Organising Videoconferencing for Collaborative Medical Diagnosis

Pre-Planned and Acute Practice

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Abstract— **How videoconferences (VCs) as a tool for real-time collaborative medical diagnosis are organised affects the content of collaborative work. The objective of this paper is to outline** *how* **the organisation of VCs for pre-planned and acute situations affects content in collaboration. Forty-seven VCs were observed and videotaped, and twenty semi-structured interviews were conducted in two studies, representing three contexts, reflecting pre-planned and acute medical problem solving. Regularly pre-planned meetings differ from others, creating a practice that includes consultations about general medical problems, the opportunity to discuss specialised problems, and information sharing between levels of care. Regularity and thus knowledge of each other and of the patient support the sharing of information about patients previously discussed. Acute use of VC is organised as a restricted service, offered during a specific timeslot during the day. The consultation is specialised (i.e., stroke), in which professional(s) with specific specialised knowledge meet. Non-planned, 24/7 acute use of VC is still left to be explored in its context. What is known is that acute knowledge is knowledge in the moment, requiring unplanned access to VC as a tool for sharing knowledge resources twenty-four hours a day. These factors should be considered when VC is implemented for collaborative medical diagnosis. The paper is relevant as it is concerned with tools to enhance collaboration online, i.e., VC, and how VC improves the value of distributed knowledge among virtual teams.**

Keywords—videoconference; Collaborative medical diagnosis; context; pre-planned; acute

I. INTRODUCTION

Videoconferencing (VC) is a well-known technological tool for collaborative work. Through the use of VC, professionals can share information and knowledge jointly, producing real-time collaborative medical diagnosis. In previous work, the results illustrate that how the VC is organised in pre-planned meetings affects the content of collaborative work [1, 2]. Continuing work with VC in unplanned acute situations [3] led to an interest in how the organising of the VC as a tool affects content in the collaboration between the professionals. How the use is organised is important for the content of collaborative work. The objective in this article is therefore to explore how different ways of organising the use of VCs affect the content of the collaboration and to outline how successful VC for collaborative medical diagnosis can be organised. This paper expands previous work by connecting the two contexts, to illuminate the differences to be considered when implementing VC in practice.

Studies on the organisation of VC have treated the tool as a technology disconnected from the context it is a part of, e.g., creating ten simple rules for organising VC anywhere [4] or a step-by-step guide to VC [5]. Several factors influence the VC practice, the context in one main factor. The effect of context is often related to a medical illness, i.e., VC between specialists and general practitioners (GPs) aimed at improving the quality of diabetes care [6], addressing administrative and clinical issues using VC in delivering psychiatric care [7], and using VC as an effective diagnostic tool for, e.g., skin lessons in dermatology [8]. In workplace settings, studies have, in many situations, been more focused on the technology used during the interaction than on the interplay with remote colleagues [9]. This work merges two different contexts, to illuminate how medical situations are unequal, demanding a different organisation. This is often overlooked when implementing new technology, as one solution is developed to cover, i.e., all acute medical situations, even all collaborative work. This expands novel knowledge to the field.

The paper focuses on collaborative work between distributed resources. The theoretical approach constitutes the framework for the studies and the paper, as the perspectives create premises for understanding collaboration in VC practice. The tree contexts, two pre-planned and one acute, are accounted for. Video-recorded observations and interviews are described as the methods for revealing the organisation of VCs and how the context affects the content in collaboration. Based on the amount of and the content in the VC meetings, the results report how collaborative work is shaped by the context. The discussion illuminates pre-planned and acute practice, and what kind of practice and problem solving to arrange for. The paper concludes with suggestions for future work.

II. FRAMEWORK

The interplay among remote colleagues and the emphasis on the context of knowledge sharing is used as a framework for understanding how the content of medical work and the organisation of the VC are mutually shaped. In workplace settings, the situated approach notes that problem solving often occurs in group settings [10]. This situated approach emphasizes a Cultural Historical Activity Perspective (CHAT), which focuses on the connection between the culture, the arteacts, objects, and tools as a social activity

[11]. Knowledge is situated within the social activity, context and culture and it is an interplay between the institutional context and the organisational structure. The studies do not frame the use of VC nor the collaborative work *itself* as a transmission of knowledge from one individual to another. The collaborative work is shaped by the context it is used and developed in, e.g., the medical culture. That i the tools the professionals use in their work, the rules they follow, the division of labour, and the community they practice in. It is the social activity in the group that develops the practice.

Collaborative medical diagnoses are culturally and historically situated [12], and the contradictions among different professionals might change the traditional treatment of patients. When knowledge from medical professionals is transferred between them by collaboration, it might change their treatment methods. Changing methods for the specific treatment or the tools they use is a change in the historical way of performing treatment. Performing medical treatment is connected to the context in which the VC is the tool that mediates the interactions and activities [13] [14] between the participants. It provides collaborative work and ensures that the meanings are socially shared. The knowledge is distributed as a result of sharing their competence and experience as individuals and as a part of their institutional practice.

III.   MATERIALS AND METHODS

Both studies were designed with the purpose of exploring the use of VC, the content for the collaborative work, and distributed knowledge sharing. The VC equipment was implemented independent of the studies explored in this paper. All the participants who used the VC in daily practice were recruited for these two studies. No payment was received for the professionals, since the collaborative work was voluntary as a part of their daily work practice.

There are three contexts in this study: contexts a and b represent hospitals with pre-planned use, and c represents VC in unplanned/acute situations. Figure 1 illustrates how one hospital with one or several general practitioners (GPs) or specialists (coloured faces), with or without patient participation (transparent face), is connected to another hospital using VC as a tool for collaborative medical diagnosis. Traditionally, the professionals in these local hospitals seek a second opinion from the larger specialist hospital over the telephone. VC replaces or supplements the use of the telephone for these activities.
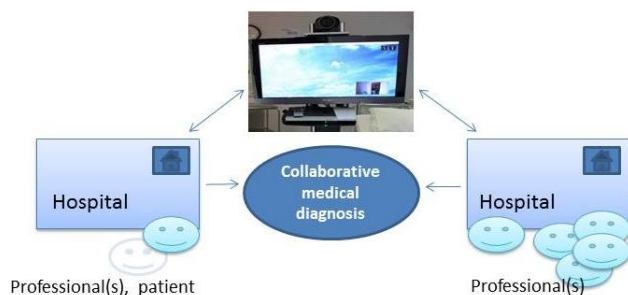

Figure 1.   Two hospitals connected using VC as a tool.

Context a   Context b   Context c

Figure 2.   Organisation of the VC in all contexts.

A.   Hospitals with pre-planned use

The pre-planned use of VC was organised differently in contexts a and b: In context a, the VC is scheduled for a specific time slot once a week and happens 'when needed'. The GP identifies the cases to discuss and makes arrangements the day before with the hospital, which arranges for the appropriate specialist. In context b, the VC meetings are held routinely four times a week, organised as part of the ordinary daily meetings at the hospital. They take place regardless of whether there are predefined medical problems to discuss. This service is still running.

In both contexts a and b, the VC equipment is located in the office of one of the GPs. At hospital A, the VC equipment is located in a smaller meeting and consulting room at the medical department. At hospital B, the VC equipment is located in the morning meeting room in the medical department.

B.   Hospitals connecting in acute situations

In context c, the VC was connected during restricted times during the day, excluding nights and weekends. This context was associated with the condition of stroke, an acute medical problem. The professionals in the emergency ward assessed the patient and connected to VC from the local hospital's emergency room. At the specialist hospital, the VC equipment is located in a dedicated room used only for this purpose. When they are called by telephone and asked for a VC meeting, the specialist on duty immediately moves to this room (Figure 2 illustrates the physical placement of the VC equipment in all contexts.)

C.   Qualitative methods

The main data of interest in all three contexts were the social interaction and the content in the VCs, requiring qualitative research methods. For the pre-planned VCs, it was possible to observe the interaction [15]. Forty-seven VCs (five in context a and forty two in context b) were observed and videotaped during the first half of 2007. This constituted all meetings conducted during the five-month period. The purpose of the observations was to illustrate the social interaction, the content of the collaboration, and how the organising affected the content. All the video recordings were transcribed, analysed, and categorised to facilitate an understanding of the content in the VCs.

Eight interviews with GPs and several of the specialists participating in the VCs, from both contexts, were conducted to evaluate the use of VCs in pre-planned collaborative work. The interviews were semi-structured, recorded, and then transcribed. The interviews lasted from twenty to seventy minutes and were conducted from August to December of 2007.

In the acute situation, context c, observations of the unplanned VCs were difficult. Therefore, all the activity using VC was automatically logged and used as a basis for conducting interviews. Thirteen professionals, nurses, physicians, and specialists from both hospitals were interviewed through twelve semi-structured interviews in the autumn of 2011. Each interview lasted from twenty minutes to two hours. All interviews were audio-recorded and then transcribed. All transcriptions were categorised according to utterances that seemed to be repeated by the practitioners. The purpose of the interviews was to reflect acute medical problem solving and the organising and use of VC.

D. Ethical considerations

The North Norwegian Regional Medical Ethics Committee (REK) approved the design of the study and how the data were collected, handled, analysed, used, and kept in contexts a and b. Context c has been registered and evaluated as a non-report obliged by the REK. The personal data are handled according to the personal information rules in Norway.

IV. RESULTS

In each context (a, b and c), two hospitals are connected (hospital A and B). Hospital A (A) and hospital B (B) use VCs as a tool for practicing collaborative work in diagnosis (Figure 1). Table 1 illustrates the use of VC in all three contexts. The content was categorised according to consultations and information exchange. A consultation consists of discussions about and exchanges related to medical problems, diagnoses and follow-ups. Information exchange consists of updating the conditions of patients treated previously and information about patients transferred between levels of care.

In context a, VC was used five times in two months before they stopped using the service. Four times, the participants reported and discussed a medical problem and once they met to exchange information about a patient discussed earlier.

TABLE I.   THE TOTAL NUMBER OF VC IN THE CONTEXTS

Context	Period and purpose of use			
	Period	*Consultation*	*Information exchange*	*Number*
a	2 months	4	1	5
b	5 months	12	13	42*
c	18 months	4	0	4

* The total also includes the category 'practical organising' used 17 times in the same period.

In context b, the VC is routinely held four times a week. During a five-month period, there were forty-two VC meetings. The service is still running today. During this period, twelve meetings were consultations and thirteen involved an exchange of information. In context c, eighteen months passed between the first time and the last time the VC service was used for acute treatments. During this period, they consulted four times regarding four different stroke patients. The service is now locally disconnected.

In Figure 3, the results illustrate how the organisation of VCs for pre-planned and acute situations affects the content of collaboration. Collaborative medical diagnosis is organised in both pre-planned and acute practice. The pre-planned use of VCs is organised as regularly held meetings, in this context four times a week at a specific hour, or reserved for a specific day when a meeting is held when needed. Regularly held meetings offer all knowledge resources available at the time during the morning meeting. The GP can present patient problems more generally and specific medical problems. In pre-planned meetings held when needed, the GP must define a medical problem and report it to the hospital the day before. These meetings are only scheduled one day a week (Wednesdays), so the GP must wait for Tuesdays to report the medical problem to be discussed. Then, the specialist on duty in the hospital prepares and meets to offer a second opinion.

The acute use of VC is organised as a restricted service, offered during a specific timeslot during the day. As the specialist hospital has less experienced staff on duty during the nights, the service is only offered weekdays from 07.30 to 19.30 and Saturdays from 09.00 to 13.00. In between these hours, the local practitioners in the emergency unit determine whether they need to discuss an acute patient with the specialist hospital.

As the purpose of collaborating is to discuss medical diagnoses, the content at all sites involves consultation. In acute situations, the consultation is specialised (i.e., stroke). Here, connecting using VCs is about collaboration concerning a specific acute situation, in which professional(s) with specific specialised knowledge meet. In a pre-planned VC, general (e.g., reviewing a medical record) and more specialised knowledge (e.g., diabetes) issues are examined. The problems might be of the same character, but consultations when needed, only once a week, involve insignificant problems. If it does not appear the day before the report time (i.e., Mondays) the problem must be of a more general character.

However, pre-planned meetings (when needed), held if there are problems to discuss, and in restricted acute situations, involve professionals with this specific knowledge. It might be the same or different professionals participating each time (Figure 3, symbols ☺ = ≠). Regularly held meetings may also include different professionals, but this is rare, as, e.g., during summer holiday among the practitioners, when stand-ins are practicing. Only regularly
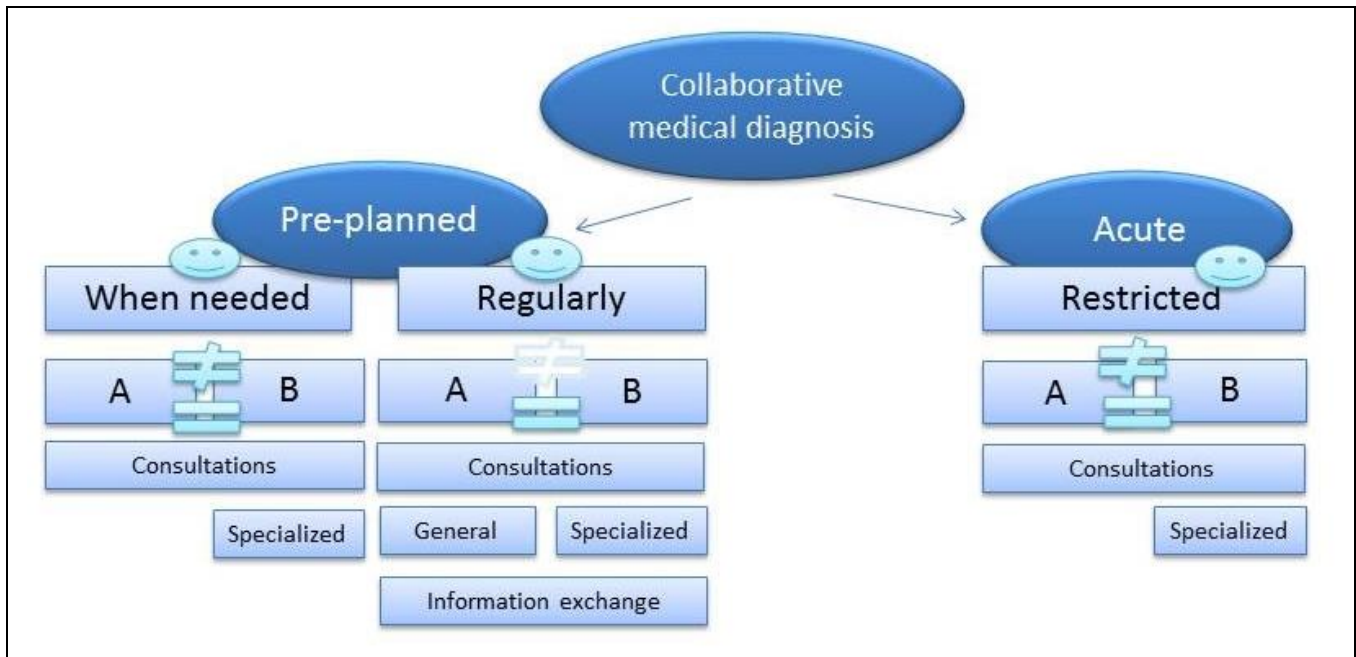
Figure 3.   The organisation of VCs for pre-planned and acute situations and the content.

held meetings, where the same professionals (Figure 3, symbols ☺ ≠ =) meet regularly, result in both consultation and information exchange. The regularity and therefore the professionals' knowledge of each other and of the patient support the sharing of information about patients who have been previously discussed.

Regularly pre-planned meetings differ from others, creating a practice that includes consultations about general medical problems and the opportunity to discuss specialised problems and exchange information about patients previously discussed. It also allows the sharing of resources among the same professionals over time, which provides opportunities to expand treatment activity together.

V.   DISCUSSION

Based on three contexts, the results show how the organisation of VCs for pre-planned, as-needed, and regular and restricted acute situations affects the content of collaboration. This paper focuses on collaborative work between distributed resources and how the context affects the content and the medical work using VC as a tool for collaboration.

As context b illustrates, VC is well-suited for consultations and medical problem solving. It is the medical condition that determines whether the situation can be pre-planned or is acute. Regularly held meetings, as a part of established activities such as morning meetings, offer an adequate way to organise the use of VC if the aim is a two-way commitment to collaborative work. Over time, the same professionals meet, discussing medical problems of diverse character and both general and more specialised problem solving. Through connecting with the same

professionals over time, often discussing the progress of the same patients over days, they are able to follow up on the treatment. Discussing patient flow between levels of care and giving feedback on previously discussed patients also provides the specialists with feedback on their second opinions. Organising VCs as pre-planned meetings allows for situated knowledge, knowledge of the patient, and the opportunity to expand the treatment activity together. This might change the direction of the object so that the practitioners start to use treatment methods and previous knowledge connected to the culture of the specialists.

Acute situations demand general biomedical knowledge according to a specific medical problem in time. The specialist does not have knowledge of the patient in advance or access to other information than what is shared. Here, the use of VC is only available during specific times. This gives an extra hampering factor (as in the context of conformity with pre-planned meetings reported the day before) for use. The medical problem must be evaluated against the ability to wait until the VC connecting time. If it is easier to connect by telephone, the traditional method of discussing medical problems is used. As acute situations cannot be foreseen and cannot wait, the activity is not restricted. Here, it is possible to suggest an alternative for organising VC to discuss acute medical diagnosis. Figure 4 includes a suggestion for organising VC in acute collaborative medical diagnosis as 'unplanned'.

Non-planned acute collaborative work benefits from being organised as a non-planned, 24/7 service. Acute, unplanned collaborative work often brings together different professionals periodically (Figure 4, symbols ☺ ≠), because
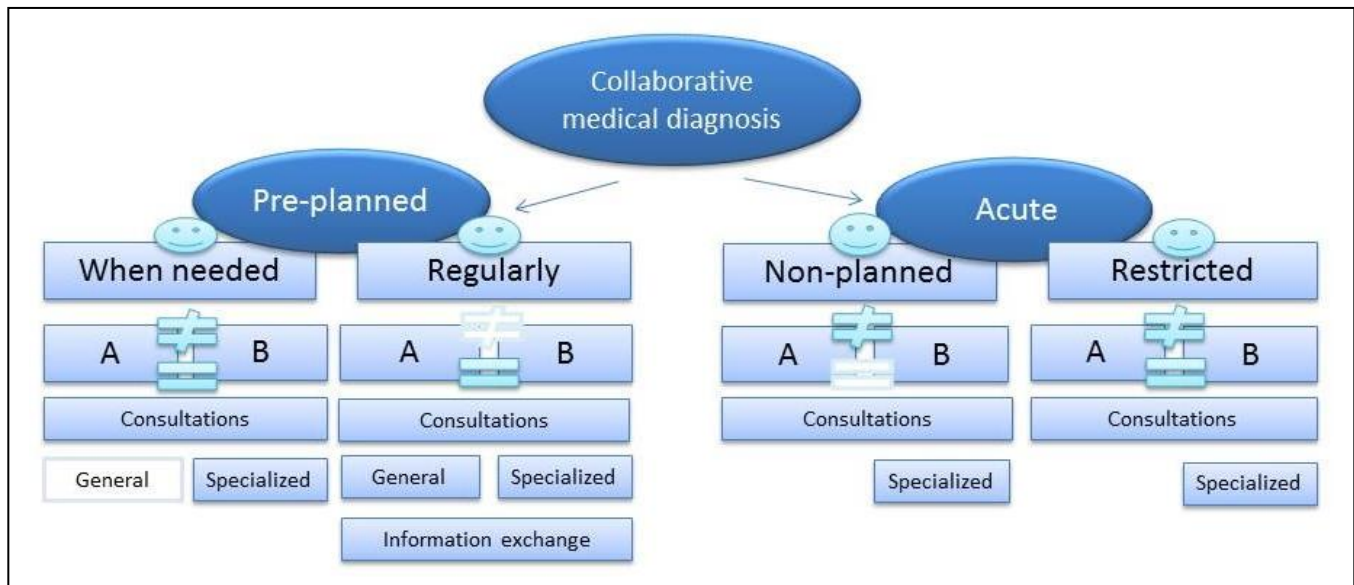
Figure 4.   The organisation of VCs for pre-planned and acute situations

the consultations demand different knowledge. Over time, this activity might change the traditional practice, creating this new activity, where the same professionals are able to meet more often. However, it is still not likely that the activity will include, i.e., information exchange, as acute situations demand specialised knowledge and an immediate start of treatment.

VC must be seen as a tool in connection with the context it is a part of. In spontaneous situations, which typically involve discussing the patient only once, the physicians do not have experience with the patient in advance. The organisation and the type of knowledge exchanged (the medical problem) are mutually attached. Connecting using VC regularly allows medical discussions of a more general character, i.e., regularly held meetings including both specialised and more general medical discussions. More general discussions can also be included in pre-planned, as-needed meetings if the same professionals meet over time.

As shown in the framework, knowledge is situated within the activity, context and culture, and it is an interplay between institutional context and organisational structure. How knowledge in daily work practice is structured is established over years, how the practitioners divide their work tasks, the rules for treatment, and the community they locally are a part of this interplay. Introducing VC for collaboration across levels of care calls for awareness of the fact that how the VC is organised and the resources shared must be seen as mutually connected. Neither the use of VC nor the collaborative work itself can be viewed as a transmission of de-contextualized knowledge from one individual to another. A medical diagnosis is the result of a social process through which professionals share a type of knowledge that often includes a treatment method practiced by other practitioners. Therefore, the use of VC also affects the traditional division of labour in health care.

Sharing knowledge leading to changes in working methods and division of labour, creates the contradictions between traditional treatment methods (i.e., referring the patient) and the new work practice. If the purpose of VC is to retain knowledge sharing, the service needs to account for practice as situated knowing so the practitioners know how to continue the activity. Regular collaborative work, including both second opinions and follow-up feedback to those sharing knowledge for treatment advice, should be kept going. This also supports successful use of VC.

VI.   CONCLUSION AND FUTURE WORK

The objective of this paper was to outline *how* the organisation of VCs for pre-planned and acute situations affects the content in collaboration. Medical situations are unequal, because the participants who interact in them occupy specialised and situated knowing of the patient and the local contexts. This is often overlooked when implementing new technology, as one solution is developed to cover, i.e., all acute medical situations. Situated knowing of local context demand for adjustment of how VC is organised and how VC is used.

Regularly pre-planned meetings create a practice that includes consultations about general medical problems, specialised problems, and information sharing. Regularity and knowledge of each other and the patient support the sharing of information about patients, as previously discussed. Acute use of VC is organised as a restricted service, offered during a specific timeslot during the day. The consultation is specialised, in which professional(s) with specific specialised knowledge meet. The acute service needs to be a twenty-four-hour service to support the context it appears in, as acute treatment is demanded regardless of time of the day. Restricted time collides with how acute care is organized, as a twenty-four-hour service. VC 'when needed', which need to be reported in advance,

also collides with traditional medical practice, i.e., medical problems need to be solved in the moment. Hence, regular knowledge sharing supports high-frequency use of VC.

Based on this, the paper does not suggest using a universal guideline for how to organise the use of VC. VC is a situated practice, calling for awareness of the fact that how VC is organised affects the frequency of use and the knowledge shared. Even though experience from other similar cases might be used as a normative guideline, the context in which the VC is going to be implemented must be taken into account. As context b illustrates, VCs that fit into the local context (as a part of existing morning meetings) support successful collaborative work.

Unplanned, 24/7 acute use of VC is still left to be explored in the future. The total number of acute medical situations will be affected if the same professionals meet over time and if they are going to follow up on previously treated patients. What is known about the context is that acute knowledge is knowledge in the moment, requiring unplanned access to VC as a tool for sharing knowledge resources twenty-four hours a day.

As time passes, technology improves, while the contexts in which professionals practice continue to be important to its successful use. Also the most advanced technology with the greatest number of applications benefits fitting into daily medical practice to succeed. Today, the availability of electronic health records (EHR) for patients has opened up the sharing of information in consulting with professionals in other areas. Unfortunately, not all hospitals and general practitioners have access to the same systems, and so are not able to access the same EHR at the same time (as in context c in this paper). In contexts a and b, practitioners had access to the same EHR. In context a, pre-checking in the EHR seemed to create more hassle in preparing for the discussions than in context b, where the specialists only relied on the general practitioners to present patient records, without looking them up by themselves. The traditional approach of orally presenting medical cases when discussing them (for example in morning meetings) seems to be fundamental to discussions. Access to pictures and other non-text-based tools in the EHR might enrich discussions, and is an interesting approach to the use of VC that can be explored in future work.

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