellingsen and Monteriro 2006, Martin et al. 2006; Schmidt et al. 2007; Balka et al. 2008).

MDTMs and their relevance to CSCW have been introduced to the literature by Kane and Luz (e.g. 2006, 2008, 2009). Their ethnographic study and quantitative analyses focused on

MDTMs for the diagnosis and treatment of lung cancer patients and included meetings prior to and after the introduction of video conferencing technologies. Their work situated the practices in these meetings within the broader context of pre and post meeting activities as well as the social and organisational contexts of the different participating hospitals. The meetings were analysed from a number of perspectives including the effects of the use of video conferencing on different aspects of the meetings (2006), the use of a visual display for text data in addition to the audio resource to support co-located and teleconferencing discussion (2008) and how diagnosis was collectively achieved (2009). Kane and Luz (2006) found that the structure of the patient discussions remained essentially the same whether conducted locally or over video conference. However, each case discussion took significantly longer with video when compared with their co-located equivalent. As a consequence, people at the main site incurred additional time costs when using video. For members at the remote site, though, these time costs were offset because of the greater time saved by them not having to travel. Further analysis of these meetings showed that there was a slower and more formal presentation of the case information when using video conferencing. While this had certain benefits for participant observers both in terms of what they were able to pick up from the presentations and opportunities for making contributions, Kane and Luz argued there was less benefit for the core MDTM members. On the basis of these findings and an analysis of the displays in the video-mediated configuration, Kane and Luz offered a number of recommendations about how new configurations might facilitate improved discussion and decision-making during video-mediated MDTMs. These included, for example, suggestions about pointing technologies and the use of multiple screens for concurrent presentation of information.

Building on their foundational work, this paper assumes the descriptions by Kane and Luz of the role and history of MDTMs and their arguments for the inevitability of their increased and expanded use in the future. Our study highlighted its own tangle of sociotechnical and

organisational issues that shaped not just how people currently *do* MDTMs but the options for change and development of supporting technologies in the future. While Kane and Luz acknowledged the importance of local hospital practices within the distributed MDTMs, these were not the focus of their work. Here we wish to extend their contribution by examining the variation within and between local practices in a different kind of multidisciplinary team setting within a different domain of cancer care, in a different health system and country. Our motivations are to contribute both to the growing case studies of multidisciplinary team meetings within healthcare settings and to the important work being done to generate conceptual and design approaches that can support the development and successful use of CSCW technologies across highly variable local settings.

The following section provides some basic background to the major issues that shaped our analysis, followed by an introduction to multidisciplinary team meetings and the particular setting of our study. We then describe the local MDTMs in hospitals A and B and the video-mediated meeting involving participants from both hospitals, focusing on variations of common aspects of the meetings. This is followed by a discussion of how these contributed to the particular challenges of the video-mediated meetings as experienced by the participants and how they might be addressed. We conclude this paper with a reflection on the importance of the recent focus on design and local variation as a direction for further development of CSCW research and technology design.

2. Settings for collaboration

Zuiderent et al. (2003), commenting from the perspective of their own work as researchers of sociotechnical practices in medical informatics, stressed the need to 'unpack' what makes computer mediated communication (CMC) "possible in the first place: its material embeddedness" (p. 171). A range of workplace studies that have focused on unpacking the 'material embeddedness' of cooperative work have demonstrated the extraordinary variability

of local work practices (e.g. Schmidt et al 2007; Ellingson and Monteiro 2006; Martin et al. 2006). Indeed this theme ran through the papers collected in the special issue of this journal: *CSCW and Dependable Health Care Systems* (Proctor et al. 2006). For example, Ellingson and Monteiro (2006) described how standardisation in one setting can cause confusion and extra work in others, even though a certain level of standardisation is required when collaborative technologies are used across multiple settings. Martin et al. (2006) argued that when processes are integrated across local sites the practices and processes in each site are thrown into 'sharp relief'. They maintained that "inconsistencies and idiosyncrasies may well become more visible, which may lead to professional concerns, and these may well have to be ironed out in order for successful integration to proceed" (p. 471).

On the one hand, increasing recognition and understanding of the extraordinary variability of local work practices has raised questions about how ethnographic studies of local settings can provide 'a dependable basis for design' when technologies need to be used within and across multiple sites (e.g. Schmidt et al. 2007). On the other, it has raised questions about how to configure collaborative technologies that need to work across a number of local settings so that they enable rather than constrain a local context (e.g. Balka et al. 2005; Ellingson and Monteiro 2006; Martin et al. 2006; Schmidt et al. 2007; Balka et al. 2008).

Schmidt et al. (2007) posed one approach to addressing these issues as the development of an analysis of "the 'higher-order' practices of endless combination and recombination of artefacts, formats, notations, etc. that are found across such sites" (p. 1). Based on case studies of two oncology clinics, they identified two categorically different relationships between studies of practice and systems design. The first is studies of "*specific settings* for the purpose of 'developing' *specific technologies*" for that setting (p. 9, original emphasis). The second is studies for the purpose of "developing more or less generic or standardised building blocks that can be combined and recombined endlessly" (ibid). They argued that the design focus in the latter case is not so much to identify and support essential variations but

more “to identify, if possible, the elements and rules of combination out of which coordinative artefacts and protocols are or could be combined and recombined” (ibid). Such an approach, they suggested, could enable participants to appropriate technologies into their practice with minimal technical assistance and to continue to develop both without the need for further workplace studies.

Another, very compatible approach to the challenges of variability in local practices is to extend traditional participatory design arguments for flexibility and tailorability of local systems to a broader notion of configurability. For example, Balka et al. (2005) suggested that a perspective on configurability that takes into account the environments in which technologies are used can support the robust interoperability of collaborative systems. They identified and described dimensions of configurability that need to be considered, including organisational relations, space and technology relations, connectivity of people, places and materials, direct engagement and support for configuration work as part of everyday technology use. The first three relate to aspects of the environment in which technologies are used and the last two relate to configuration support. Balka and Wagner (2006) used these perspectives to analyse further case studies as a way of broadening our understandings of the range of things that needed to be configured when technologies are appropriated into specific settings.

In a later paper, Balka et al. (2008) drew on the findings of three workplace studies, within six health care settings, to develop a typology of eight possible sources of variation within local work practices. These were then mapped to the three social arenas for design and participation that Gärtner and Wagner (1996) had much earlier identified as requiring different approaches to generating design solutions: the political and policy-making context, the institutional/organisational context for action and the context of systems and workplace design. By focusing on the sources of variation that were common within settings, rather than the specific variations themselves, the typology enabled variations in specific local practices

to be tied to their generative contexts while maintaining their interrelationships within a particular setting. The resulting typology was proposed as a descriptive tool to use in discussions throughout the design and implementation of health technologies. Yet Balka et al. (2008) still concluded that exactly how to identify essential sources of local variation of local practice remained an open issue within CSCW (p. 523). Exactly how to design collaborative technologies to be sufficiently flexible and robust, that they need not constrain important local variations, also remains an open issue within CSCW. These analyses that extend across, identify and compare the 'higher-order' practices of endless combination and recombination in different settings offer a rich opportunity to develop this important direction in CSCW research.

Findings from early media space identified a number of the major issues affecting technology-mediated communication and interaction. These included: a range of novel communicative asymmetries introduced by audio-visual technologies (e.g. Heath and Luff 1992); the role played by the physical medium in which social activities occurs on how these activities are, and can be, done (e.g. Gaver 1992); and the embodied actions of participants (e.g. looking at the same thing at the same time), that need to be mutually available if people are to successfully coordinate their actions with others (e.g. Robertson 1997, 2000). Writing from the context of many years of media space research, Luff et al. (2003) wrote "the interdependence of action and the environment is critical to the ways in which participants are able to make sense of and coordinate their actions with others" (p. 77). They suggested that these particular relationships of interdependence between action and environment define ecologies in which remote communication might be successfully supported. Problems arise, they argued, when participants in remote communication do not have equal access to the environment in which the actions are unfolding; "their actions are fractured - fractured from the environment in which they are produced and from the environment in which they are

received" (p 55). Participants need then to develop strategies and workarounds to 'splint' these fractures that emerge in the ecologies in which they interact (Zuiderent et al. 2003).

This focus on the dependencies between interaction and the physical and social environments in which it occurs is reflected in another important body of literature round the role of physical space in the constitution of place as an ongoing relationship between people and the resources they use to collaborate, including physical space and the objects within it (e.g. Fitzpatrick et al. 1996; Harrison and Dourish 1996; Dourish 2006; Harrison and Tater 2008; Ciolfi et al. 2008). Ciolfi et al. in their editorial introduction to a special issue of this journal, *Settings for Collaboration: the Role of Place* (2008), observed that apart from media space work, the relationship of people to the physical spaces in which they were embedded was largely ignored in the development of collaborative systems through the 90s. They recognised an ongoing debate within the literature about different concepts of place and their implications for technology design, particularly in terms of methodological approaches (p. 92).

We are not particularly interested here in space-place relations in themselves. However, when we started the study reported in the remainder of this paper, we thought it was of the first kind identified by Schmidt et al. (2007) – a study of a single setting, the video-mediated MDTM. Instead we found ourselves investigating the collaborative practices, and the relations between them, in three very different settings, two local and one video-mediated MDTM. This was because the video-mediated meeting was always embedded within and dependent upon the two local meetings. It only happened when a surgeon at the larger hospital was responsible for the treatment of a patient being cared for at the smaller hospital. The physical spaces, in which the two local MDTMs were held, shaped in fundamental ways how interaction occurred and was experienced in the very different physical space of the video-mediated meetings. At the same time, deeply embedded and evolved sociotechnical practices within local settings and specific organisational contexts were just as active in

constituting the video-mediated meetings. For these reasons, in analysing and presenting the findings of our study, we have taken our cue from the title of the special issue on the *role of place* (Ciolfi et al. 2008) and approached the two local meetings and the video-mediated meeting as three different *settings for collaboration*.

3. Research context

The particular configuration of patient care that defined our research setting was the division between private and public service provision in Australia's health system. Balka et al. (2008) grouped the sources of variation they found in local practices in hospital work into the three social arenas defined by Gärtner and Wagner (1996). This mix of public and private falls within the social arena of the *political and policy-making context*, where political decisions affecting the design of health care systems are made and policy measures designed (Balka et al. 2008, p. 517). So this section begins with a brief overview of the relations between public and private health care in the Australian health system. This is followed by a summary of the function and local history of MDTMs. The section ends with an introduction to the specific research setting of our study and a brief account of our research methods.

3.1. Australia's health system

Australia's health system is a complex web of interwoven components operated by the Federal and State Governments, non-government organisations and private sector organisations and individuals (Dugdale 2008). A universal public health system called Medicare is funded by the federal Government through a levy on personal income tax supplemented by general revenues. Medicare underpins much of both public and private health care though people are encouraged to supplement it with private health insurance. Universities, responsible for most medical training, are funded and regulated by the Federal Government. The main teaching hospitals are public hospitals and most of these are funded and operated by the various state governments though some are operated by religious

organisations. Private companies own the usually smaller, non-teaching private hospitals, though these too might ultimately be run and owned by religious organisations.

First contact with the health system is usually through a general practitioner (GP). Those needing specialised care are referred on to specialist medical practitioners, other health professionals, hospitals or community-based health care organisations. People can directly access public hospitals through emergency departments. Public patients are treated, without charge, by doctors and specialists nominated by the hospital. Patients treated in a private hospital—or as a private patient in a public hospital—can choose their own specialist and level of care, but must then pay for all of the services they receive (such as specialist fees, accommodation and surgical supplies). Medicare subsidises the fees charged by doctors and private health insurance funds contribute towards both medical fees and the hospital costs for insured patients (Australia's Health 2008). The important point is that care is paid for differently and from different sources depending on the specific patient's location in the public/private system.

Patients diagnosed with cancer might be referred to a surgeon in a private practice, or in either a public or private hospital-based clinic. Some specialists, such as surgeons, radiologists and pathologists, work in both the public and private sectors, dividing their time, and their sources of income, between the two sectors in various ways. As a consequence of this mixed practice, there is also a mixed referral network; for example, a patient from a private clinic might be referred by his or her surgeon to a senior radiologist who works at a public hospital. Or, as is the case in this study, some patients at smaller private hospitals are treated by surgeons at a larger public hospital. The video-mediated MDTMs in our study are held specifically to discuss the cases of these patients.

3.2. Multidisciplinary teams and their meetings

Multidisciplinary care is an integrated team approach to healthcare in which relevant health care professionals consider treatment options and collaboratively develop a treatment plan for individual patients. They have been particularly encouraged for the treatment of various kinds of cancer where there is increasing evidence that multidisciplinary care improves patient outcomes (Zorbas et al. 2003). Cancer care involves a range of services including screening, diagnosis, treatment (surgery, chemotherapy and radiotherapy), rehabilitation, supportive care and palliative care. Multidisciplinary teams (MDTs) for cancer treatment commonly include surgeons, radiologists, pathologists, medial oncologists, radiation oncologists, psychologists, oncology nurses, social workers, data mangers and general practitioners.

Regular MDTMs are considered an integral component of multidisciplinary care. Kane and Luz (2006) provide a thorough account of the various functions of the MDTMs in their study and these were common to the MDTMs in ours. The central function of the MDTM is for health professionals from different disciplines to collectively review patient cases, establish diagnosis, and decide upon the management of cancer patients. Patient records and radiology and pathology images both ground and structure these case reviews. The main outcome of the MDTM is to reach a decision on patient management. But a number of different things go on in these meetings other than the formal activities of presentation and discussion of patient cases. As Kane and Luz (2006) commented, most of these "serve to make intersecting systems more reliable" (p. 502). MDTMs assist in the coordination of activities between different hospital departments and agencies and provide clinicians working in these with opportunities to discuss their recommendations with the rest of the team. They are a source of patient referrals for clinicians working in private practice as well as important venues for recruiting cancer patients for clinical trials and for the collection of information for audit purposes. Meetings also have an educational function, for medical students, for clinicians from different disciplines and for peers in the same discipline. Most importantly,

MDTMs, particularly the beginning and endings, serve an important social function to support the development of collegial relationships.

Multidisciplinary cancer team meetings are currently held regularly in hospitals in Australia (e.g. Delaney et al. 2004; Australian National Breast Cancer Centre 2005). Video conferencing and other collaboration technologies have been used to extend the traditional MDTM, with local case discussions and other local activities involving people in the same room, to enable collaboration with remote team members.

3.3. The research sites

We conducted a field study within a large group of multidisciplinary breast cancer professionals from two hospitals in Sydney, a large, public teaching hospital (hospital A) and a much smaller private hospital (hospital B). Both hospitals have had MDTMs for breast cancer care over the past eight years. Currently both hospitals schedule meetings from 8am every Wednesday morning. There are generally twenty to thirty participants at hospital A and ten to fifteen participants at hospital B. Meetings last between one to two hours in each hospital. Five to ten patient cases are discussed at each meeting. Some of the surgeons at (public) hospital A also treat privately insured patients at (private) hospital B. In these cases, a senior radiologist at hospital A might review the radiology test of the patient but the pathology tests are reviewed by a senior pathologist at hospital B. If there are currently patients such as these in hospital B, that is, patients who are being treated by a surgeon at hospital A, then the two meetings join via video conferencing technology for the joint discussion of these patient cases. Generally two or three cases were discussed in the video-mediated meeting.

The video-mediated meeting was introduced two years before our study. Throughout this time there have been multidisciplinary team enhancement projects managed by the teams at each hospital and coordinated by the state health government authority. These are funded by

the New South Wales Cancer Institute to implement a number of strategies aimed at improving MDT function and patient outcomes. Strategies include the employment of a breast care nurse at hospital B, the establishment of the video link between the hospitals A and B and the development of protocols for care planning and reporting to patients' GPs. There is a dedicated project officer of the MDT enhancement project who is responsible for on-going development of good practice. There is a dedicated breast cancer nurse at each hospital for whom the coordination of meetings is a specified part of their work. The meetings follow the standard guidelines (Australian National Breast Cancer Centre 2005) and their various practices and protocols that have developed over time.

In Hospital A, meetings are held in a large multi-purpose meeting room while in hospital B they are held in a smaller, dedicated video-conferencing room. A standard commercial video conferencing system using ISDN connection at 256 kbit/s is used to connect the two sites for video-mediated meetings.

3.4. Methods

Our study was conducted over a three-month period. A team of four researchers observed twelve meetings and interviewed eleven of the key participants, six in hospital A and five in hospital B. Members of the research team split into two groups to attend both local weekly meetings, swapping round from week to week so each had opportunities to observe both sites. Researchers communicated actively with meeting participants, both at the meetings and via telephone and email at other times. The nurse coordinators at each hospital assisted with the organisation of both the observations and interviews.

Our aims were to understand the meeting practices and how the different settings shaped and were shaped by the meeting activities. Observations focused on group behaviour, the group activities and interaction, in both the local and video-mediated meetings, and the roles played by various technologies and other artefacts. Each researcher kept observation notes

during the meetings as well as notes of other issues that emerged during the informal talk with the clinicians at the beginning and end of the meetings (Jordan and Henderson 1995). Audio and video recordings were made during meetings. The research team met following each MDTM to share initial understandings and perceptions of the meetings, to reflect on emergent findings and to maintain and direct the focus of the research.

The semi-structured interviews focused on the participants' perspectives of their work in general; the exploration of points of interest observed in the meetings; participant views about their experience in the MDTMs; and suggestions for improved support during the video-mediated meetings. A surgeon, radiation oncologist, pathologist and nurse co-coordinator were interviewed at each hospital as well as two radiologists at hospital A and the medical oncologist at hospital B. Whenever possible, interviews were held directly after meetings. Other participants were informally interviewed when opportune moments arose during meetings.

Participants in this study are busy clinicians and work under constant time constraints. Some were on-call during interviews; for example, the interview with a pathologist was stopped several times as she needed to respond to urgent requests for diagnosis from a surgeon during surgery. So areas of questioning were prioritised to ensure that essential information about the MDTMs was captured in even the shortest interview. Radiologists and pathologists were interviewed in their departments so we could see their work environment and appreciate the complexity of their preparation work before the meetings. Single frames from the video recordings of the meetings were used to prompt participants to discuss their experiences in the meetings. Video editing software was used to synchronise and annotate recordings of each side of the video-mediated meetings. Videos were reviewed by the researchers during the various stages of analysis.

4. The meetings

Participants in the MDTMs at both hospitals start arriving round 8am, help themselves to breakfast, supplied at each hospital by various drug and medical supply companies, and then join in the different discussions going on in the room. These can focus on almost any aspect of patient care, general health practice, local hospital issues, social and education events or the activities of the meeting, to identify just some of the areas discussed in the very early and informal stages of the meeting. Eventually, anything from 10 to 30 minutes later, people drift and/or are herded towards the chairs and the meeting shifts in a quite relaxed way into its more formal activities.

These informal interactions and the first part of the formal discussion of patient cases relevant to the team members at the respective locations are conducted locally. Only if there are patients whose care and management is shared by the two hospitals do the two meetings then come together using the teleconferencing equipment. This is known prior to the local meetings and the actual timing of the shift to the video-mediated meeting is coordinated by phone by the breast cancer nurses at each hospital. When the patient discussions have ended the video conferencing also ends. The meetings become local once more. There may then be other activities at each meeting such as general housekeeping and planning, presentations on some aspect of beast cancer and its care, other relevant matters, or indeed any work that needs to be done when the group are all together. Another period of informal interactions follows the end of the formal part of each meeting and participants leave as they wish to go about the rest of their day (see also Kane and Luz 2006).

Yet in the planning discussions about this study, the other kinds of activities that are part of MDTMs, that is all those that were not the direct discussion of patient cases, were not mentioned. There was little discussion about the local meetings in which the video-mediated meetings were embedded. These video-mediated discussions of patient cases were presented and discussed as a discrete MDTM, even though the work done in it was a subset of that *also*

being done in the parallel local meetings in which it was embedded. It was this video-mediated meeting that was presented as needing intervention and improved technological support. This is the reason for our comment in the introduction to this paper that we expected to be studying a single setting (Schmidt et al. 2007) but found instead that this setting was deeply embedded within and shaped by two others. The different social, organisational and technology aspects of each local meeting had their own local histories, processes and practices that were to all intents unremarkable during the local meetings. But these aspects, including the ways they were embedded within their local settings, only became salient when the two different meetings were brought together during video conferencing. This meant, in practice, that any intervention in the video-mediated meetings needed to consider the same issues that have defined so much CSCW research and are shaping the growing literature on variations in local settings. That is, it meant understanding why various activities were done the way they were; how they related to the basic function and aims of the MDTMs, namely the management of patient treatment; where variations in the activities came from and if, and in what ways, the variations mattered; and how those that mattered might be addressed.

To develop this discussion, we look first at the process of presentation and discussion of patient cases, so central to the goals of MDTMs. We then describe how this work gets done in each local setting, focusing on those aspects that most affect the way that the work unfolds: the spatial layout, presentation practices and the use and preparation of the artefacts used to structure the case reviews. From there, we consider the video-mediated meeting as a separate setting in its own right, focussing on the same aspects as in the local settings. Our intention, in presenting our analysis of similar aspects of each setting 'side by side' in this way is to uncover the ways in which the various embedded processes, practices and technologies of the local settings constrained and shaped the processes, practices and technologies of the video-mediated meetings.

4.1. The discussion of patient cases

The features of this work, its function, its assumed inputs and its expected outcomes were essentially identical across our sites; that is this work is a commonality in MDTMs (Schmidt et al. 2007; Kane and Luz 2006, 2008, 2009). Surgeons initiate a list of patients to be discussed. Breast cancer nurses coordinate with their respective surgeons and circulate the patient list to the relevant radiologists and pathologists by early afternoon on Fridays. Since radiology and pathology examinations of the patient can be performed at different institutions, the nurses need to ensure that appropriate images and results are ordered so they are available at the meetings. A clinical data form is prepared in advance for each patient. This form includes the relevant medical history, summary of surgery/treatment to date and psychosocial risk factors. The forms for each patient are gathered and organised in folders that are made available to everyone attending the meetings so they can be reviewed and referred to during discussions.

Typically the case discussions are chaired by one of the senior specialists present who ensures all issues relevant to the patients' future management are presented and that the necessary discussion by team members takes place. During the case presentation part of the meeting, the clinical status, radiological findings and the pathology results are presented patient by patient. Each patient's care and management is discussed within the group. Discussions about the treatment and management of the patient can require references to relevant evidence bases, guidelines and research findings. Opinions are sought from the members of the team that can include surgeons, oncologists, nurses, psychologists, social workers and the patient's general practitioner. The suitability of each patient for entry into clinical trials is discussed. The outcomes of these discussions are agreed recommendations about ongoing patient treatment and care. The chairperson summarises the recommendations arising from the discussion before proceeding to the next patient case. The breast cancer

nurses record these recommendations together with the responsible clinicians. Patients will be informed of these recommendations at their next consultation.

The presentation of radiology and pathology images 'sits in the middle' of this patient discussion. The progression of, and references to these images structure both the initial presentation of each patient's condition and the discussion that follows (Schmidt et al. 2007). Significantly, this means that there are two different kinds of images that may need to be transformed in some way so that they can be made publicly available for a group of people to look at together (Robertson 1997). Radiology images are X-ray, CT scan and MRI, either on film or disk, while pathology images are treated samples of actual body tissue on a glass microscope slide. Local variation in how these images were transformed, or not, for presentation led to the most significant fractures in the video-mediated meetings (Luff et al 2003).

4.2. Setting A – local meeting at a large public teaching hospital

Up to 30 people attend any one MDTM at hospital A. Table 1. lists the various participants at the meetings. They include 'key' participants, those that have a formal role in the meeting and 'non-key' participants, without formal responsibility, whose attendance and participation varies.

<Table 1. Participants at hospital A - centred>

4.2.1. Physical setup

There are limited options available within the hospital to accommodate a meeting of this size so it is held within a generic, general purpose 'lecture room' that also serves as the venue for other large meetings, other video conferences, various seminars and educational gatherings as well as storage for a collection of tables, screens and other spare furniture (see Figure 1). The room, including the furniture, display and audio technologies, is organised primarily for the

purpose of presentations. A large projector screen is set up at the front. The default seating arrangement is rows facing the projector screen. While this is not fixed there is the usual inertia to re-arrangement. There is a console in the front right corner where speakers stand and from where the computer linked to the overhead projector is controlled. The video conferencing system is positioned on the left side of the room with the camera pointing across the room, parallel to the front projection screen and towards the console. A table with up to eight chairs is usually set up at the front of the room, between the video camera and the console.

Meeting participants position themselves within this arrangement. The chairperson generally sits in the front of room facing diagonally into the room so they can swivel either towards the rows of chairs or the front projection screen. The four or five key participants usually sit in the first row of the audience. Other participants populate the remaining rows of chairs. A junior pathologist and radiologist stand at the console of the room, oriented diagonally to the audience but still able to turn to see the projection screen at the front.

< Figure 1. Site plan of the room at Setting A – centred>

4.2.2. Presenting the patient cases

The patient overview is presented by the responsible surgeon. The medical images are presented by a junior radiologist and pathologist who both stand at the console. They use a PowerPoint presentation that includes summaries of the patient history and various patient reports augmented with selected radiology and pathology images. These images have been edited and annotated during preparation to assist the multidisciplinary audience to follow the presentation. The computer used for the presentation is on the console and the junior radiologist and pathologist are responsible for navigating through the slides to support the case discussion.

The senior radiologist sits in the audience and provides further explanation during the discussion using a laser pointer to point at relevant parts of the images displayed on the projection screen at the front of the room. There is no mechanism for the senior radiologist to navigate through the slides. Navigation is collaboratively achieved through a combination of explicit commands by the senior radiologist or by the junior radiologist responding to cues within the discussion. The pathology images are presented by the pathologist at the console who is generally the only pathologist at the meeting.

The overall atmosphere of the meetings is professional and cooperative. People explore issues of interest in a relaxed way. They share jokes and sometimes leave their seats to get drinks. The discussion is mostly among the key people who may from time to time turn to talk to the psychologists, social workers, nurses etc sitting behind them. This is a large teaching hospital and there is a hierarchical structure both within the hospital and also within each of the disciplines. Any individual's place in the hierarchy tends to be reflected in where they sit in the room. For example, the meetings are intended to also provide an education environment for medical students and junior doctors. The majority of these sit at the back observing and do not participate in the discussion.

4.2.3. Preparing the images

At the end of the week preceding the meeting, the breast cancer nurse seeks out the patient records needed to generate patient summaries for patients on the list to be discussed in the meeting. A junior radiologist is then responsible for preparing the necessary medical images for each patient. There is no Picture Archiving and Communication System (PACS) used in either hospital so films need to be located from physical storage, and reports need to found or faxed from wherever they were taken. The junior radiologist analyses the films and reports, and selects those images that best illustrate the diagnosis. These images are then photographed with a digital camera and the digital images are uploaded to a computer.

PhotoShop is used to improve the quality of the images and to annotate any Areas of Interest (AoI). These images are then incorporated into the PowerPoint presentation along with the patient summaries. A similar process applies to the preparation of the pathology images. A junior pathologist locates the slides and reports from their various storage places, selects the best slides, identifies the AoI, digitises the pathology images using a camera attached to a microscope, uploads the digitised images to a computer and inserts the images and summary of the diagnosis into the PowerPoint presentation. This preparation is extremely time consuming for both the pathologist (up to three hours) and the radiologist (up to eight hours). This work is generally done outside of normal work hours, mostly at weekends.

There are a number of reasons why these specific preparation practices have developed and continue. Firstly, while there is a light box in the meeting room, that could be used to view some the radiology images during the meeting, these would only be visible to a small number of people in the room. The size of the meeting means that the images have to be transformed so they are able to be viewed via some kind of presentation technology. Secondly, this is a public teaching hospital where the senior radiologists and pathologists have a support structure of junior medical professionals to whom the preparation of the presentation can be delegated without incurring any further financial cost. Finally, as a teaching institution, the materials used during the meeting are an important resource for subsequent teaching and research activities by various meeting participants. This means that some kind of transformation of the raw mages is likely to happen anyway as they need to serve a number of purposes.

4.3. Setting B – co-located meeting at a small private hospital

Up to fifteen people attend the MDTMs at hospital B. These include the following key and other participants as shown in Table 2.

<Table 2. Participants at hospital B – centred>

4.3.1. Physical setup

The MDTM takes place in a small dedicated meeting room where the six or seven key participants sit around a semi-oval table with two large TV screens side by side on the wall at one end (see Figure 2.). The table is shaped so key participants can easily see their local colleagues as well as the TV screens. There is a light box mounted on the wall adjacent to the presentation screens. Other participants sit around the periphery of the room.

<Figure 2. Site plan of the room at hospital B - centred>

4.3.2. Presenting the patient cases

A surgeon and a medical oncologist take turns to chair the meetings each week. Cases are presented by the surgeons responsible for the patient. The radiologist uses the light box to directly display the radiology films for each patient to the rest of the participants. She stands besides the light box and points directly to parts of the film during discussion. The pathologist uses a digital microscope with a camera attached to present selected pathology slides. These are displayed on one of the screens at the end of the table. AoI in the slide are highlighted by physically moving the slides under the microscope so the parts under discussion are in the centre of the display. This direct slide projection is used both during the case presentation as well as when questions raised by the other participants in the local meeting are discussed. When answering questions, the pathologist references the printed pathology reports placed adjacent to the microscope. Slide selection and presentation are then tailored on the fly to fit with the immediate needs of the case discussion.

Communication in the local meeting is informal and free flowing. Organisational hierarchy is much less prevalent than in hospital A; there are fewer participants and a much smaller room. Participants appear to be quite relaxed and willing to express uncertainties or

disagreements. For example, the pathologist at hospital B typically receives more questions from the team than the pathologists at hospital A. If necessary he or she looks for the answer in the reports and moves the slides round on the microscope while answering.

4.3.3. Preparing the images

The breast cancer nurse provides the radiologist and pathologist with the patient list and prepares the patient summary cover sheets. The radiologist collects the necessary films associated with each of the patient cases and brings them along to the meeting. The pathologist selects microscope slides that illustrate particular features of the patient case summary and places them in a slide box that is taken to the meeting. Sometimes the pathologist will annotate the actual microscope slides to highlight particular regions of the image, but this is not always done prior to the meeting.

This is a small private hospital, without teaching responsibilities and where neither the senior specialists nor junior staff are salaried. There is no one to facilitate preparation of images and their integration with the various reports and patient summaries. The onus is entirely on the primary radiologist and pathologist. Within this local setting, there is no requirement for large projection or for the recording of images for other purposes; image preparation practices have been developed where no transformation of original images is involved.

4.4. Setting C – Video-mediated meeting between hospitals A and B

If there are patients whose care is distributed across the two hospitals then, towards end of the discussion of the local cases at each setting, the two meetings join together through the video conferencing system. Typically these patients are from hospital B and either the patient's responsible surgeon works at hospital A or the reviewing radiologist is the senior radiologist at hospital A (see Table 3).

<Table 3. Location of responsible/participating clinicians in setting C – centred>

4.4.1. Physical setup

While the two sites are connected by standard, commercial video conferencing units, the configuration of the conferencing technologies is quite different at each site.

Participants who are located at hospital A. The key people from the team at hospital A move to position themselves around the table in front of the video conferencing system and within audible distance of the single conference microphone on the table. We will refer to this group as *group A1*. They watch the television screen that is part of the videoconferencing system. The default display is the view of participants at hospital B. If the pathologist at hospital B uses the camera attached to the microscope to display the pathology slide at hospital B then this display automatically switches to the pathology slide.

The remaining participants at hospital A remain seated in the rows of seats facing towards the main projector screen at the front of the room. We will refer to this group as *group A2*. This group sees the local radiology images from the PowerPoint presentation at hospital A, or whatever outgoing stream from hospital B is being displayed on the videoconferencing television screen to group A1. The shift between the local radiology images and the video streams from hospital B needs to be done manually by the junior radiologist standing at the console in hospital A. Group A2 cannot be seen by the people at hospital B; they are at increasing distance from the microphone feeding audio to hospital B and the speakers feeding audio from hospital B. To participate in the discussion members of group A2 move from the rows of seats to the table at the front. Figure 3. is a site plan of hospital A and B during the video-mediated meetings; that is, it is a site plan of Setting C.

<Figure 3. Site plan of setting C – centred>

Participants who are located at hospital B. Participants at hospital B are already seated facing the video conferencing system. The same televisions screens are used in the local and distributed meetings. There are two flat screen displays at hospital B. One displays *either* the video stream from hospital A, the view of group A1 or the PowerPoint presentation of patient data and radiology images, *or* the local pathology images being displayed via the digital microscope. The second screen displays the local camera view of themselves, that is the outgoing video stream of the participants at hospital B. Apparently this was how the displays were configured on installation and no one knows how to change them.

4.4.2. Presenting the patient cases

The prepared PowerPoint presentation of radiology images from hospital A is used in the presentation and discussion along with the pathology slides from hospital B. A typical discussion starts with a surgeon (either hospital A or hospital B) verbally reporting the case. In hospital A, the junior radiologist displays the prepared radiology PowerPoint slides while presenting the patient summary. As in Setting A, the senior radiologist at hospital A then takes over that discussion using a laser pointer on the projected display at the front of the room to make reference to those parts of the images relevant to his discussion. The position of the laser pointer is available to the group A2, watching the projected display, but not to group A1 (unless they turn and watch the main screen), nor those at hospital B, because they view the outgoing stream from the videoconference system in hospital A. As a workaround, the junior radiologist, at the console in hospital A, controls the mouse pointer and tries to closely follow, on the computer screen, the laser pointer gestures made by the senior radiologist on the projected screen. These cursor movements are then available to those viewing the PowerPoint slides at hospital B or via the videoconferencing display at hospital A.

The pathologist at hospital B presents the pathology slides directly from the slides on the microscope. The pathologist selects slides to display and searches for appropriate sections of

the image by moving the slide round on the microscope while the slides are projected into the screen. In terms of bandwidth, direct projection of moving slides is costly, and there is a noticeable time lag before these changes at hospital B arrive and focus at hospital A. The pathology image lag was been identified as a major technical problem by the majority of interview participants and finding solutions to it was a major motivator for this study in the first place.

4.4.3. Preparing the images

There is no special preparation of images for the video-mediated meeting. Both hospitals used the images they would normally use in local meetings.

4.4.4. Discussion of Setting C

As the local meetings come together, participants in both need to organise their work around the additional sets of factors introduced not just by the technology but also by the embedded practices and expectations of the remote participants. There was general agreement among participants in both hospitals that there were major technological and interactional problems in Setting C (for a detailed discussion of these problems see Li et al. 2008)

> The meetings are pretty efficient until you go to the video link and then their efficiency drops off dramatically and people disengage at that point.
>
> As far as our interactions once the video conferencing goes across to (Hospital A) it is my perception, and I know from discussion the feeling of a number of the other people at our end, that things does not go quite well. I think there is much less cross-interaction between the two groups than there should be. I think firstly we are not probably used to interactive video conferencing as a group, in other words you are not sort of there with the person, you just physically do not seem to interact as well.

Ten of the eleven participants we interviewed perceived a drop in the level of discussion during the video conferencing meetings relative to the local meetings. Participants in general were perceived by other members to be less willing to ask questions, discuss issues and resolve disagreements. There are regular instances in the data of participants from hospital B asking about the presence of people who may or may not be in group A2, such as “Is X there

or not?" ,"Is Y sitting in the background?". Interview participants strongly expressed their desire to see the whole room of the remote site.

> It certainly does limit…The body language is not often seen on a video link particularly if not everyone in the room is able to be seen on the screen, and that could be part of why one end doesn't talk so much because people can't see somebody on the screen.

As explained in the previous section, for group A1, watching the single video conferencing screen, the switching between the view of hospital B participants and hospital B pathology images happens automatically in response to behaviour initiated by the pathologist at hospital B by switching on/off the camera display from the microscope. But this is not the case for group A2, sitting in the rows of seats watching the presentation screen at the front. The junior radiologist at the console needs to manually switch between the video streams from hospital B. We observed several occasions when for various reasons this process broke down and no switching occurred. Neither group A1 or those in hospital B were aware of these breakdowns. At hospital A, there is an expectation that the pathology images from hospital B will also be displayed via PowerPoint. At hospital B there is no local reason why either the radiology or pathology images need to be transformed, nor, most importantly, is there anyone to do this work.

We observed occasions when problems with the technology led to breakdowns in the established social protocols round case presentation. For example, when there were difficulties with the connections, for whatever reasons, the systems at one or both hospitals generally needed to be rebooted. Rebooting took some time and was usually done well before the meeting started so that only the connection needed to be established during the meeting. If the system needed rebooting during the meetings then a later time to start the video-mediated meeting was negotiated by phone and both sides continued with other local activities. On one occasion, hospital B tried to connect to hospital A at a pre-arranged time but there was no response. Hospital A rang to report connection problems they could not fix and they needed

to reboot their system. So both sides continued with other activities in meantime. By the time the connection had been established and the video-mediated meeting could begin, it was clear that a case that should have been discussed in Setting C had already been discussed in Setting A and decisions had already made about the patient's ongoing care. In practice this was regarded as an extremely rude thing to do. Most importantly, it was also a breakdown in protocol that could undermine the appropriateness of the decisions made about the patient's treatment. So the case presentation was repeated and discussed again in Setting C.

5. Discussion

We have put these three settings for collaboration alongside each other as a way of displaying, on the one hand, how the local practical actions of the participants in each setting accomplished the common core procedures of the MDTMs - the presentation and discussion of patient cases and the collaboratively achieved recommendations for their ongoing care (Suchman 1983; Kane and Luz 2006, 2009; Schmidt et al. 2007). On the other hand, by describing how these procedures are achieved, in the three different settings, we wanted to make visible not just *how* the work gets done differently in each, but also something of *how* and *why* the local configurations, arrangements and practices of each setting arose in the first place (Balka and Wagner 2008). The video-mediated MDTMs exist adjacently and within local MDTMs and, as such, are shaped through various dependencies associated with the practices of these local meetings. This means the video-mediated meeting cannot simply be treated as an isolated domain for technical intervention, nor can the variations in local settings be understood without recognising where they have come from and why they are there (ibid). Any intervention, technical or otherwise, will have flow on implications for each of the settings because of the array of interdependencies within local meeting setups that have evolved over time and within broader demands from both the organisational and policy arenas (Gärtner and Wagner 1996).

Our interviews and discussions with the participants from both hospitals showed very clearly that they were well aware of the fractured interactions and difficult collaborations in the video-mediated meeting. Our analysis presented here has highlighted how variations in local settings contributed to the particular challenges of the video-mediated meetings and some of the specificity of how these challenges were experienced by MDTM participants during our study. Three main issues emerged repeatedly: the social cohesion of the group; interaction round shared images and the coordination of the meeting.

5.1. The social cohesion of the group

Participants at hospital A recognised the problems caused by the physical layout of their meeting room that meant, among other things, that they split onto two separate groups during the video-mediated meeting. There were problems of visibility, audibility and identity for those at the peripheral of the room who were not perceivable to those at hospital B. These were caused by the setups of the seating and the audio-video devices, the limitation of the audio-video quality and especially the multiple visual displays where what was being displayed at any one time was not necessarily the same on each. Sometimes, but not always, displays at hospital A needed to be switched manually and were not necessarily what the participants expected. As part of our study participants at hospital A initiated experiments with various reconfigurations of the room layout to avoid the need to split into two groups during the video-mediated meetings. These led to some perceived improvements in the experience of collaboration within these meetings. But none of the reconfigurations sat entirely comfortably within the demands of the local meeting nor with the other organisational functions of the room at other times. The practice of reconfiguring the room before each MDTM was not sustained.

From a technical perspective, some of these problems will be reduced by an improvement in the quality of the audio and video connections that a fast broadband connection might

provide, once policy and funding issues for installing and maintaining such new technologies across both public and private spheres are resolved (Balka et al. 2008). But any technical solution would also need to be adaptable to the 'physics' of the space (Gaver 1992), such as optimum location, size of the devices, a suitable technical configuration and the provision of feedback to local participants about how they are being perceived by the remote participants. Issues such as the configuration of the displays, what is shown on them and how switching is done between data streams could be resolved by participants, designers and the IT support at both hospitals using fairly standard human centred design methods. This will require organisational decisions and changes at participating hospitals to enable the installation of more robust and usable versions of such technology and to provide technical support to maintain it.

From a social perspective, moving from the local meeting to the video-mediated meeting makes demands on the participants to take on the communicative work involved in making the communication in the video-mediated setting robust. This is not just about the importance of social and communication skills in cooperative work (Robertson 2000) but also about how willingly health professionals, across all levels of the professional hierarchy, participate in this communicative work as part of their normal professional activities and how this work is recognised and supported in both the organisational and policy arenas (ibid). While training in both multidisciplinary and communication skills is increasingly central to professional development and accreditation, the use of technology to enable distributed MDTMs adds a further training and professional requirement – that of working effectively in these kinds of environments (ibid).

5.2. Interaction around shared images

There are two very different ways of presenting pathology images during the video-mediated meetings: at hospital A these images are digitised and then embedded in a PowerPoint

presentation, which requires a large amount of preparation time before the meeting. At hospital B images are not transformed but displayed directly via a digital microscope, which causes both an image and focus lag at hospital A. Both ways work sufficiently well in their local settings that there is no local imperative to change. But there are problems with both in the video-mediated setting.

This is not just an issue about the digitisation, or not, of these images, nor just about the availability of sufficient network capacity to prevent lag during transmission over distance, though these are significant issues in their own right. The main factor here is how the work of selecting and annotating pathology images ready for presentation gets done, who is responsible for doing it and who pays. The underlying issue is the particular mix of public and private health service structures in Australia and the particular kinds of relationships and practices that have developed to integrate the two systems. These include very different funding practices and responsibilities. While participants at Hospital A considered their way 'the better way', participants at Hospital B were quite happy with their own solution. Private hospitals do not maintain the kind of infrastructure that enables resources to be allocated to the preparation of images for presentation in MDTMs. Moreover, there is no existing mechanisms at hospital B to change this particular set of practices. Any technical solutions will need to be sufficiently flexible that these very different requirements in the sharing of medical images can be accommodated and integrated.

The ways in which these practices may evolve in the future will be influenced by changes in technology, training practices and health policies. There was a clear interest from the radiologists at hospital A in introducing a PACS to the MDTM to lighten the meeting preparation work and to support the research and teaching activities of the hospital. However, a radiologist at hospital B expressed concern a PACS would introduce technical problems into a setting which lacked organisational, financial and technical support for such technologies and which would demand a long learning curve for MDTM participants without

any perceived benefit to the local setting. Moreover, the main issue is the sharing of the pathology images. Kane and Luz (2006) ended with the observation that while a PACS would help at a local level, this will not resolve problems with maintaining image integrity and exchange (p. 532). A PACS in the settings for our study could provide access to digital images when they exist, but it will not solve the issue of the work involved in digitising images and will not resolve the current problems with the live presentation of pathology images at hospital B.

The shared viewing of images in video-mediated MDTMs might be considered an example of the 'higher order' coordinative practices Schmidt et al. (2007) suggested as a way to approach designing technologies that might work across local variations in otherwise comparable settings. From this perspective, increased access to higher bandwidth might allow the development of solutions that support both the transmission of transformed images, including those within a PACS, and direct transmission of the originals, as well as providing the network latency to resolve image lag and focus problems. This approach is also interesting for CSCW concerns in that it identifies, separates and privileges the support for robust communication round shared images from a solution that is primarily intended for storage and other organisational and policy concerns. It echoes the question Schmidt et al. (2007) raised "What exactly are the work practices for which collaborative technologies and systems are to be developed and adapted" (p. 1).

A related 'higher order' issue, is the use of pointing and annotation tools in video-mediated meetings to synchronize the focus of discussion of shared artefacts across different physical sites. The laser pointer, currently used in hospital A as the preferred pointing tool, is not visible to participants at hospital B, or indeed to those in group A1 who are watching the video conferencing screen. Given that the surgeons speaking to the images are not near the computer driving the display, a tabletop type of pointing tool, such as a mouse or tablet, is not shareable for multiple participants. As such, our findings support Kane and Luz's (2006 p.

530) recommendation for multiple wireless pointing devices that can be used from wherever the current speaker is positioned and which are visible to all the participants, from wherever they are watching. Research and development of such technologies is underway (e.g. Shae et al. 2001; Ohta et al. 2006) and they might eventually be examples of "more or less generic or standardised building blocks that can be combined and recombined endlessly" (Schmidt et al. 2007), irrespective of the setting, whenever people need to focus group attention on some aspect of something they are looking at with others (Robertson 1997). Finding such an alternative to the laser pointer would solve at least one of the major issues identified by our participants, while not requiring substantial changes to the local practices at hospital A.

5.3. The coordination of the video-mediated meeting

Setting up the video-mediated meetings took both time and effort and did not always go smoothly. Patient discussions within the local meetings neither started nor finished at the same time. The breast cancer nurses phoned each other to negotiate when both local meetings would be ready for the video-mediated meeting. The participants at the site which finished earlier needed to fill in time with other local MDTM work until the other site was ready. In another words, video-mediated MDTMs will always require that particular clusters of technologies, work practices, social and organisational protocols, and interpersonal relationships are reconfigured into working situations. This is the work, such as pre-meeting preparation and maintaining the integration of patient artefacts within a coherent narrative in the meeting, that turns the meeting into a smooth process irrespective of the various constraints on it, including those arising from local variations in how this work gets done.

But, significantly, we did not find this to be a major issue in practice unless there was a connection problem. Then it could take between five and ten minutes, sometimes longer, for the two sites to connect, disconnect and re-connect and doing this mid-meeting was extremely disruptive to the flow of activities. When the connection worked well, the negotiation work to

coordinate the video-mediated meeting, and to ensure that the video-mediated meeting ran both smoothly and according to established social protocols around patient care, was managed by negotiation between the breast cancer nurses and the various participants in the local meetings. This was done with obvious good will and a general willingness from the participants to be flexible in local meetings. But when there were technical problems, established practices for coordinating meetings became difficult to maintain and the coordination the video-mediated meetings became a site for breakdown and participant frustration. In other words, technical problems caused by brittle and inadequate technologies were experienced and perceived by participants as problems to do with the activities the technologies were supposed to be supporting, enabling or mediating, in this case coordinating the video-mediated meetings. The argument then becomes one about matching expectations, about increasing MDTM practices and extending video-mediated collaborations, with the provision of robust, appropriately designed and supported communication technologies. This argument echoes Kane and Luz's (2009) comment that: "Results presented here suggest that large scale practice of conducting PCDs (patient care discussions) over a teleconference network is unsustainable using the technology that is currently available" (p. 389). It is also an argument that needs to be initially resolved in the policy and organisational arena (Gärtner and Wagner 1996) before solutions can be develop in the other arenas.

6. Conclusion

> Thus, the ideal room for the MDTM will have a high speed wireless network, utilise ubiquitous devices to record the presence of individuals, will maximize the visual display area potential of the space and have enhanced audio support. The room would be equipped with enough visual display area to allow comparison of several images at once, and allow for the simultaneous display of the bronchoscopy image, microscope image and/or video taken in the operating theatre. A record, or outcome, of the discussion will be available for review, as needed, afterwards. (Kane and Luz 2009, p. 388).

One simple, very basic question lurked throughout this study. Why, after all the years of CSCW and related research, were these highly skilled, dedicated and professional people using such inadequate, brittle technology so inappropriate to the demands being made of it and to the settings for collaboration in which it was being used? Cost was certainly an issue. But very early media space research found that that even basic video-mediated technologies could support both formal and informal collaboration "if users can *systematically control*, even in the developing course of an activity, their audio and visual accessibility to each other and to local environments (Heath and Luff 1992, pp. 343-344, our emphasis). Our users lacked this *systematic control* over their accessibility to each other and to the other's local environments. The problems we identified in the MDTM settings, their causes and their effects on the interaction of the participants were mostly soberingly familiar to us from the results of many years of workplace studies, our own as well as those reported in the now sizable literature. This is why we claimed in the beginning of this paper that we were witnessing some of the 'grand' themes of CSCW research being played out in this very specific healthcare setting. Yet little, if anything, that we have learned in the field, about designing technology to support, enable or mediate cooperative work over distance, appeared to have had any input or benefits to the MDTM settings we observed.

Offering ideal solutions, such as the one cited at the beginning of this section, has enormous value in providing something to aim towards, but dedicated rooms and systems are difficult and expensive solutions. On the one hand, as Kane and Luz (2009) acknowledge, the large scale use of such technologies, that would be necessary to justify their cost, is "unsustainable using the technology that is currently available" (p. 388). On the other, as we have demonstrated here, local variations within organisational settings and meeting preparation practices have developed to suit local conditions; they may not easily fit standardised solutions no mater how 'ideal' they might be.

We have sought in this paper to focus on the variations in local practices and their causes across different settings for collaboration. This approach is intended as a way to contribute to recent endeavours to develop both conceptual and design tools to enable the development of CSCW technologies that can be used across highly variable local settings without unnecessarily compromising well-established local practices. Schmidt et al. (2007) proposed "developing an analysis of 'higher order' practices of combination and recombination of aretefacts, formats etc" as a way out of the dilemma posed by the relationship between ethnographic studies of local work practices and systems development. In a similar way, taking variations between local settings seriously might offer a way out of the dilemma posed by the rediscovery and reiteration of well-established findings, about the limitations of video conferencing systems, and the continued use of inapproriate, badly designed and unsupported technologies in workplaces.

It has been an interesting shift to knowingly and explicitly present a site of fieldwork in terms of local variation, that is, as one of potentially many such sites, instead of a more familiar approach of presenting a site as a discrete setting in its own right. The shift has meant that the commonalities of the work of MDTMs can then be used to ground the discussion of the variations in the local practices used to accomplish that work. It is a potentially productive way to structure the findings of work practice research because it demands attention to the sources of variation so that tools, such as the typology developed by Balka et al. (2008), can be used to support reasoning and decision making about suites of solutions and their impacts in different sites at different times. Most importantly, as Balka et al. claimed, such conceptual tools offer mechanisms "through which concepts traditionally outside of the domain of systems designers can be addressed within design and project management activities" (p. 523). At the same time studies of local variation, such as the one presented here, can extend our understandings of the kinds of variation and related issues that need to be considered when developing and using such conceptual tools in the first place. The further development

of this strand of research offers real potential for progress to be made in CSCW research so the rich and valuable insights and developments of the field might at last be appropriated into everyday technology design.

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References

Aanestad, Margunn (2003): The Camera as an Actor: Design-in-Use of Telemedicine Infrastructure in Surgery. *Computer Supported Cooperative Work,* vol 12 , no. 1, pp. 1-20.

Australia's Health (2008) Australian Institute of Health and Welfare. http://www.aihw.gov.au/publications/index.cfm/title/10585

Australian National Breast Cancer Centre. (2005): *Multidisciplinary Meeting for Cancer Care: a Guide for Health Service Provider,* Camperdown, NSW, NBCC, 2005.

Balka, Ellen, Ina Wagner and Jensen, C.B. (2005): 'Reconfiguring critical computing in an era of configurability', Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility, ACM, Aarhus, Denmark, pp. 79-88.

Balka, Ellen and Ina Wagner (2006): Making Things Work: Dimensions of Configurability as Appropriation Work. In *CSCW '06. Proceedings of the Conference on Computer Supported Cooperative Work*, Banf, Canada. New York: ACM Press, pp.229-238.

Balka, Ellen, Pernille Bjorn and Ina Wagner (2008): Steps toward a typology for health informatics. In CSCW '08. Proceedings of the Conference on Computer Supported Cooperative Work, San Diego, USA. New York: ACM Press, pp. 515-524.

Berg, Marc (2001): Implementing information systems in health care organisations: Myths and challenges. *International Journal of Medical Informatics*, vol. 64, nos. 2-3, pp. 143-156.

Ciolfi, Luigina, Geraldine Fitzpatrick and Liam Bannon (eds) (2008): Settings for Collaboration: the Role of Place. Special Issue, *Computer Supported Cooperative Work*, vol. 17, nos. 2-3.

Delaney, G., Jacob, S., Iedema, R., Winters, M. and Barton, M. (2004) Comparison of face-to-face and videoconferenced multidisciplinary clinical meetings, *Australasian Radiology* 48:487-492.

Dourish, Paul, (2006) Re-space-ing place: "place" and "space" ten years on. In CSCW 2006, Proceedings of Conference on Computer Supported Cooperative Work. Banf, Canada. New York: ACM Press, pp. 299-308.

Dugdale, Paul (2008) *Doing Health Policy in Australia*. Allen and Unwin.

Ellingsen, Gunnar and Eric Monteiro (2006): Seamless Integration: Standardisation across Multiple Local Settings. *Computer Supported Cooperative Work*, vol. 15, pp. 443-466.

Fitzpatrick, Geraldine, Simon Kaplan and Tim Mansfield (1996): Physical spaces, virtual places and social worlds: a study of work in the virtual. in Proceedings of the 1996 ACM conference on Computer supported cooperative work, (Boston, Massachusetts, United States, 1996), ACM, 334-343.

Gärtner, Johannes and Ina Wagner (1996): Mapping Acting and Agendas: Political Frameworks of Systems Design and Participation. *Human Computer Interaction*, vol. 11, pp. 187-214.

Gaver, Bill (1992): The Affordances of Media Spaces for Collaboration. In *CSCW 1992, Proceedings of the Conference on Computer Supported Cooperative Work*. Toronto, Canada, New York: ACM Press, pp. 17-24.

Hailey David, Risto Roine and Arto Ohinmaa (2002) Systematic review of evidence for the benefits of telemedicine. *Journal of Telemedicine and Telecare,* vol. 8 pp. 1-7.

Harrison, Steve and Paul Dourish (1996): Re-Place-ing Space: The Roles of Place and Space in Collaborative Systems. In *CSCW 1996. Proceedings of the Conference on Computer Supported Cooperative Work*, Cambridge, MA, New York: ACM Press, pp. 67-76.

Harrison, Steve and Deborah Tatar (2008) Places: People, Events, Loci – the Relation of Semantic Frames in the Construction of Place. *Computer Supported Cooperative Work*, vol. 17, nos. 2-3, 97-133.

Heath, Christian and Paul Luff (1992): Media Space and Communicative Asymmetries: Preliminary Observations of Video-Mediated Interaction. *Human-Computer Interaction*, vol. 7, pp. 315-346.

Heath, Christian. And Paul Luff, (1996): Documents and professional practice: 'bad' organisational reasons for 'good' clinical records. In *CSCW 1996 Proceedings of the 1996 ACM Conference on Computer Supported Cooperative Work*. Boston, USA. New York: ACM Press, pp. 354-363.

Jordan, Brigitte and Austin Henderson (1995) Interaction Analysis: Foundations and Practice. *The Journal of the Learning Sciences*, vol. 4, no. 1, pp. 39-102.

Kane, Bridget and Saturnino Luz (2006): Multidisciplinary medical team meetings: an analysis of collaborative working with special attention to timing and teleconferencing. *Computer Supported Cooperative Work*, vol 15, nos. 5-6, 6pp. 501–535.

Kane, Bridget and Saturnino Luz (2008): Taking Lessons from Teleconference to Improve Same Time, Same Place Interaction, In *Proceedings of the 21st IEEE International Symposium on Computer-Based Medical Systems*, Jyväskylä, Finland, pp. 494-499.

Kane, Bridget and Saturnino Luz (2009): Achieving Diagnosis by Consensus. *Computer Supported Cooperative Work*, vol. 18, no. 4, pp. 357-392.

Li, Jane, Toni Robertson, Susan Hansen, Tim Mansfield and Jesper Kjeldskov (2008): Multidisciplinary medical team meetings: a field study of collaboration in health care. IN Proceedings of OZCHI 2008. Cairns, Australia, pp. 73-80.

Luff, Paul, Christian Heath, Hideaki Kuzuoka, Jon Hindmarsh, Keiichi Yamazaki and Shinya Oyama (2003): Fractured Ecologies: Creating Environments for Collaboration, *Human-Computer Interaction*, vol. 18, pp. 51-84.

Martin, David, Mark Hartswood, Roger Slack and Alex Voss (2006): Achieving Dependability in the Configuration, Integration and Testing of Healthcare Technologies. *Computer Supported Cooperative Work*, vol. 15, nos. 5-6, pp. 467-499.

Ohta, Shoichi, Hideaki Kuzuoka, Mariko Noda, Hirokazu Sasaki, Shiro Mishima, Tadashi Fujikawa, Tetsuo Yukioka (2006): Remote support for emergency medicine using a remote-control laser pointer. *Journal of Telemedicine and Telecare*, vol. 12, pp. 44-48.

Proctor, Rob, Mark Rouncefield, Ellen Balka and Marc Berg (eds.) (2006) Special Issue: CSCW and Dependable Health Care Systems. *Computer Supported Cooperative Work*, vol. 15, nos. 5-6.

Reddy, Madhu, Paul Dourish and Wanda Pratt (2001): Coordinating Heterogeneous Work: Information and Representation in Medical Care, In *ECSCW 2001, Proceedings of the Seventh European Conference on Computer-Supported Cooperative Work*, Bonn, Germany, pp. 239-258.

Robertson, Toni (1997): Cooperative Work and Lived Cognition: A Taxonomy of embodied actions. In *ECSCW 1997, Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work*, Lancaster, UK, pp. 205-220.

Robertson, Toni (2000): Cooperative Work, Women and the Working Environments of Technology Design. *Australian Feminist Studies*, vol. 15, no. 32, pp. 205-219.

Robertson, Toni (2002): The Public Availability of Actions and Artefacts. *Computer Supported Cooperative Work*, vol. 11, pp. 299-313.

Schmidt, Kjeld and Liam Bannon (1991): Taking CSCW Seriously: Supporting Articulation Work. *Computer Supported Cooperative Work*, vol. 1, nos. 1-2, pp. 7-40.

Schmidt, Kjeld, Ina Wagner and Marianne Tolar (2007): Permutations of cooperative work practices: a study of two oncology clinics. In *GROUP '07. Proceedings of the Conference on Supporting Group Work*, Florida, USA. New York: ACM Press, pp. 1-10.

Shae, Zon-Yin, Belle Tseng and Wing Ho Leung, Immersive Whiteboard Collaborative System. *Annals of Software Engineering*, vol. 12, no. 1, pp. 193-212.

Smith, Anthony and Leonard Gray (2009): Telemedicine across the ages. Medical Journal of Australia, Vol. 190, No 1, 2009, pp. 15-19.

Suchman, Lucy. (1983): Office procedure as practical action: models of work and system design, *ACM Transactions on Information Systems (TOIS)*, New York: ACM press, pp. 320-328.

Suchman, Lucy. (2007): Sociotechnologies of Care: Vision and realities. In J. Westbrook, E. Coiera, J. Callen and J. Aarts (eds): Proceedings of the 3rd International Conference on Information Technology in Health Care: Socio-technical Approaches, pp 1-2.

Voida, Amy, Stephen Voida, Saul Greenberg and Helen Ai Hi (2008): Asymmetry in Media Space. In *CSCW 2008, Proceedings of the Conference on Computer Supported Cooperative Work*. San Diego, USA, New York: ACM press, pp. 313-322.

Zorbas, Helen, Bruce Barraclough, Kathy Rainbird, Karen Luxford and Sally Redman (2003) Multidisciplinary care for women with early breast cancer in the Australian context: what does it mean? *Medical Journal of Australia*, vol.179, no. 10, pp. 528-531.

Zuiderent, Teun, Brit Ross Winthereik and Marc Berg (2003): Talking about Distributed Communication and Medicine: On Bringing Together Remote and Local Actors. *Human Computer Interaction* , vol. 18, no. 1, pp. 171-180.

Figures

Figure 1. Site plan of the room at Setting A. Note that all participants are seated in the rows of chairs. The video conferencing system and the table in the front are not used

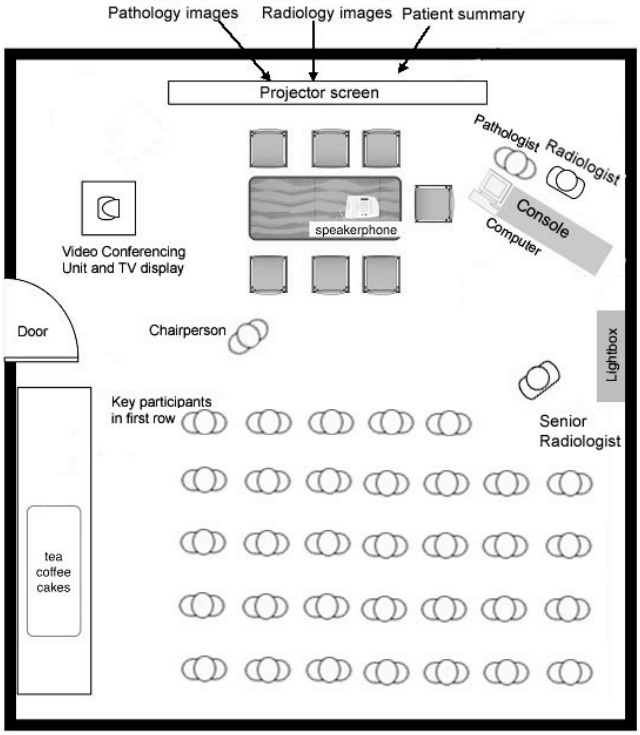


Figure 2. Site plan of the room at hospital B

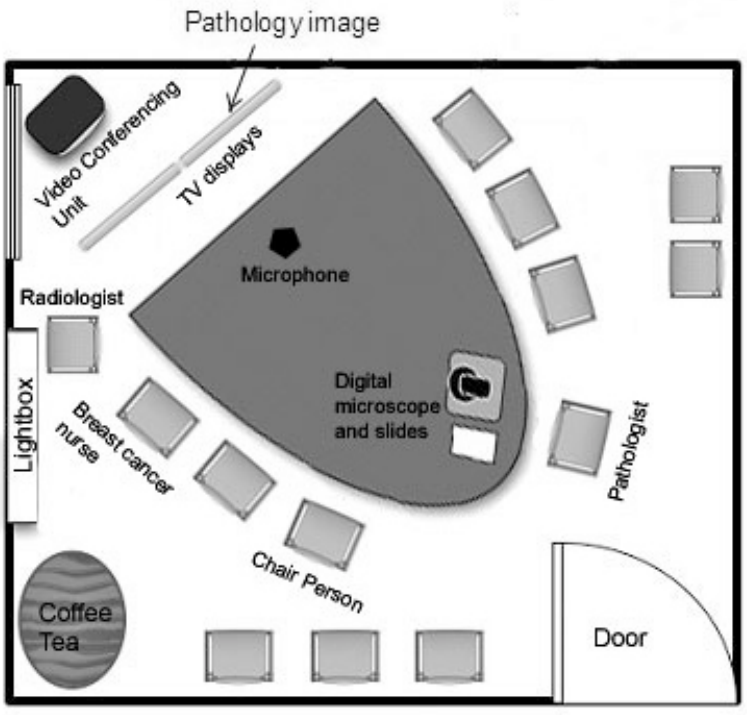
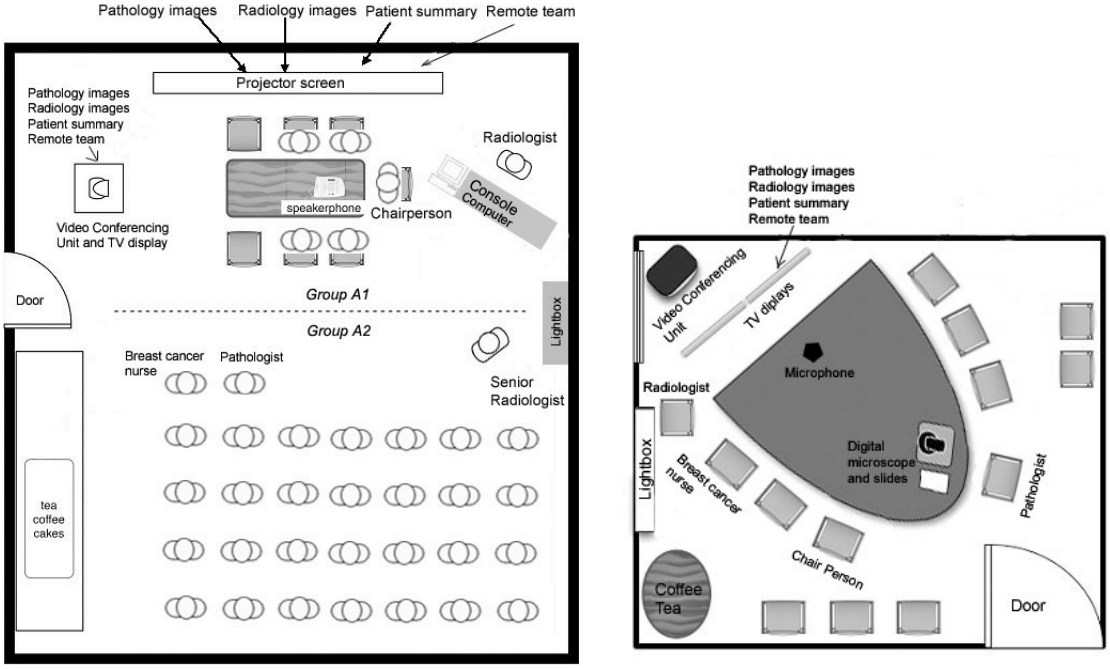


Figure 3. Site plan of setting C. Note that the participants in hospital A have divided into two distinct groups who look at different displays. Group A1 watch the videoconferencing screen, group A2 the presentation screen at the front of the room. These different views are not synchronised and the display on the presentation screen is controlled manually by the radiologists at the console in Setting A



Tables

Table 1. Participants at hospital A

Key participants	*Non-key participants*
two breast cancer surgeons (one surgeon chairs the meetings)	nurses
one senior radiologist and one junior radiologist	psychologists
one pathologist	social workers
one medical oncologist	occasionally general practitioner/s
one radiation oncologist	registrars
one breast cancer nurse	junior doctors
	medical researchers
	medical students

Table 2. Participants at hospital B

Key participants (sitting at the table)	*Non-key participants*
One or two breast cancer surgeons	one project officer
one radiologist	one psychologist
one pathologist	one social worker
one or two medical oncologists	occasionally general practitioner/s
one radiation oncologist	one researcher
one breast cancer nurse	

Table 3. Location of responsible/participating clinicians in setting C. Patients are at hospital B. The clinicians who present the cases are highlighted in grey.

Responsible Clinician	*Location*
Surgeon	Hospital A or B
Radiologist	Hospital A
Pathologist	Hospital B
Medical oncologist	Hospital B
Radiation oncologist	Hospital B
Breast cancer nurse	Hospital B