

Characteristics of successfully implemented telemedical applications

Aud Obstfelder^{1,2§}, Kjersti H Engeseth¹, Rolf Wynn^{1,3}

¹ Norwegian Centre of Telemedicine, University Hospital of Northern Norway, Tromsø, Norway

² Department of Nursing and Health Science, University of Tromsø, Tromsø, Norway

³ Department of Clinical Psychiatry, University of Tromsø, Tromsø, Norway

[§]Corresponding author

Email addresses:

AO: Aud.Obstfelder@fagmed.uit.no

KHE: Kjersti.Halvorsen.Engeseth@telemed.no

RW: Rolf.Wynn@gmail.com

Abstract

Background

Recent years have seen an increased interest in the use of telemedical applications in clinical practice. Considerable effort has been invested in trials and experimental services. Yet, surprisingly few applications have endured beyond the research and development phase. The aim of this study is to explore characteristics of successfully implemented telemedical applications.

Methods

A large body of telemedicine literature was searched in order to identify relevant articles. Following a defined selection process, a small number of articles were identified that described characteristics of successfully implemented telemedical applications. These articles were analysed qualitatively, drawing on central procedures from Grounded Theory, including condensation and categorisation. The analysis resulted in a description of features found to be of importance for a successful implementation of telemedicine. Subsequently, these features were discussed in light of STS theory and the concept of 'social negotiation'.

Results

Telemedical applications introduced into routine practice are typically characterised by the following six features: 1) that local service delivery problems have been clearly stated, 2) that telemedicine has been seen as a benefit, 3) that telemedicine has been seen as a solution to political and medical issues, 4) that there was collaboration between promoters and users, 5) that issues regarding organizational and technological arrangements have been addressed, and 6) that the future operation of the service has been considered.

Conclusions

Our findings support research arguing that technologies are not fixed entities moving from invention through diffusion and into routine use. Rather, it is the interplay between technical and social factors that produces a particular outcome. The success of a technology depends on how this interplay is managed during the process of implementation.

Background

One of the more significant developments over the past decades has been the emergence and widespread deployment of information and communication technologies (ICT)[1,2,3]. The ‘digital revolution’ has transformed our everyday lives and has had a pervasive influence on work and organizations. ICT has captured the attention of health care providers as well as health policy makers, who are encouraging these technologies primarily as they may have the potential to address issues such as inequalities in access to health care and the need to reduce costs, whilst delivering at least equivalent, if not better, standards of health care than traditional alternatives [4,5,6,7,8].

Telemedicine is the use of information technology to support delivery of health care from a distance [6]. Despite the general impact of new technologies in society and the political will to promote telemedicine in public health care, telemedicine has primarily been used on a small scale in clinical activity. As a field of practice, telemedicine is mainly characterized by trials, demonstrations, or experimental services that do not endure beyond the life of specific research and development projects. Only a few developments have been implemented on a wide scale and sustained [9,10,11,12,13,14].

It is commonly suggested that the main reason for the low routine clinical use of telemedical applications is the insufficient evidence of its efficacy, in terms of both clinical and organizational impact on the health care sector. Without evidence of any effect, professional and political support for telemedicine cannot be sustained [12, 13,15]. However, the outcome of clinical trials does not tell the whole story about what is needed to make telemedicine systems and services work [15]. Conditions operating during the process of design and implementation of the applications, which could have been important for the outcome of the trial, are seldom mentioned or questioned. Neither is the correlation between positive outcomes of clinical trials and routine use proven or questioned. In addition, it is often not clear in the literature whether the telemedical service being discussed has been introduced into routine operation and whether any such routine operation in fact is an extension of the pilot study or represents a new introduction of the application in a completely different part of the health service.

An understanding of why telemedicine is seldom used in clinical practice is important to clinical and policy proponents of these technologies, who see telemedical applications offering solutions to some key problems in improving access to health care and equitably distributing specialist clinical expertise [12]. Previous telemedicine research provides little insight into why there is so little routine use of telemedicine in clinical practice. During the last years, however, studies on ‘organizational issues’ have emerged [7,12,13,15,16]. Some of the studies refer to STS theory [17,18], and the term ‘social negotiation’ has been used to describe a key aspect of the difficulties of clinical use [17]. The term indicates that while technological issues such as inadequate design or poor performance will reduce the system’s chances of being implemented successfully [19], use or non-use is determined by the social context in which the technology is implemented. This is because a more or less explicit controversy will always arise when a new technology is implemented. The controversy may involve the problems which the technology is to solve as well as the

ways in which they are to be solved. The various actors may also have different perceptions of what the organizational challenges concern, what the solution should look like, and also whether an implementation is to be understood as a success or a failure.

From the perspective of those who question the assumption that insufficient evidence of telemedicine is the reason for low clinical use, it is clear that new technologies alone do not create change. Rather, it is the interplay between technical and social factors that produces particular outcomes [17,18,19]. That is, organizational difficulties lie in the deep interrelation of technical and social aspects of designing and implementing technologies. Conversely, success entails handling these complex, heterogeneous factors which are expressed in controversies and solved through social negotiation.

The purpose of our study is to contribute to this emerging literature on telemedicine and organisational issues by doing an in depth analysis of the characteristics of telemedical services *that have been implemented* into routine clinical practice. Our method is a study of the literature on telemedicine. Our principal research questions are: 1) What are the characteristics of telemedical services that have successfully been implemented in routine clinical practice? 2) In what way are these characteristics associable with the emerging literature on telemedicine and organisational issues, particularly with respect to STS theory and the concept of ‘social negotiation’.

On the basis of our findings, we aim to suggest how proponents of telemedicine should proceed when planning to implement telemedicine in clinical practice, and to indicate areas for further research.

Method

Overall research design and method

A large body of telemedicine literature was searched in order to identify relevant articles. In selecting the articles to be included in the study, we initially searched a range of data-bases, using specific key-words. The search was subsequently refined, and the number of articles reduced, by excluding less relevant literature. The procedure followed is described in more detail below. Thus, a small number of articles were identified that described characteristics of successfully implemented telemedical applications. We found that the research questions (see above), as well as the type (i.e. mainly qualitative) and small quantity of the articles describing successfully implemented telemedical applications, would be best approached with a qualitative method. We analysed the data with a qualitative method drawing on central concepts from Grounded Theory, including condensation, categorisation and data saturation [20,21,22] (see below). The analysis resulted in a description of features found to be of importance for a successful implementation of telemedicine. Subsequently, these features were discussed in more detail in light of STS theory and the concept of ‘social negotiation’ [17,18].

Strategy for the database search

The research on telemedicine is interdisciplinary, and dominated by demonstrations, feasibility- and evaluation studies [23]. We expected few articles on telemedicine with success, and a wide variation in use of keywords. Thus, we performed a broad initial research. The following electronic databases were searched: Cochrane, PubMed, Web of Science (ISI), TIE, sociological abstracts (Cambridge), ERIC, PsychInfo, and CINAHL. The keywords used were: assessment, evaluation, utilization, case, clinical application, difficulties, barriers, challenge, critical issues, facilitators, limitation, prevention, success, failure, diffusion, dissemination, adoption, meta-analysis, review and telehealthcare, telemedicine, e-health. To validate the keywords used in the initial search, the first and second author made a list of possible keywords by reading through articles of telemedicine studies from our personal archives. We performed a test research of all the keywords and those with hits on more than 1000 were deleted. References of the included studies and citations were not searched.

The process of exclusion and inclusion of studies

Despite performing a test search, the retrieved number of articles after the initial search was vast (Figure 1: n=12089). To reduce the sample to a more manageable size, articles after given criteria were excluded (Figure 1: n=2117). The exclusion criteria used at this stage were articles written in a language other than English and those published before 1990. Studies in which the use of telecommunication technologies was primarily for educational and administrative purposes and not linked directly to patient care, as well as studies in which the patient was not physically present at either point of care, were also excluded [23]. Studies on telephone consultation services, internet services where no communication between professionals and/or professionals and patients was possible, and review or discussion papers were also excluded. In addition, if any single study resulted in multiple publications, we included only the principal article, focusing on the clinical use of telemedicine. Finally, all studies that had no abstracts when retrieved from the original electronic databases were excluded.

To assess the remaining studies for relevance, the first and second author started to browse title and abstract on each article. However, we quickly realised that a separation of studies of telemedicine with success from the other studies, especially the evaluation- and outcome studies, could not be done this way. A more comprehensive reading of all the articles was required, which was something we could not do within the frame of the present research project. Thus, we had to reduce the selected articles further and we did another search within the sample looking specifically for *empirical* studies on telemedicine in clinical use (Figure 1: n=208). The keywords used at this stage were *evaluation, outcome and implementation*. To determine the remaining studies potential suitability for the present study, title and abstract of each article, were read by all three authors. The full articles were then assessed for relevance (Figure 1: n=84). The articles were subsequently sorted into the following main categories: 1) 'Clinical use' 2) 'Outcome study' 3) 'Uncertain' 4) 'Background'. The inclusion criteria for studies in the 'Clinical use' category were that the authors of the studies themselves categorized the applications as such. In addition, the articles had to document some type of activity in the described telemedical service.

Figure 1. Selection process for studies included in analysis

Qualitative data analysis

The articles in the category 'clinical use' were analysed further qualitatively, drawing on central concepts from Grounded Theory [20,21,24,25]. The next step in the analysis was to identify (condense) common concepts and features in the articles relevant to the present study and then cluster these concepts and features in linked themes (categorization). That is, on the basis of similarities and dissimilarities in the content of the articles (data), relevant categories that included concepts and features of similar meaning were elicited from the articles. Next, in order to describe the properties of each category, the concepts and experiences assigned to each category were explored further. The content of the articles was categorized throughout the research process. As new data emerged, the categories were tested and refined until 'data saturation' [20,22] occurred. That is, until the categorization process did not give us new insight about characteristics of successfully implemented telemedical applications. As the research progressed, memos were produced summarizing findings and explanations. These memos were subsequently used to produce the results presented below.

Results

Overview

Of the more than 12000 articles initially retrieved, we identified only 16 studies of telemedical applications in clinical use. Following the analysis, we found certain general characteristics of these applications, which we have described in terms of six main categories (Box 1). These categories are: 1) Local health care service delivery problems are clearly stated. 2) Telemedicine is seen as a benefit. 3) Telemedicine is seen as a solution to political and medical issues. 4) There is collaboration between promoters and users. 5) Issues regarding organisational and technical arrangements are addressed. 6) The future operation of the service is considered.

Box 2. Criteria for success of telemedical applications

Examples of how these common features are reflected in successful telemedical trials appear below. Categories number 1 and 2 and 5 and 6 will be presented together in the same section. All the articles that are discussed are presented in the appendix.

Local service delivery problems are clearly stated and telemedicine is seen as a benefit (Categories 1 and 2)

In all the studies of telemedicine in routine use, the local medical and health-related challenges that the technology is to solve are clearly described. The medical challenges that are described vary from acute and chronic diseases to disabilities. For example, La Monte et al. [26] describe how telemedicine is used to provide optimal acute stroke treatment where local specialists are not available. The study shows how an emergency department physician is linked with a specialist in a stroke department centre and how this consultation provides an opportunity for administration of thrombolytic drugs within the short therapeutic time window (approximately 3 hours) associated with ischemic stroke. An example of a study in which telemedicine is used

to handle challenges associated with chronic and medically complex conditions is described by Gray et al. [27]. The authors show how Baby CareLink, a multifaceted telemedicine application, can provide enhanced educational, emotional, and medical support to families of high-risk newborns both during their hospitalization and following discharge. Another example is provided by Ono and Lindsey [28], who describe how a children's hospital is using telemedicine to provide and coordinate care to children with paediatric orthopaedic conditions and chronic burn scars in 22 hospitals on the Pacific islands. A final example is Moses, McGowan and Ricci [29], who point out that conditions for performing routine endoscopies in rural areas are poor and illustrate how a tele-endoscopy service supports primary care physicians performing endoscopies.

Telemedicine is seen as a solution to political and medical issues (Category 3)

Reasons provided in support of telemedicine implementation include its role in efforts to solve local medical and health-related challenges and the health policy objective that citizens should have the same access to health services regardless of their geographical location. A typical example is Gulube and Wynchank [30], who described the development and implementation of a large telemedicine programme in South Africa. The programme is based on the government's wish to compensate for the negative consequences of previous political rule, which inter alia led to an unacceptable concentration and inappropriate distribution of health practitioners and expertise. Today, health care and expertise are concentrated in the major urban centres, while people living in rural areas have limited access to basic health care because of geographical isolation and poor public transport.

In many studies, the argumentation related to health policy is supported by descriptions of the unfortunate consequences that may arise if particular groups who live in outlying districts do not receive health assistance or other support. The descriptions of the consequences are based on relevant medical research and the rights of various interest groups. Examples of studies that refer to medical research include Moses et al. [29], Chan et al. [31], LaMonte et al. [26], and Lawton et al. [32].

There are only two studies [29,31] that legitimate the implementation of telemedicine by referring to evaluations of previous pilots including analysis of costs, user satisfaction, and clinical outcome. Moses et al. [29], in particular, maintain that it is not enough to justify implementation of telemedicine by referring to local challenges, health policy, and medical research. All implementation trials must be based on evaluation results that demonstrate diagnostic quality of the images, costs, and provider/patient satisfaction. This is to enable organisations to make informed choices prior to the investment of significant time and resources. In the other studies, in contrast, it is promised that evaluation results will be produced during the coming years. Evaluation activities have taken place during the trial, but it is often commented that the sample size was too small to assess any outcome variables. A prerequisite for thorough evaluation is a certain activity level in the services.

Two further arguments are used to justify the local implementation of telemedicine services. The first argument is a reminder that a general transfer of competence takes place from the specialist health service to the local health service. For example, in the case of telemedicine for stroke [26], this general transfer of competence has led to

improved abilities of the community hospital to recognize stroke and increase the speed of basic care provided. Another study emphasizing telemedicine's role in transfer of competence is DeLieto et al. [33]. The second argument is more a reservation about the benefits of the technology, stating that it should not replace face-to-face medical practice, but rather provide an additional tool to complement current health care services [28-35].

There is collaboration between promoters and users (Category 4)

Promoting acceptability of the new telemedicine service and adapting the technology to the requirements of the health care service are key aspects in all the studies of successful telemedicine. Acceptability and adaptation are promoted through a close dialogue between the initiators of the technology and its users throughout the trial phase. Users of the technology include individuals at management level, clinicians and patients. The dialogue is both informal and formal. The informal dialogue emerges through the presence of the researchers, project managers and system developers in the local context in which the technology is to be implemented. This presence enables the various actors to become acquainted with each other's work and knowledge, and thus establish a basis for developing a mutual understanding of the challenges as well as the solution to the problem. The formal dialogue takes place *inter alia* through the creation of local project groups for planning and implementation, through users' participation in developing the goals and methods of practice, and their involvement in planning and carrying out the implementation. Organization of training in the use of the technology, implementation of in-depth evaluation studies and communication with government agencies represent other more formal means of interaction.

Doolittle [36], Chau and Hu [37], and Khoja et al.[38] provide good examples of promoting acceptability of telemedical applications. In different ways they point out that ultimate success of telemedicine as a viable alternative for service delivery and collaboration requires that organizations who will implement the technology address technological and managerial challenges. Another good example of a study focusing on adoption and acceptability relates to Baby CareLink [27]. It is not explicitly stated that this type of activity is a criterion for success, but the study provides a detailed description of the way in which general Internet technology is adapted to the needs that the service has been promised to fulfil. The needs are built into the system architecture, which implies a sound knowledge of the field of practice and thus a high level of informal involvement. A final example is LaMonte et al. [26], that effectively illustrates how user involvement and participation is accomplished. The process for involvement and adaptation is described more explicitly than in Gray et al. [27], but here too there is no reference to involvement as a criterion of success.

Issues regarding organisational and technical arrangements are addressed and the future operation of the service is considered (Categories 5 and 6)

Descriptions of how the new telemedicine service has become grounded in organizational and technical arrangements, whether this is in established structures or in new ones created as a result of telemedicine, are striking in studies of successful telemedicine. For example, in the study of telemedicine for stroke [26], we see that the telemedicine service is based on a telephone consultation service between a team

of specialists in stroke treatment and community hospital emergency departments throughout the state of Maryland. The study is a description of the way the emergency department of *one* community hospital replaced telephone consultations with a telemedicine service. Other examples of how the telemedicine services become anchored in existing structures are Baby CareLink [27] and tele-endoscopy [29]. Baby CareLink was implemented as a part of a comprehensive NICU telemedicine application and tele-endoscopy as a component of a state-wide health information network.

Other studies reflect a stronger emphasis on establishing formal routines for the use of the services. LaMonte et al. [26] describe the establishment of fixed routines for training in the use of the technology in response to frequent changes in staff and episodic refresher courses for permanent staff. Gulube and Wynchank [30] point out the importance of establishing guidelines for how to use the system. Gray et al. [27] describe the importance of establishing arrangements for maintainability of the system. In one study, a new position was even created to support the telemedicine service [39].

In all the articles, we see assertions that implementing the telemedical application in routine use requires service financing and that at a minimum, a programme must be economically accountable for operating costs incurred in service delivery. Only a few authors, however, such as Chau and Hu [37], can refer to routine funding of the telemedicine service. Such routines are however highly dependent on an evaluation of the telemedicine service with positive results.

Discussion

Introductory comments

We will now discuss our findings from the qualitative analysis, i.e. the typical characteristics of successfully implemented telemedical applications, in relation to the concept of 'social negotiation'. We begin with a general discussion of what type of negotiations the project managers have to deal with during the process of implementation. Then, a more detailed discussion of each of the categories presented in the results section, with an emphasis on categories number 4, 5, and 6, will follow. Thereafter, we will discuss some aspects of our method, and finally present our recommendations for how to proceed when planning to implement telemedicine in clinical practice.

The concept of 'Social negotiation' and the successfully implemented telemedical applications

When new technology is implemented, a controversy about which problems the technology is to solve as well as the ways in which they are to be solved will typically arise [17,18]. The various actors involved in implementation of the technology may have different perceptions of what the organizational challenges concern, what the solution should look like, and also whether an implementation is to be understood as a success or a failure. Technological success entails handling these controversies through social negotiations. Our research revealed that in clinical settings where telemedical applications are in routine use, such controversies have been handled through the phase of implementation. As telemedicine is a field of applications that

are not clearly defined at the outset [40], but need to be specially designed for use in different and particular medical specialities, this point is of special importance. In the studies of successful telemedical applications, the disagreements, concerns, and discussions are however not often described explicitly. Rather, there are descriptions of the problems that the technology is to solve, and the way in which the various actors have worked together throughout the implementation project precisely to reach an agreement on the way in which the technology can contribute to solving the problems. As the services have succeeded, we must assume that the actors in question have managed to reach agreement. That is, what we have seen in our study is that the applications and the fields of practice have been treated as dynamic units that have undergone a process of mutual adjustment, via the process of implementation. Alternatively, we can say that the project management to a great extent has accepted the inevitable uncertainty accompanying every technology implementation project, balanced carefully between initiating organizational change and drawing upon technologies as a change agent without attempting to pre-specify and control this process [19].

The characteristics of successfully implemented telemedical applications

Local service delivery problems are clearly stated and telemedicine is seen as a benefit (Categories 1 and 2)

Most of the studies of the successful telemedical applications have described how the applications are used to solve specific local problems of a medical, technical, or organisational type. As the types of problems in which telemedicine is seen as a solution vary much, we believe that telemedical applications may be of use in many, if not all, medical specialities. However, it seems to be a requirement for success that clinicians have recognised and identified a problem that should be addressed, and that they work together with IT-specialists in integrating the new technology in the established clinical, organisational, and technological systems.

Telemedicine is seen as a solution to political and medical issues (Category 3)

In addition to having seen telemedical applications as a solution to specific local problems (cf. Categories 1 and 2), successfully implemented telemedical applications have also typically been described as advantageous from a health policy or financial perspective. We believe that this indicates that many different people are involved when a telemedical application is implemented, and that the implementation process (and the subsequent description of the process) represents an effort to make the telemedical application valuable and attractive for all those involved.

There is collaboration between promoters and users (Category 4)

In the studies of telemedical application with success, we have identified three categories actors: 1) policy entrepreneurs, managers, and bureaucrats 2) the responsible actors, who are the project leaders, researchers, and designers 3) the users, who are the professionals and patients. The different actors have different perceptions of what telemedicine is, and whether an implementation is to be understood as a success or a failure [13]. In studies of telemedical applications with success we have seen how the actors, who are responsible for implementing the technology, have to balance the different perceptions during the process of implementation. For example,

while the policy entrepreneurs, managers, and bureaucrats understand telemedicine as a general technological solution to structural problems that affect access to health care, the project leaders, designers, and researchers, are made responsible for translating the optimistic expectancies into project descriptions, system ‘thinking’, and study protocols. However, in this detailed specification work, the project managers encounter other political expectations, namely expectations that the evidence base for a technology should act to discipline decisions about policy and public spending. The expectations automatically link evaluation and adoption of a technology, and in studies of successful telemedicine, we see the tie-in; all the studies reflect promises that evaluations will come, but first the activity in the service must increase. It is true that reference is made to some effects of the implemented technology, but according to the authors of the studies, it is not possible to make a general statement about the effects precisely because the technology has not been used a great deal in the phase during which it was implemented.

These promises of future evaluation studies reflect that the emphasis is on integrating the technology into various local practices, and not the accomplishment of randomized controlled trials. Consequently, the studies of successful telemedicine are often descriptions of the process of implementation of a telemedicine application, where it is the implementation itself that is emphasized and not the evaluation activity. We also believe that telemedical services in clinical use turn out to be more pragmatic and conventional solutions to health care delivery problems than the policy entrepreneurs and bureaucrats are proposing.

Thus, at the level of technical implementation, the project managers therefore encounter the expectations of the users of the new technology, not the policy makers or the bureaucrats. And, in most of the studies of successfully implemented telemedicine applications, we catch a glimpse of how the local service delivery problem, technical, and organisational structures are mutually shaped during the process of implementation. As mentioned above, we understand that such an approach has been at the expense of producing evidence of the effect of telemedicine. In these studies, the motivation for introducing telemedicine is not evidence of the effects of telemedicine per se. Rather, it is a central motivation to increase access to specialist competence. So, it seems that the project leaders balance the different perceptions of telemedicine by simply ignoring the policy entrepreneurs’ and the bureaucrats’ perception of telemedicine *in* the process of implementation. In the descriptions of the studies’ aims, however, it seems that they try to oblige them all. It is often unclear whether the intention is to describe the technical specification of the application, the research design and outcome of the application, or the teamwork in the field. The risk of not dedicating the study to one of the actors, or, to choose perspective, is that the descriptions of the themes become superficial. For the readers, whether it is health care professionals who encounter health delivery problems, managers who consider costs related to telemedicine, or project leaders who have become responsible for a telemedicine project, such studies are subsequently often of limited use.

Issues regarding organisational and technical arrangements are addressed and the future operation of the service is considered (Categories 5 and 6)

As we mentioned above, technology implementation presupposes a type of project management that carefully balances between initiating organizational change and drawing upon technologies as a change agent without attempting to pre-specify and control this process [19]. Such a form of project management is not explicitly described in the studies of successful telemedicine implementation, but we assume that it has been present, since the collaboration and the dialogue between clinicians and those with technical competence typically is described as close. The local clinical context in which the service is to function forms the point of departure for the dialogue, and the telemedical applications need to be adjusted to the local clinical needs. Nothing completely new is created, but parts of the activities and general technological possibilities of the local context are mutually formed and reformed in an open and dynamic teamwork relationship. This applies to the problem to be solved as well as to the methods of solving it. For example, in several of the studies, we see that the successful telemedicine application has been integrated and adapted to established telemedicine networks [27], or it is a further development of an established service [26]. This type of integration can be seen as a criterion for success, and it requires adequate cooperation between those involved. Cooperation and dialogue promote integration of the technology, but also users' acceptance of and familiarity with the technology. Thus, we can say that an adopted and integrated application is a feasible application.

In the studies, success relates to the implementation of the technology in a clinical setting, evidence that it functions effectively, and the clinicians' satisfaction with the technology. However, and because no evaluation results have been produced about its outcome during the implementation period, a paradoxical situation arises when the implementation is regarded as complete. This means that even though the implementation project itself is successful in the sense that it has resulted in a telemedical solution which is functional and adapted to its users, it becomes difficult to obtain support for further operation of the service because the positive experience cannot be documented. All the studies therefore end with a comment that more detailed evaluation will be undertaken in the near future. The service is regarded as stable, the activity is expected to grow, and this will make it possible to set up evaluation protocols based on the principle of randomized trials. The challenge is however to raise funds for further operation because no evaluation results are available. The result is that the activity in the application does not increase and the evaluation cannot be carried out. The outcome of this paradoxical situation is not described anywhere, but we believe that when such a situation occurs, the clinical involvement may disappear and a potentially successful service may be discontinued.

In all the studies of successful telemedicine, allowance is made for the fact that the operation of the service must be secured after the implementation activity itself is complete. Ways in which this is achieved include integrating the new application in established organizational structures as well as creating new ones. One of the new routines is the system for funding the service. However, only Dolittle [36], Chau and Hu [37] and Khoja et al. [38] refer to an agreement of this nature. We do not know whether this agreement is based on positive evaluation results. Neither do we know anything about how the other telemedicine success stories finance the operation of the service. This element is unfortunately not described in the studies.

Methodological issues

In the present study, we have carried out a qualitative analysis, drawing on principles from Grounded Theory (GT) [20,21,22,25]. Following the data analysis, we discussed the results in light of STS theory, particularly the concept of 'social negotiation'. While there clearly are different opinions and practices relating to the role of prior research and theory in carrying out GT research [41,42], we believe results obtained by means of GT work fruitfully may be seen in light of other theories, and that results from GT analyses fruitfully may be used to discuss other theories.

Few studies describe telemedicine services in routine operation. These studies also provide little information about the level of activity in the service when the article was written, and whether the service is in operation at present. In addition, it has been difficult to determine whether some of the studies are descriptions of successful development projects that have slid into a more or less continuous phase, or descriptions of successful implementations, so-called implementation projects. Especially has it been challenging to make this distinction if the development projects have continued over several years, where there has been a strong focus on the implementation issues, where the new service has been incorporated in established telemedicine networks, and efforts are made to boost the activity of the service precisely to make it possible to complete the process of evaluations. Examples of such studies are Moses et al. [29], Gray et al. [27] and LaMonte et al. [26]. Here, titles and abstracts may give the impression that they describe telemedicine programmes that have been implemented with the object of establishing a new service, which is a successful telemedical application. The content of the articles provides a picture of the way that the local health care service, the project and the technology have undergone changes precisely to get the service to function in practice and to be able to produce evaluation results. The articles conclude that there is a desire for these services in the clinical setting and further evaluations will be conducted so that the positive experience can be documented in a more scientific manner. In contrast, the word 'project' is used in the acknowledgements, and the authors of the articles thank those who have supported the project.

The criteria that we set up in our method intended to include only studies of telemedicine in routine operation, but because of the confusions discussed above, we have not been able to define our study unit precisely. It has been difficult to distinguish different forms of studies from each other and the studies mentioned in the discussion above, which *may be* considered as implementation projects, have been included.

Another methodological challenge is that we have only explored characteristics of telemedicine *with* success. That is, we do not know if studies of telemedicine *without* success have some of the same qualities.

Despite the methodological challenges and despite the scarcity of descriptions of successfully implemented telemedicine applications, we believe that it is possible to make some general statements about the features that characterize successful telemedicine services. The elements presented in Box 1 are general, and we have above shown how they are handled in the various studies of successful telemedicine. We believe our data suggest the notion that it is the local handling of these more

general issues that represents the real success factor. This is also discussed by Berg [19], Linderoth [40], and May et al. [12,13,14].

Recommendations

Telemedicine success is no simple matter. The factors presented in Box 1 may be involved in promoting success, but this success is largely dependent on the project management and the extent to which it has succeeded in handling these factors in each telemedicine project. The practical implication of such insight is that the project management of telemedicine implementation projects must receive more attention. It must be recognized that the mutual adaptation process between technology and problem solving is difficult to control, and the same applies to the outcome. As well as this recognition, it would be of great interest to obtain more research-based knowledge about the mutual adaptation process between technology and the clinical challenge, the way in which the process has been handled in each case, and the outcome of the approach followed.

Based on our work, we believe that more attention should be given to the differences between forms of projects and between projects and routine practice. Our impression is that the distinction between development projects and implementation projects is not seen as a problem, and is therefore not made explicit. By 'development project', we mean a project in which new technology is tried out in a clinical context. By 'implementation project', we mean a project in which established technology is tried out in a new clinical context. Development, implementation and evaluation will necessarily feature in both cases, but the emphasis is different. The sliding transition between project and routine merits further research and awareness.

Another issue which we feel should be discussed is the implication of this unclear relationship between project and routine for conducting evaluation studies while the projects are in progress, cf. our discussion above. The lack of evaluation studies may make it difficult to obtain support for further operation of the service. It thus becomes even more problematic to increase the activity in the service and thus produce results about its outcome. Therefore, we need to question the relationship between positive evaluations and the diffusion of telemedicine. Should the evaluation results be the only basis for decision making? No studies that we are aware of have investigated the relationship between positive outcomes of clinical trials and the will to use the service after the trial, nor has the opposite relationship been investigated.

Box 2. Recommendations

Conclusions

There have been great expectations for telemedicine, but implementation of the service has proven to be difficult, and it is not widely used. It is commonly suggested that the major reason for the low clinical use of telemedicine is the insufficient evidence of its efficacy in terms of both clinical and organizational impact in the health care sector. Without evidence of an effect, professional and political support for telemedicine cannot be sustained. However, during the last years, studies on 'organizational issues' have emerged in field of telemedicine and they state that the outcome of clinical trials does not tell the whole story about what is needed to make telemedicine systems and services work.

Our research is a contribution to this emerging literature, and by exploring studies of telemedical application with success, we have described conditions operating during the process of implementation, which are of importance for the outcome. That is, we asked what are the characteristics of telemedical services that have been successfully implemented in routine clinical practice. We found that local medical and health-related challenges which the various telemedical applications are intended to solve are clearly described and motivated. The teamwork between those who initiate the services and the fields of practice affected is close. The services and the fields of practice are treated as dynamic quantities that undergo a process of mutual adaptation via the introductory phase. The individual burdens that accompany such adaptation processes are recognized. The services are grounded in stable, but flexible organizational and technological structures. The need to secure the future operation of the services is also taken into account.

Our findings support the literature on ‘organisational issues’ which argue that technologies are not given entities moving from invention through diffusion and into routine use. That is, new technologies alone do not create change. Rather, it is the interplay between technical and social factors that produces particular outcomes. Organizational difficulties lie in the deep interrelationship of technical and social aspects of designing and implementing technologies. Conversely, success involves handling these complex, heterogeneous elements which are expressed in controversies and solved through social negotiation. Practical consequences of our research should be a recognition of the uncertainty that accompanies implementation of telemedicine, and more stringent requirements for competence in the discipline should be set for those who are to manage such projects. More research on the complex conditions that arise when technology is introduced should be encouraged. Last, but not least, a debate should be initiated in the professional telemedicine community about whether the evaluation result of outcome studies should be the only criterion for introducing telemedicine in routine operation.

Competing interests

The authors have no competing interests.

Authors’ contributions

AO and KHE have been involved in all stages of the research process.

RW has been involved in all stages of the research process except in the initial stage, when the idea was developed and the data were collected.

Acknowledgements

The work upon which this article is based was supported by the Northern Norway Regional Health Authority and the Norwegian Research Council (KIM and FRIHUM programmes).

References

1. Heath C, Luff P, Svensson M: **Technology and medical practice.** *Sociol Health Illn* 2003, 25: 75-97.
2. Wajcman J: *Techno Feminism.* Cambridge: Polity Press; 2005.
3. Stalder F: *Manuel Castells.* Cambridge: Polity Press; 2006.
4. Beach M, Miller P, Goodall I: **Evaluation telemedicine in an accident and emergency setting.** *Comput Methods Program Biomed* 2001, 64: 215-23.
5. May C, Gask L, Atkinson T, Ellis N, Mair F, Esmail A: **Resisting and promoting new technologies in clinical practice: the case of telepsychiatry.** *Soc Sci Med* 2001, 52: 1889-901.
6. Lehoux P, Sicotte C, Denis JL, Berg M, Lacroix A: **The theory of use behind telemedicine: how compatible with physicians' clinical routine?** *Soc Sci Med* 2002, 54: 889-904.
7. Nicolini D: **The work to make telemedicine work: A social and articulative view.** *Soc Sci Med* 2006, 62: 2754-67.
8. May C, Finch T, Mair F, Mort M: **Towards a wireless patient: Chronic illness, scarce care and technological innovation in the United Kingdom.** *Soc Sci Med* 2005, 61: 1485-94.
9. Hersh WR, Helfand M, Wallace J, Kraemer D, Patterson P, Shapiro S, Greenlick M: **Clinical outcomes resulting from telemedicine interventions: A systematic review** *BMC Med Inform Deci Mak* 2001, 1:5.
10. Roine R, Ohinmaa A, Hailey D: **Assessing telemedicine: a systematic review of the literature** *CMAJ* 2001, 165: 765-71.
11. Wootton R, Herbert MA: **What constitutes success in telehealth?** *J Telemed Telecare* 2001, 7 Suppl 2: 23-7.
12. May C, Harrison R, Finch T, MacFarlane A, Mair F, Wallace P: **Understanding the normalization of telemedicine services through qualitative evaluation.** *J Am Med Inform Assoc* 2003, 10: 596-604.
13. May C, Mort M, Williams T, Frances M, Gask L: **Health technology assessment in its local contexts: studies of telehealthcare.** *Soc Sci Med* 2003, 57: 697-710.
14. May, C: **A rational model for assessing and evaluation complex interventions in health care.** *BMC Health Serv Res* 2006, 6:86.
15. Harrison R, MacFarlan A, Wallace P: **Implementation of telemedicine: the**

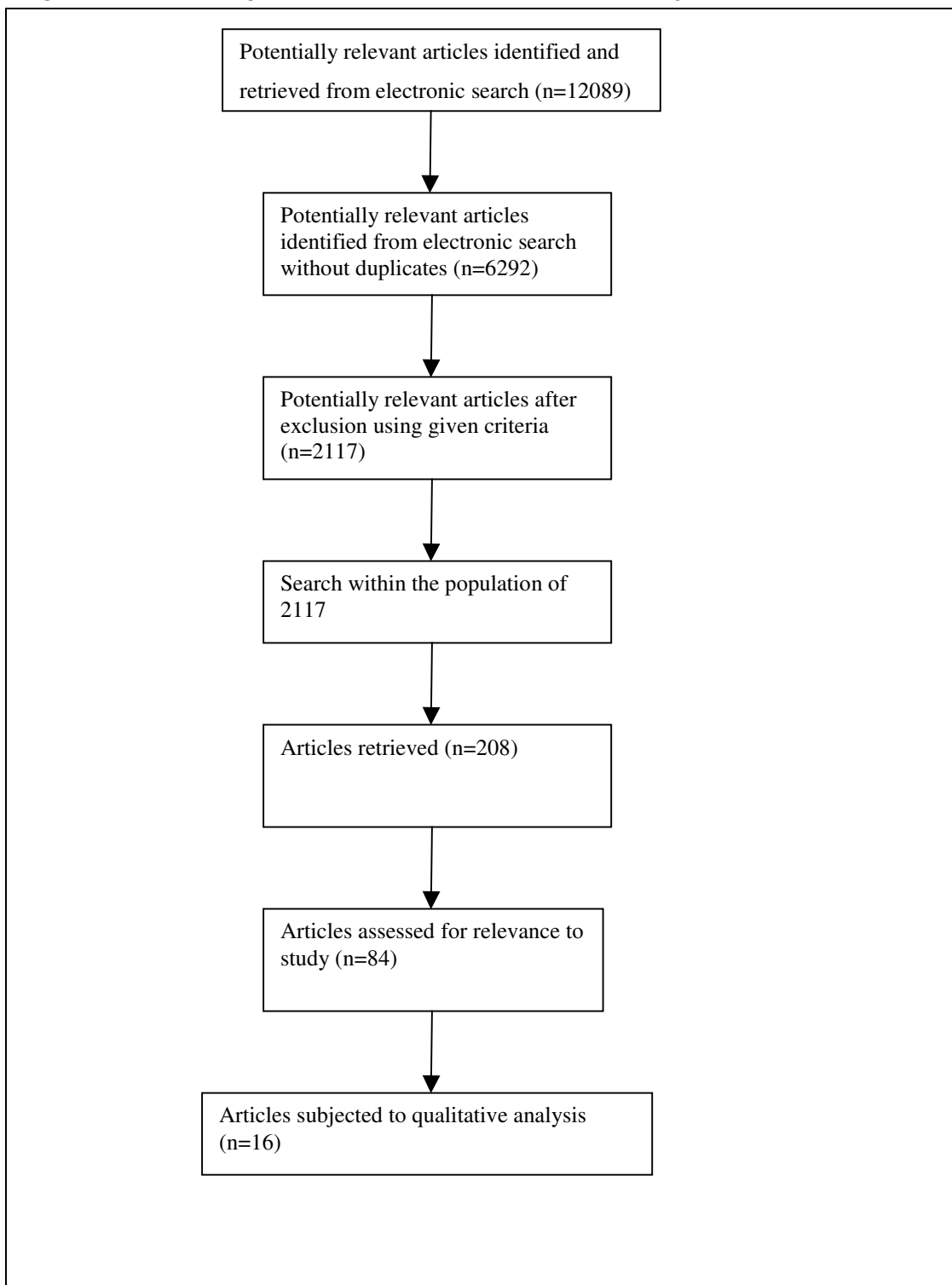
- problem of evaluation.** *J Telemed Telecare* 2003, 8 Suppl 2: 239-40.
16. Gagnon M-P, Lamothe L, Fortin J-P, Cloutier A, Godin G, Gagné C, Reinharz D: **The impact of organisational characteristics on telehealth adoption by hospitals.** *Proceedings of the 27th Hawaii International Conference on System Sciences*; 2004.
 17. Bijker W, Law J: *Shaping technology building society: studies in sociotechnical change.* Cambridge, MA: MIT Press; 1992.
 18. Bauchspies WK, Croissant J, Restivo S: *Science, technology and society. A sociological approach.* Oxford: Blackwell Publishing; 2006.
 19. Berg M: **Implementing information systems in health care organizations: myth and challenges.** *Int J Med Inform* 2001, 64:143-56.
 20. Glaser BG, Strauss AL: *The Discovery of Grounded Theory: Strategies for Qualitative Research.* Chicago, Aldine Publishing Company; 1967.
 21. Malterud K: **Qualitative research: standards, challenges, and guidelines.** *Lancet* 2001, 358: 483-8.
 22. Guest G, Bunce A, Johnson L: **How many interviews are enough?: An experiment with data saturation and variability.** *Field Methods* 2006, 18: 59-82.
 23. Mair F, Whitten P: **Systematic review of studies of patient satisfaction with telemedicine.** *BMJ* 2000, 320: 1517-20.
 24. Miller WL, Crabtree BF: **Clinical research: a multimethod typology and qualitative roadmap.** In: *Doing qualitative research.* Edited by Crabtree BF and Miller WL. Thousand Oaks: Sage Publications 1999, 3-30.
 25. Wynn R: **Psychiatric inpatients' experiences with restraint.** *J Forensic Psychiatr Psychol* 2004, 15: 124-144.
 26. LaMonte M, Bahouth MN, Hu P, Pathan MY, Yarbrough KL, Gunawardane R, Crarey P, Page W: **Telemedicine for acute stroke. Triumphs and pitfalls.** *Stroke* 2003, 34: 725-8.
 27. Gray J, Pompilio-Weitzner G, Jones PC, Wang Q, Coriat M, Safran C: **Baby CareLink: Development and implementation of a WWW-based system for neonatal home telemedicine.** *Proc AMIA Symp* 1998, 351-5.
 28. Ono CM, Lindsey JL: **Shriners Hospitals for Children, Honolulu's experience with telemedicine: program implementation, maintenance, growth, and lessons learned.** *Hawaii Med J* 2004, 63: 296-9.

29. Moses PL, McGowan JJ, Ricci MA: **Efficacy of tele-endoscopy in a rural capitated market.** *Proc AMIA Annu Fall Symp* 1997, 398-402.
30. Gulube S, Wynchank S: **Telemedicine in South Africa: success or failure?** *J Telemed Telecare* 2001, 7 Suppl 2: 247-9.
31. Chan FY, Soong B, Watson D, Whitehall J: **Realtime fetal ultrasound by telemedicine in Queensland. A successful venture?** *J Telemed Telecare* 2001, 7 Suppl 2: 27-11.
32. Lawton S, English J, McWilliam J, Wildgust L, Patel R: **Development of a district-wide teleradiology service.** *Nurs Times* 2004, 100: 38-41.
33. DiLieto A, Giani U, Campanile M, De Falco M, Scaramellino M, Papa R : **Prenatal telemedicine: clinical experience with conventional and computerised antepartum telecardiotocography** *Eur J Obstet Gynecol Reprod Biol* 2002, 103: 114-8.
34. Lin C-C, Chen H-S, Chen C-Y, Hou S-H: **Implementation and evaluation of a multifunctional telemedicine system in NTUH.** *Int J Med Inform* 2001, 61: 175-87.
35. Urness DA: **Evaluation of a Canadian telepsychiatry service.** *Stud Health Technol Inform* 1999, 64: 262-9.
36. Doolittle GC: **Telemedicine in Kansas: The successes and the challenges.** *J Telemed Telecare* 2001, 7 Suppl 2: 243-6.
37. Chau P, Hu P J-H: **Technology implementation for telemedicine programs.** *Comm ACH* 2004, 47: 87-92.
38. Khoja S, Casebeer A, Young S: **Role of telehealth in seating clinics: a case study of learners' perspectives.** *J Telemed Telecare* 2005, 11: 146-9.
39. Kavanagh S, Hawker F: **The fall and rise of the South Australian telepsychiatry network** *J Telemed Telecare* 2001, 7 Suppl 2: 41-3.
40. Linderoth H: **Managing telemedicine: from noble ideas to action.** *J Telemed Telecare* 2002, 8: 143-150.
41. McLeod J: *Qualitative research in counseling and psychotherapy.* London: Sage Publications; 2001.
42. Martin PY, Turner BA: **Grounded theory and organizational research.** *J Appl Behav Sci* 1986, 22: 141-57.

43. Johnson L: **Utah Deaf Videoconferencing Model: Providing vocational services via technology.** *J Rehabil* 2004, 70: 33-7.
44. Schneider NM: **Managing congestive heart failure using home telehealth.** *Home Healthc Nurse* 2004, 22: 719-22.

Figures

Figure 1. Selection process for studies included in analysis



Box 1. Criteria for success of telemedical applications

Criteria for success
1) Local health care service delivery problem is clearly stated An effort is made to describe the local health-related challenges that the technology is intended to solve
2) Telemedicine is recognized as a benefit A telemedical application is seen as a potential solution to the challenge (cf. Criterion 1)
3) Telemedicine is seen as a solution to medical and/or political issues Equal access to health care is often a major concern, justifying the implementation of telemedicine
4) There is collaboration between promoters and users Successful implementation depends on teamwork, involving the initiators of the technology as well as the managers, clinicians, and patients
5) Issues regarding organisational and technical arrangements are addressed Successful implementations are often characterised by a sound anchoring in established organisations and technical structures, or by the establishment of new structures
6) The future operation of the service is considered Plans for future use and for future financing are important to success

Box 2. Recommendations

Recommendations
Recognize that implementation of telemedicine is challenging Success involves handling complex, heterogeneous criteria which are expressed in controversies and solved through social negotiation (cf. Box 1)
Pay more attention to project management Uncertainty and dilemmas accompanies implementation of telemedicine, and requirements for competence in the discipline should be set for those who are to manage implementation projects
Recognize the relationship between development and routine use as vague and incomplete

<p>The accomplishment of evaluation studies while the implementation is in progress is difficult. A debate should be initiated about whether evaluation results should be the only criterion for making decision about future operation of a telemedical service/introducing telemedicine in routine operation</p>
<p>Encourage studies of implementation processes</p> <p>More research on the complex conditions that arise when technology is introduced is needed</p>
<p>Encourage studies of telemedicine in routine practice</p> <p>More research is needed on characteristics of telemedicine in routine use, on the relationship between development and routine use of an application, and between positive outcomes of clinical trials and the will to use the application after the trial</p>

Additional files provided with this submission:

Additional file 1: appendixlandskapfinalmai.doc, 70K

<http://www.implementationscience.com/imedia/5483170101448990/supp1.doc>