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Three essays on the transformative role of IT in healthcare : the case of telepathology

par
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Résumé

Les technologies de l'information (TI) pénètrent de plus en plus le secteur de la santé, avec le potentiel d'améliorer de manière substantielle les façons dont les soins de santé sont prodigués aux patients. La télépathologie, consistant en la pratique de la pathologie à l'aide d'images numériques, est une forme particulière de télémédecine et l'une de ces innovations radicales. La majorité des études publiées sur le sujet se sont portées sur les questions techniques relatives aux solutions matérielles adoptées et la qualité des diagnostics, mais peu de travaux de recherche ont porté sur la nature et l'étendue des changements et impacts associés à l'utilisation de la télépathologie. La télépathologie engendre en effet de nouvelles possibilités, comme une plus grande accessibilité aux services médicaux spécialisés, mais crée aussi de nouveaux besoins.

L'objectif premier de cette thèse par article est d'approfondir notre compréhension des transformations associées à l'utilisation d'une forme particulière de télémédecine, soit la télépathologie. Le premier article est une revue de cadrage. Cette recension des écrits porte sur les impacts et défis d'implantation associés à la télépathologie, et fait ressortir d'une part la nécessité de contextualiser l'évaluation des impacts de la télépathologie et, d'autre part, les défis humains, organisationnels et légaux associés à l'implantation de cette innovation technologique dans le secteur de la santé.

Les deux autres articles sont articulés autour d'un ambitieux projet de télépathologie destiné à mettre en réseau plus de 17 établissements de santé au Québec. Le deuxième article, qui s'appuie sur une étude de cas de type positiviste, évalue la nature et l'étendue des impacts générés par l'utilisation de la télépathologie au sein de cet important réseau. En matière de collecte de données, nous avons eu principalement recours à des entrevues semi-structurées. 43 entrevues en profondeur ont été menées auprès de pathologistes, technologistes, chirurgiens et administrateurs. En complément, nous avons recueilli des données quantitatives sur le système de télépathologie, son utilisation et les délais de traitement. Nos résultats indiquent que l'objectif d'assurer des services d'examens extemporanés en tout temps au sein des établissements requérants a été atteint. Toutefois, plusieurs défis humains, organisationnels, normatifs et législatifs doivent être relevés afin de généraliser les bénéfices de la télépathologie. L'étude précise également les conditions de succès d'une telle initiative.

Le troisième article s'intéresse aux effets micro de la télépathologie. Il porte sur les pratiques de travail des professionnels de la santé, et analyse comment leurs pratiques de coordination évoluent suite à l'introduction de la technologie. Les résultats suggèrent des changements dans trois aspects des pratiques de coordination, soit : la prévisibilité des tâches coordonnés repose moins sur les routines, et plus sur des plans et règles formels; la compréhension commune entre acteurs repose elle plus sur des normes et moins sur la familiarité entre intervenants; et l'imputabilité des tâches évolue. L'introduction de la télépathologie est ainsi associée à une clarification des frontières entre professions, l'imputabilité devenant moins collective et plus individuelle et contractuelle. Enfin, le rôle de la proximité contribue à déterminer l'imputabilité, même dans les contextes de télépathologie.

Mots clés : télépathologie, informatique médicale, coordination, transformation, impact, implantation, pratiques de travail

Méthodes de recherche : Revue de littérature, étude de cas, recherche qualitative

Abstract

Information technology has disrupted multiple industries and is becoming increasingly prevalent in healthcare, with the potential to significantly improve how care is delivered to patients. Telepathology, the practice of pathology using digital images, is a form of telemedicine and one of these radical innovations. While most studies on the topic address technical aspects of hardware and software configurations, or the issue of accurate diagnoses, few empirical studies have addressed the nature and the extent of the transformations associated with the use of telepathology in healthcare settings. Telepathology generates new possibilities in care, such as greater accessibility to specialized medical services. It also creates new needs and constraints, such as training personnel to scan slides and to manipulate large specimens previously handled by pathologists.

The first objective of this three essay thesis is to expand the knowledge base of the transformations associated with the adoption of telepathology. The first essay is a scoping review of the impacts of telepathology and its implementation challenges. The essay highlights the need to contextualize the impacts of telepathology, and to differentiate implementation challenges at the human, organizational and legal levels.

The other two essays focus on a large-scale telepathology project whose aim was to connect 17 sites in Eastern Canada. The second essay is a positivist case study that assesses the nature of and the extent of the impacts of the deployment of telepathology. Data was collected through 43 in-depth interviews with pathologists, surgeons, technologists and administrators involved in the project. The study also quantitatively assesses the use of and the delays associated with the telepathology system. The study's findings suggest that the objective of ensuring continuous availability of intraoperative consultation services in referring sites was reached. However, there were several human, organizational and legal challenges to extending these benefits across the whole network. This case study also uncovers some of the conditions necessary for success of complex telepathology initiatives.

The third article addresses micro-level effects of telepathology. It focuses on the work practices of telepathology stakeholders, and analyzes how coordination practices evolve following the introduction of this form of telemedicine. Results highlight shifts in three major aspects of coordination practices, namely: the predictability of coordinated tasks shifts from relying on routines to relying more on formal plans and rules; common understanding is based more on standards than on familiarity among stakeholders; and stakeholders' task accountability evolves. The introduction of telepathology is associated with a clarification of boundaries between professions, as accountability becomes less collective and more individual and contractual. The role of proximity in determining accountability remains important, even in telepathology settings.

Keywords : telepathology, healthcare informatics, coordination, transformation, impacts, implementation, work practices

Research methods : Literature review, case study, qualitative research

Table of Contents

List of tables and figures

List of acronyms

IT : Information technology

IOC : Intraoperative consultation

RUIS Laval: Réseau universitaire intégré de santé de Laval

À Inês, Alice et David,

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Introduction

Understanding the impacts and transformations generated by information technology is one of the major objectives of information systems research. Notably, health care organizations have been and continue to be transformed by information technology. The first waves of change were mainly digitized ancillary, non-clinical tasks, such as pay, billing or patient admissions. More recently, digitization has started to reach clinical activities and processes, the core business of health care institutions, changing how care is provided to patients, and transforming the dynamic capabilities of healthcare organizations (Singh et al. 2011). The promises of these new technologies are significant, such as facilitating the continuum of care, reducing medical errors and duplications of tests and procedures, and ensuring timely access to information for clinicians (Paré, 2006; Lucas Jr et al. 2013). The development of telemedicine has widespread effects. Telemedicine is economically significant as its market is forecasted to grow to $43.4 billion worldwide in 2019 (BCC Research 2014). Telemedicine has also changed the nature of health care services, allowing new kinds of services, such as home telemonitoring or medical centers specialized on serving distant patients. This thesis investigates a particular and emerging form of telemedicine known as telepathology. Telepathology can be defined as the practice of pathology using digital images (Williams et al. 2010).

The opportunity to access an exceptional field, as part of a research study sponsored by Canada Health Infoway, was the impetus for this thesis. The setting of this thesis was the implementation of a telepathology system in the Réseau Universitaire Intégré de Santé de l'Université Laval (RUIS Laval), a health administration area in Eastern Quebec. The purpose of this large scale project, the biggest in Canada and one of the biggest in the world at the time of implementation, was to facilitate communication between pathologists and other clinicians across a region with large swathes of sparsely populated areas. Ultimately, the goal was to ensure universal and immediate access to pathology services. This goal implies that major transformations in the healthcare system need to take place at different levels. For example, transitioning from looking at glass slides through a microscope to viewing digital slides on a computer greatly alters the material dimension of the pathologists' diagnosis practice. This transition also involves adapting the technical and organizational structures of care delivery to ensure the coordination of distant organizations and people.

Like other information technologies, such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems, telepathology is an example of "radical" innovation (Carlo et al. 2012) associated with significant transformations of organizations and work practices. Telepathology may mean organizational changes, such as the closing of laboratories, the abolishment of organizational boundaries (Aas 2001; Cornish et al. 2012), and the standardization of work practices (Dietel et al. 2000). These changes are supposed to have a positive impact on patient care and on healthcare network efficiency, but the role of technology is entangled with that of human agency (Orlikowski 2010). The overarching purpose of this thesis is to explore the transformative role of telemedicine, by focusing on the case of telepathology and the transformations it enables. It explores the extent to which proposed benefits are actually achieved, transformations at the organizational and at the global health levels (macro-level perspective), and the impact on the work practices of the stakeholders involved (micro-level perspective).

Theoretical framework

This thesis consists of three essays. The first one is a literature review that highlights a rich body of literature on telepathology, mostly conducted by medical and health informatics researchers. These studies mostly address two issues, a technical one, the hardware and software configurations required for telepathology projects, and a clinical one, the accuracy of diagnoses in a telepathology context. As these issues do not focus on information systems, this highlights a gap in knowledge in telepathology and an area of potential interest for scholars. An initial investigation revealed that studies in informational systems are both less numerous than clinical or health informatics studies, and more diverse in terms of research questions and methods, resulting in a less cumulative research body. Thus, a scoping review on telepathology's impacts and implementation challenges was appropriate. A scoping review is a particular type of literature review that aims to map key issues underpinning a research topic (Arksey and O'Malley 2005). The implications of this review have two outcomes. First, it acts as a point of reference providing clear indications for future research on telepathology. Second, it illustrates the utility of scoping reviews to the fields of health informatics and information systems. The scoping review and its resulting paper were disseminated in both clinical and information system research fields. A paper, based on the scoping review, was presented during the Hawaii International Conference on System Sciences (Meyer and Paré 2014). An extended version of the paper was published in the Archives of Pathology & Laboratory Medicine (Meyer and Paré 2015).

Canada Health Infoway, the federal organization whose mission is to finance and coordinate the development, adoption and effective use of digital health solutions across Canada, sponsored an expert report on the implementation of RUIS Laval telepathology project, and the second paper of this thesis is based in-part on work from this report. The telepathology network, implemented in late 2010, connects 17 hospitals and provides health care services over a territory the size of Germany, but is inhabited by only 1.7 million people (19% of Quebec population). The population density of this region varies with a densely populated urban centre with a university hospital, and sparsely populated remote areas served by small regional hospitals. The DeLone and McLean (1992, 2003)'s framework of information systems success is applied to identify and evaluate the effects of this project. It is a framework well established in the field of information systems, but rarely used in the context of telemedicine projects. The study uses indicators developed for telepathology by an expert panel (Canada Infoway, 2012). It is a positivist case study (Dubé and Paré 2003) that combines qualitative (47 interviews) and quantitative (data from diverse clinical and administrative systems) data. The Canada Health Infoway report draws a rich and nuanced picture of the reality of a telepathology project (Paré et al. 2013). Not only are there levels of variations in its use, there are also benefits and drawbacks for users and organizations. The report was favorably received by Canada Health Infoway decision-makers. In terms of contribution to research, it contributes to research. It methodological focus on clinical and economic benefits, both perceived and realized, makes it possible to contextualize the theoretical potential of telepathology suggested in the extant literature. For instance, the usefulness of telepathology is evaluated by stakeholders in light of the alternatives: the prospect of losing all access to intraoperative consultations makes telepathology appealing to surgeons, but even partial solutions such as a part-time pathologist makes telepathology much less crucial. The evaluative expert report was submitted to Canada Health Infoway in August 2013. It is intended for a non-academic audience of decision-makers, and some of its recommendations related to the governance of telepathology projects were communicated to the Collège des Médecins du Québec. An article based on this report was published in Revue Gestion (Meyer et al. 2014), as part of a special issue on health care. In addition to interest by practitioners, this study also drew interest from researchers. An academic paper was published in Telemedicine and eHealth (Paré et al. 2016), and some of its results were integrated to peer-reviewed journals, namely Diagnostic Pathology (Têtu et al. 2014) and Diagnostic Histopathology (Têtu et al. 2014).

The empirically-based second paper raised multiple questions, leading to the genesis of the third essay. The extent of use, but also the nature of work practices associated to telepathology, varied significantly. The methodological approach of essay two is appropriate for measuring clear and stable success factors, but less appropriate for explaining emerging transformations associated to the introduction of the technology. The possibilities, constraints, and meanings given to telepathology are constructed differently by the different stakeholders and institutions involved. Telepathology radically transformed how diverse stakeholders, including physicians from different specialties, nurses and technicians, coordinated their work. Real-time coordination of intraoperative consultations is a complex and high risk process, as it happens while surgeries are taking place. This complexity is compounded when coordination unfolds at a distance under technological constraints. To account for these transformations and differences in coordination practices, a different theoretical and methodological approach, focused on work practices, was needed. Thus, the objective of the third essay was to explain the transformations in coordination practices associated with the introduction of telepathology. From a methodological standpoint, 60 interviews of stakeholders from 14 different hospitals were conducted. Following the principles of explanatory positivist case studies (Dubé and Paré 2003; Paré 2004), the focus was put on understanding the coordination mechanisms unfolding during two major forms of telepathology usages, namely, intraoperative consultations and expert opinions. Coordination practices were analyzed both in a traditional context and in a telepathology context, and then let inductively emerge theoretical propositions as to the nature of these transformations. These propositions point to four transformations in how coordination is achieved. First, the introduction of telemedicine leads to a shift from routines to formal plans and rules to create the predictability necessary to coordinate effectively. Second, telemedicine leads to a shift from a reliance on familiarity to an emphasis on standard protocols to ensure common understanding among stakeholders. Third, while coordinating, greater importance is given to local than to distant accountabilities. Finally, telemedicine-based coordination renders accountability less collective and more individual than in a traditional work environment. A preliminary version of the third essay was accepted for presentation at the Hawaii International Conference on System Sciences to be held in 2017.

Overall, this thesis is diverse in its form, as it is composed of a stand-alone literature review, an evaluative study combining qualitative and quantitative approaches, and a study aimed at theory development. It addresses an important, yet under-investigated theme, that is, the transformative role of telemedicine.

Chapter 1
Essay 1: Telepathology Impacts and Implementation Challenges: A Scoping Review

Abstract

Telepathology is a particular form of telemedicine which fundamentally alters the way pathology services are delivered. Prior reviews in this area have mostly focused on two themes, namely, technical feasibility issues and diagnosis accuracy.

The purpose of this review is to synthesize the literature on telepathology implementation challenges and broader organizational and societal impacts and to propose a research agenda to guide future efforts in this domain.

Two complementary databases were systematically searched: MEDLINE (Pubmed) and ABI/INFORM (ProQuest). Peer-reviewed articles and conference proceedings were considered. The final sample consisted of 159 papers published between 1992 and 2013.

This review highlights the diversity of telepathology networks and the importance of considering these distinctions when interpreting research findings. Various network structures are associated with different benefits. While the dominant rationale in single site projects is financial, larger centralized and decentralized telepathology networks are targeting a more diverse set of benefits, including extending access to pathology to a whole region, achieving substantial economies of scale in workforce and equipment and improving quality by standardizing care. Importantly, our synthesis reveals that the nature and scale of encountered implementation challenges also vary depending on the network structure. In smaller telepathology networks, organizational concerns are less prominent, and implementers are more focused on usability issues. As the network scope widens, organizational and legal issues gain prominence.

1.1 Introduction

Telepathology is defined by the American Telemedicine Association as "the electronic multimedia communication across a network of pathology-related information, between two or more locations for use-cases between pathologists and/or qualified laboratory personnel, and may include involvement by clinicians and/or patients."(Clinical Guidelines for Telepathology 2014).This particular form of telemedicine has several applications. First, a distant pathologist can provide a primary diagnosis to a site with no pathologist. Within that category, intraoperative examination enables a diagnosis to be provided immediately during surgery. Second, a pathologist can request a second opinion from a distant colleague for a complex or ambiguous case, or an expert referral from a subspecialist. Third, other telepathology applications include quality assurance, education, and research. Telepathology is a rapidly growing segment of the telemedicine field. The global telepathology market totaled nearly \$2.1 billion in 2012. According to a recent report, this market is expected to grow at a compound annual growth rate of 14.7% from \$2.2 billion in 2013 to nearly \$4.5 billion in 2018 (Global markets for telemedicine technologies 2012)

Prior research on telepathology has focused on two important themes. The first concerns technical feasibility issues such as image quality, bandwidth, hardware selection, and information technology (IT) architecture (Garcia Rojo et al. 2009; Park et al. 2012).The second theme refers to diagnosis accuracy, that is, "how accurate are all diagnoses made via telemedicine, and how does this level of accuracy compare with diagnoses made through conventional medical care."(Grigsby et al. 1995).This stream of research suggests that telepathology diagnoses are acceptable, although no systematic reviews have been identified (Evans et al. 2009),(Kayser 2012).See the study by Weinstein et al for a summary (Weinstein et al. 2001).

While deepening our knowledge on these two topics remains important, we believe that non-technical issues deserve more attention. A recent survey of IT practitioners by the Gartner Group suggests that technical skills were the main source of failure in less than

1% of IT projects versus 78% for organizational skills (Mieritz 2013).And in the particular context of telepathology, Furness and Bamford noted that "as technology advances, and as prices fall, the main barrier to implementation is increasingly a resistance to change amongst the humans rather than the limitation of the machines."(Furness and Bamford 2001)

Telepathology more than other forms of telemedicine involves radical changes in workflows, clinical processes and professional responsibilities. Unlike most forms of telemedicine, telepathology does not require the patient's presence, which makes it a more dematerialized and frequently asynchronous form of telemedicine. Teleradiology, telepathology's close cousin, does not require the patient's presence either, but radiologists' transition to digital perpetuates their practice of working with digital images, while pathologists traditionally examine physical artifacts. Tellingly, the physical slide still retains legal value and must be examined and archived in most jurisdictions. The transition to telepathology thus adds extra steps to the process and involves laboratory technicians performing tasks previously devolved onto pathologists, such as manipulating large pieces of tissues and specimens.

In light of the above, the primary objectives of this review article are twofold. We aim to synthesize the extant literature on the implementation challenges and impacts of telepathology and to propose a research agenda to guide future efforts in this domain. The remainder of this article is structured as follows. In the next section, the methods that guided the review process are detailed. Next, we present the profile of the studies included in our sample, and the main findings that emerged from a thematic analysis. In the discussion section, we propose a research agenda to orient future efforts in this growing field.

1.2 Materials and Methods

Scoping reviews aim to map the key issues underpinning a research topic and the main sources and types of empirical evidence available (Arksey and O'Malley 2005),(Levac et al. 2010).They usually focus on breadth rather than depth of analysis, and their main strengths "lie in [their] ability to extract the essence of a diverse body of evidence and give meaning and significance to a topic that is both developmental and intellectually creative."(Davis et al. 2009).Two complementary databases were searched: MEDLINE (Pubmed) and ABI/INFORM (ProQuest). The following keywords were used: telepathology, digital microscopy, virtual microscopy, distance pathology, digital macroscopy, digital pathology, digital slide, virtual slide and whole slide imaging. Only peer-reviewed articles and conference proceedings were considered. MEDLINE and ABI/INFORM returned 1,248 and 167 papers, respectively. As mentioned earlier, our focus was on telepathology implementation challenges and impacts; hence, we excluded papers focusing on technical feasibility and diagnostic accuracy issues. As shown in Figure 1, the final sample consisted of 159 relevant papers published between 1992 and January 2013.

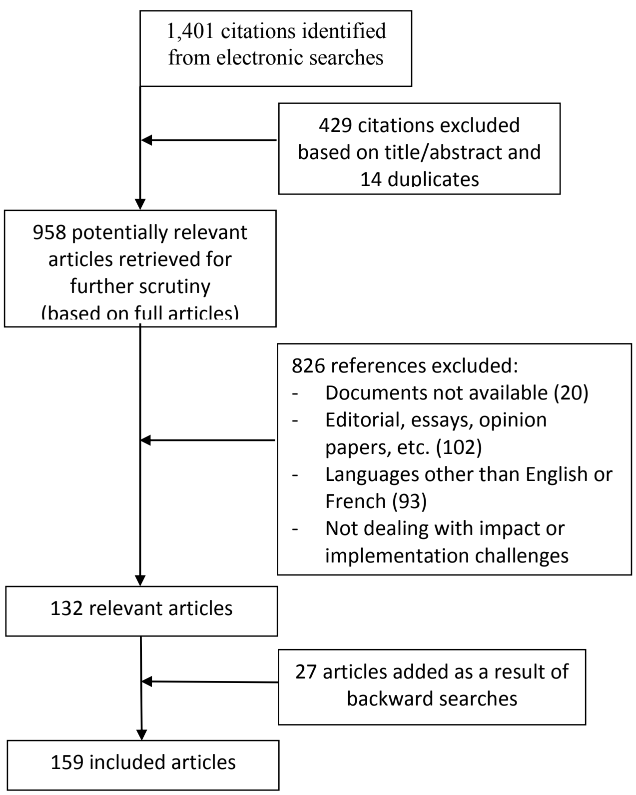

Figure 1. Diagram of study selection process

Data charting refers to a technique for synthesizing and interpreting qualitative data by sifting, charting and sorting material (Ritchie and Spencer 2002).In this review, the first author coded all 159 articles using a reference management software. The coding scheme was designed a priori to cover the objectives, methods, context and nature of the papers. However, as Levac et al note, in scoping studies "the nature and extent of data to extract from included studies is unclear."(Levac et al. 2010).Therefore, following their recommendation, both authors modified iteratively the coding scheme to embrace field diversity rather than to reduce it. The studies included in our final sample are listed in the online Appendix.

Table 1. Profile of the sample

Category	Value	n (%)
Year	1992 – 1998	22 (14%)
	1999 – 2005	55 (35%)
	2006 – 2013/01	82 (52%)
Digital pathology application	Diagnosis (primary or secondary)	84 (53%)
	Overview of applications or unspecified	42 (26%)
	Education	18 (11%)
	Other (quality assurance, conferences, research, aids to diagnosis)	15 (9%)
Type of article	Conceptual papers	60 (38%)
	Descriptive case studies	54 (34%)
	Evaluative studies	45 (28%)
Total		**159 (100%)**

1.3 Results

1.3.1 Profile of the Primary Studies

As shown in Table 1, interest in managerial telepathology research has risen steadily, with 22 (14%) of the papers in the sample published between 1992 and 1998, rising to 55 (35%) during the 1999-2005 period and progressing to 82 (52%) between 2006 and early 2013. Publication outlets are diverse, with papers in our sample published in 64 distinct outlets, mostly in pathology (72, 46% of papers) and medical informatics (60, 38%) peer-reviewed journals. The topics addressed in those two parent disciplines are roughly similar in terms of frequency, suggesting the interdisciplinary nature of the topics and the relevance of a scoping review to synthetize the extant literature.

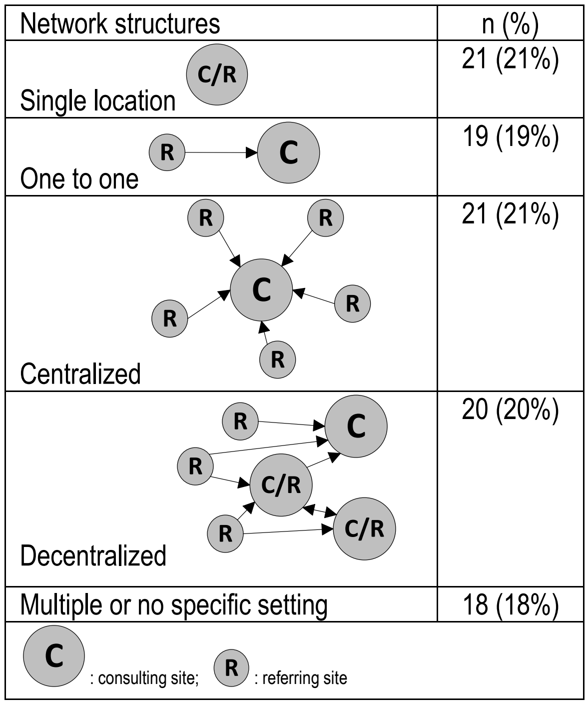

Figure 2. Profile of telepathology network structures in various settings

The diversity of the sample is revealed by several indicators. First, only 84 (53%) of the papers specifically focus on a context where telepathology is used for diagnoses (the sample did not allow a reliable distinction between primary and secondary diagnosis). A significant portion of the papers (42, 26%) address multiple or unspecified forms of telepathology applications, suggesting that even telepathology managerial research remains often driven by the telepathology artifact rather than by its purposes. Second, the nature of scientific evidence also varies widely as shown in Table 1. For one thing, 60 (38%) of all papers included in our sample are conceptual, with no original empirical data. Further, 54 (34%) are descriptive case studies, providing an account of a telepathology project and the lessons and observations derived from it, typically with no specific research question being addressed. The relative importance of this group illustrates the still exploratory nature of managerial telepathology research. Last, we count 45 (28%)

evaluative studies which assess one or several aspects of telepathology in healthcare organizations.

Out of the 99 empirical papers, 42 (46%) do not explicitly describe the source of the evidence presented, especially in descriptive case studies, where knowledge usually stems from the authors' first-hand involvement in the project. Evaluation studies more systematically embrace a specific investigation method, with researchers using quantitative data, mostly from surveys, in half of the papers. The sample remains also largely atheoretical, with only seven papers explicitly applying theories or conceptual models. For instance, Delone and McLean's IT success model was used to investigate technology impacts;(Trudel, Paré, Têtu, et al. 2012) while the Technology Acceptance Model (TAM) helped explain telepathology adoption among pathologists (Djamasbi et al. 2009).For its part, the theory of knowledge barriers was used to deepen our understanding of telepathology implementation challenges (Tanriverdi and Iacono 1999).

Table 2. Number of articles referring to digital pathology impacts and challenges (n=159)

Impacts		Implementation challenges	
Categories of impacts	**n (%)**	**Categories of Barriers**	**n (%)**
Accessibility of care	35 (22%)	Individual	65 (41%)
Quality of care	18 (11%)	Organizational	38 (24%)
Efficiency	52 (33%)	Legal	45 (28%)
Educational outcomes	18 (11%)		
Healthcare structure	54 (34%)		

Of utmost interest, diverse telepathology network structures emerged from our sample as shown in Figure 2. In single location projects, slides are digitized for local use only. Most of these projects are educational telepathology, generally in teaching hospitals (Szymas and Lundin 2011). Telepathology can also be set up in single sites for quality assurance purposes (Ho et al. 2006). In a one-to-one network, two healthcare sites are connected where a consulting site provides pathology services to a referring site. This network type is typical for experimenting with telepathology,(Wiley et al. 2011) providing quality assurance to a satellite organization,(Graham et al. 2009) or substituting for a local or visiting pathologist (Almagro et al. 1998; Moser et al. 2003). In a centralized network, a large institution usually provides pathology expertise to one or several smaller healthcare organizations. These are often more mature telepathology projects, such as a teaching hospital offering pathology consultations to sites located either in a remote region or in integrated healthcare systems such as the US Veterans Integrated Service Network (Dunn et al. 2001; Elford 1997; Nakajima 2010). Lastly, a decentralized network connects multiple locations with no single hub for consulting pathologists (point-to-point network). As an example, the Eastern Québec Telepathology Network in Canada aims at providing uniform diagnostic pathology services to pathologists and surgeons in a territory of 408,760 km2 with 1.7 million inhabitants where the density, in certain areas, is as low as 0.4 inhabitants/km. This network, one of the largest in the world, counts no single responding site to which community hospitals turn for pathology services. Rather, the architecture of the network was purposely designed to encourage decentralization and the development of a regional organization of pathology services (Trudel, Paré, Têtu, et al. 2012).

1.3.2 Thematic Analysis

We now turn our attention to the main themes investigated in the selected articles, namely, telepathology impacts and implementation challenges. The online appendix shows the final coding sheet while Table 2 presents a summary of the coding process. Note that a single article may address more than one impact or benefit. For each topic, we summarize in the following paragraphs the main findings and underline key areas where we feel further research is needed.

Telepathology Impacts - *Accessibility of care* - Accessibility of care usually refers to the relative ease or difficulty in obtaining health services in the face of obstacles that can be geographic, economic, or social(Bashshur 1995). Access to pathology is critical to enable diagnoses, of cancers for instance. The absence of a local pathologist and of telepathology is palliated by slow physical tissues transfer, roaming pathologists and, when immediate diagnosis is needed, more aggressive surgeries or patient transfers to larger institutions.

These alternatives can impair patient health, generate delays and costs, and constrain surgery options and planning (Trudel, Paré, Têtu, et al. 2012).

Pathologists are unevenly distributed as the presence of full-time pathologists may not be justified in low population density areas, and interest in telemedicine in general and telepathology in particular is moderately related to population density (Moser et al. 2004). In fact, some of the earliest telepathology experimentations were conducted to address this problem in sparsely populated areas such as Northern Norway (Kayser 1995; Nordrum et al. 1991). Telepathology can improve access to pathology by: (1) widening access to pathology services in regions underserved in pathology;(Swett et al. 1995) (2) preventing service loss when a pathologist leaves;(Têtu et al. 2012) (3) providing a substitute when the local pathologist is absent, sick or on vacation;(Ranson 2007) and (4) preventing service disruptions by sparing pathologists travel to remote locations (Graham et al. 2009).

Pathologists are also unevenly distributed around the globe, with half of trained pathologists residing in the United States, serving less than 5% of the world's population (Weinstein et al. 2012). Telepathology has been used to provide pathology services to developing countries with no or limited access to pathology and subspecialty pathology (Brauchli et al. 2005; Hitchcock 2011; Shiferaw and Zolfo 2012; Weinstein et al. 2012). Another key accessibility benefit is better access to consultations. This is true for isolated pathologists needing a second opinion, but also for those sending expert referrals to subspecialist pathologists (Danilović et al. 1995). As the pathology discipline becomes increasingly specialized, advice from subspecialists, such as neuropathologists, becomes sought after (Horbinski and Hamilton 2009; Têtu et al. 2010). A case in point is the Union for International Cancer Control, which offers a worldwide service specialized on second opinions for tumor diagnostics (Dietel et al. 2000).

In the long run, telepathology may render pathology services and its subspecialties available 24/7 by routing cases at night to pathologists in different time zones,(Ranson 2007; Weinstein et al. 2001) as can already be observed in some cases with teleradiology. Nevertheless, while improved accessibility to pathology and care in general is the major benefit claimed by telepathology implementers, especially in larger centralized and decentralized settings, empirical evidence for such impacts remains scarce and anecdotal(Dervan and Wootton 1998; Horbinski and Hamilton 2009).

Quality of care - Quality of care is generally addressed in the literature through the angle of diagnosis accuracy, with researchers investigating whether telepathology diagnoses are as good as the microscope-based gold standard. Nevertheless, telepathology adds direct and indirect clinical value of its own. First, improved access to pathology can lead to better care. Intraoperative telepathology examinations, for instance, allow less numerous, more timely, better informed and less aggressive surgeries.26 Second, telepathology offers long-term unique potential for image treatment and aids to diagnosis, which promise to assist pathologists in their diagnostic work(Isse et al. 2012; Kayser et al. 2012). Third, it facilitates quality assurance even for isolated pathologists (Hassell et al. 2011). Finally, telepathology facilitates learning and expertise building. Explaining the diagnosis provides an educational benefit to the referring pathologist or surgeon (McLemore et al. 2006). Competence building is even the main project goal in some developing countries' initiatives (Hitchcock 2011; Sohani and Sohani 2012). But pathologists in reference centers also benefit from telepathology by accessing complex cases, since for "subspecialists to work together in a critical mass is essential for them to preserve their diagnostic and scientific acumen."(Wiley et al. 2011). Telepathology may thus play a key role in increasing pathologists' specialization (Cross et al. 2002). Compelling empirical evidence associated with these promises remains to be provided, though.

Efficiency - Only telepathology for educational purposes offers unambiguous evidence of simultaneous improved access (to learning materials) and improved quality (of students' learning and satisfaction) at a lower cost (Ayad and Yagi 2012; Bloodgood 2012). For other applications, "telepathology slides, unlike the transition to digital radiology, have no immediate and readily identifiable payback that resonates with the holders of the purse-strings."(Hassell et al. 2011). Economic benefits are difficult to monetize, and efficiency has rarely been investigated systematically (Pantanowitz et al. 2011; Williams et al. 2010). Some researchers even argue that profitability is not to be expected and should not be a goal (Callas et al. 1996). Nevertheless, there is increasing demand for economic evaluations of telemedicine projects (Drummond et al. 2005).

Hardware, software and support contract costs are easy to monetize and, hence, the most often cited, along with the costs of technicians, networks and data storage (Cornish et al. 2012; Isaacs et al. 2011; Isse et al. 2012). Telepathology can generate cost savings for healthcare organizations. The most prominent and widely cited is on pathologists' salaries when a full-time expert is not justified (Almagro et al. 1998; Horbinski and Hamilton 2009). Telepathology also enables economies of scale and optimization of resources such as laboratories, microscopes and equipment, and the automation of certain repetitive activities in slide processing, cytology screening or quality assurance activities (Isse et al. 2012; Kldiashvili 2008; Leong and Leong 2005). Finally, it can reduce courier and archiving costs, although this kind of gain is often downplayed as relatively minor, given that slides still need to be stored and archived for legal reasons (Isaacs et al. 2011; Kayser 2012).

Telepathology renders access to patient files easier and faster, especially for case slide re-consultations and for pathology students (Harris et al. 2001; Ho et al. 2006; Montalto 2008) It can also reduce travel time for pathologists (Kldiashvili 2008) From a revenue perspective, a few healthcare institutions have invested in telepathology to increase income generated by their leading specialists and to boost their staffing levels by reducing their travel time (Graham et al. 2009; Tanriverdi and Iacono 1999; Williams et al. 2010)

Two main approaches have been used to investigate the efficiency of telemedicine projects, namely cost-effectiveness analyses and cost-benefit analyses (Bashshur 1995; Drummond et al. 2005) In a cost-effectiveness analysis, telepathology costs are compared to those of alternative solutions providing equal service, such as a courier service to send slides to another site or an onsite or a roaming pathologist (Agha et al. 1999; Becker et al. 1993; Dunn et al. 2001; Moser et al. 2003) Findings, typically in one-to-one networks, suggest that profitability is context dependent. A long distance between two sites favors telepathology over courier, as does a medium level of activity (Loane et al. 1999). Low activity levels favor courier because of telepathology's high set-up costs, while high activity levels may justify a resident pathologist (Agha et al. 1999). However, these analyses need to extend beyond one-to-one networks. Moreover, evolving technologies and decreasing IT costs mean that most findings are already obsolete.

By contrast, cost-benefit analysis is a value-added approach in which costs and benefits are comprehensively assessed using standardized measures, including operational elements of enhanced patient care. Benefits are maximized when the detected medical conditions have a high incidence, high risk in case of early detection failure (or high benefits of early detection) and are not trivial (e.g., tumors) (Grigsby et al. 1995; Isaacs et al. 2011). The study by Isaacs et al is the only one that used the cost-benefit analysis technique to assess telepathology benefits(Isaacs et al. 2011). More such analyses are required to account for improvement in accessibility of care, the key motivation for investing in such projects. A comprehensive and long-term approach to impact evaluation should also include changes in pathology laboratory workflows and in broader healthcare structures (Kayser et al. 2012).

Organization and structure of pathology services - Last, researchers have also noted the potential impact of telepathology on healthcare structures. As pathologists team up to serve larger areas, pathology services will likely be concentrated into centralized laboratories (Cornish et al. 2012; Dunn et al. 2000; Leong and Leong 2005; Wilbur 2011). Enlarging healthcare networks may lead to the emergence of globalized diagnostic services (Eide and Nordrum 1994; Shanmugaratnam 2007). To small healthcare institutions, telepathology offers the potential to outsource pathology at lower cost, leveling the playing field by allowing smaller structures to use telepathology instead of hosting their own pathology service (Graham et al. 2009; O'Malley 2008; Pantanowitz et al. 2011). Academic and other subspecialty practices may have ambivalent outcomes as they will benefit from better use of their specialists but be financially affected negatively by increased competition and lowered prices (Carter 2011).

Telepathology implementation challenges - Once a decision to invest in telepathology has been made, clinicians and managers face a variety of implementation challenges beyond technical aspects. Indeed, telepathology projects represent sociotechnical changes that require overcoming a wide variety of challenges or barriers (Attewell 1992; Broens et al. 2007; Tanriverdi and Iacono 1999). Beyond technical issues, which fall outside the scope of this review, challenges can be found at the individual, organizational and legal levels (see Table 2). Each of these categories will be discussed in turn.

Individual barriers - Telepathology implementers need to ensure that targeted pathologists, technicians and surgeons accept the new system and/or work environment. Many clinicians see the lack of clinical value as one of the primary barriers (Hassell et al. 2011). Attitudes of pathologists towards telepathology have long been investigated, as shown by Callas et al (Callas et al. 1996). As in other forms of telemedicine, project champions play a key role in overcoming implementation challenges and ensuring overall acceptance (Cross et al. 2002; Dennis et al. 2005; Tanriverdi and Iacono 1999). Beyond pathologists, surgeons are often the direct requesters of telepathology diagnoses and need to actively solicit telepathology and be convinced of its usefulness and reliability. Finally, technicians in charge of slide preparation and scanning are key telepathology users (Cross et al. 2002). Overall, surgeons' and laboratory technicians' views and reactions towards telepathology deserve more attention in future work.

Referring clinicians are asked to use telepathology to make complex clinical decisions, and they need to trust not only the technology but also the other stakeholders involved in the process. First and foremost, clinicians need to trust the images and telepathology-based diagnosis. Pathologists can be reluctant to base a diagnosis on images sent by another pathologist, technicians need to trust distant pathologists to guide them through the digitization process, and surgeons mistrust the diagnosis of a pathologist they may not be familiar with(Baruah 2005). To create trust, face-to-face introductions of pathologists, capping the number of healthcare entities a single pathologist interacts with and, more generally, defining roles clearly can help(Brauchli et al. 2004; Carter 2011; Wiley et al. 2011). Conversely, the introduction of telepathology can have a positive effect on interpersonal trust and generate a sense of collegiality between professionals from the connected sites (Almagro et al. 1998). Trust also involves questions of confidentiality, security and privacy (Blobel 2012).

While pathologists in general find telepathology acceptable to perform various pathology duties, attitudes towards telemedicine are polarized (Gabril and Yousef 2010; Stanberry 2000). This has been explained by fear that telepathology "could turn pathology services into a geographical unbounded community"(Cornish et al. 2012) and by the significant changes in work practice involved (Williams et al. 2010). Further, some might consider that separating patients and pathology won't allow a good clinical work because high quality pathology can only be performed having tight connections with clinicians attending directly the patient. In such case, pathologists may accept telepathology for local use only, even in non-teaching hospitals. To alleviate these concerns, researchers have suggested focusing on user needs. This can be achieved by addressing the three critical challenges of usability, training and support. Each of these is briefly discussed below.

First, telepathology can be time consuming, a widely investigated usability issue (Callas et al. 1996; Ho et al. 2006; McClintock et al. 2012; Williams et al. 2010). Although the long-term potential to enable time savings was mentioned, in most cases telepathology slows workflows by adding steps to the pathology process. It requires logging into a patient file, scanning slides, uploading and downloading the virtual slide and navigating through a not always ergonomic application, as opposed to simply picking a slide, positioning it in a microscope and focusing on the area of interest in a matter of seconds (Williams et al. 2010). While the introduction of digital radiology has been shown to improve the productivity of radiologists,(Montalto 2008; Nitrosi et al. 2007) the use of telepathology has the opposite effect for pathologists, which may partly account for telepathology's slower diffusion.

Second, telepathology changes the way pathologists, technicians and surgeons work and interact. Familiarity with the system and training reduce resistance and improve efficiency (Bamford et al. 2003; Dennis et al. 2005; Horbinski and Hamilton 2009; Williams et al. 2010). Training has also been shown to improve interpersonal communication in virtual teams (Warkentin and Beranek 1999). The learning is not only about technology, but more importantly about adapting oneself to the new work practices involved: surgeons to leveraging the immediate availability of pathology, and pathologists to cooperating with distant colleagues (Têtu et al. 2012). Surgeons and technicians also need to be trained to take over some pathologists' roles in referring sites, and the technicians' training curriculum requires specific adjustments to telepathology activities (Giansanti et al. 2008). More research must be conducted on the nature and effectiveness of the training strategies in use.

Third, technical support helps ensure that clinicians and technicians who are less familiar with IT are not discouraged or stopped by technological hurdles. Support is mainly provided at two levels. Internally, targeted users need to have access to qualified people to troubleshoot problems and ensure the system is operational and reliable whenever needed (Horbinski and Hamilton 2009). Externally, healthcare organizations need to partner with reliable IT providers to support and update the systems in use and to tailor the technological solutions to their particular needs(Hasegawa and Murase 2007). We suggest that more studies be devoted to provide a better understanding of the role mediating institutions such as consulting firms and technology integrators play in helping healthcare organizations overcome technological knowledge barriers when implementing telepathology (Tanriverdi and Iacono 1999).

Organizational barriers - Healthcare organizations also face important challenges such as financing, workflow reengineering and diagnosis accountability assignment. Each of these challenges will be discussed in turn. First, financing involves two distinct challenges: funding upfront investments and, possibly more difficult, funding operational expenses (Broens et al. 2007). Each stakeholder needs to be properly compensated, be it in a single payer healthcare system(Hasegawa and Murase 2007) or a private insurance system (Tanriverdi and Iacono 1999). The issue may be less complex in single location projects and one-to-one networks. In centralized and decentralized telepathology networks, investments are spread over several institutions, the issue of sharing running costs and rewarding each stakeholder becomes more complex, and divergence of interests becomes more likely (Pagni et al. 2011). The sources of financing remain unclear, as researchers call for governments, pathologists or corporate sponsors to step in and finance running costs (Hipp et al. 2011; Nakajima 2010; Shiferaw and Zolfo 2012). Further research needs to investigate viable financing models for various forms of telepathology projects in both public and private healthcare systems.

Second, the introduction of telepathology often involves the revision of existing workflows and processes (Aas 2001; Kayser et al. 2012; Tanriverdi and Iacono 1999; Têtu et al. 2012). A telepathology system is both a content management tool and a collaborative platform connecting non-experts (referring clinicians) to experts (pathologists or subspecialty pathologists) (Brauchli et al. 2004). As a content management tool supporting pathology processes and information, the system is increasingly embedded in existing clinical information systems and their workflows, such as laboratory information systems and electronic medical records. This involves interoperability issues requiring considerable integration efforts and harmonization of information and communication standards (Daniel et al. 2012; Garcia Rojo et al. 2009; Kayser 2012). As a collaboration tool, pathologists need features such as working drafts and prioritization, as well as efficient case assignment. In that regard, three distinct models of case assignment are suggested. First, in the subspecialty model, subspecialist pathologists directly sign out centralized cases. This is considered an appropriate model for large and centralized institutions with sufficient staffing of subspecialty experts, like the Armed Forces Institute of Pathology (Dunn et al. 2001). Second, in the case triage model, a pathologist assesses the case and, if need be, routes it to a subspecialty pathologist. This pre-screening reduces the need for subspecialty pathologists;(Bhattacharyya et al. 1995) and as a single pathologist is needed, it is adequate for one-to-one or small centralized networks. In a variant of this model, case triage can be tiered, as in the national Croatian telepathology system, where smaller institutions refer their cases to three regional centers, which can themselves route their cases to a national center (Danilović et al. 1995). Last, in the virtual group practice model, cases are assigned automatically on the basis of pathologists' characteristics, such as availability or relevant experience. This model is mainly used to provide specialty pathology services to underserved organizations and is likely to be more appropriate for decentralized networks (Kayser et al. 2004; Têtu et al. 2012).

Third, telepathology raises accountability issues relating to information privacy, contractual arrangements with other organizations involved and the extent of coverage provided. One salient issue is whether the consulting pathologist is accountable for the diagnosis (Brauchli et al. 2004). In expert groups, consulting pathologists commit to diagnoses, an arrangement appropriate for more structured networks such as centralized or one-to-one networks, where the institutions are integrated and able to set up the conditions for accountability transfer across sites. Expert groups can further be structured around expertise centers, where pathologists have a rotation duty plan that ensures continuity of service (Aas 2001; Brauchli and Oberholzer 2005; Dietel et al. 2000). Alternatively, in discussion groups, consulting pathologists leave the final interpretation and diagnostic accountability to the referring clinician and do not necessarily reach a conclusive diagnosis. Discussion groups seem more relevant for decentralized networks such as the iPath project (Brauchli et al. 2005). In this inter-organizational project, consulting pathologists and referring clinicians from unrelated organizations all over the world freely request and provide consultations.

Table 3: Key impacts and challenges by network structures

Network structure	Key impacts	Key challenges
Single location	Mostly educational	Mostly technological
One-to-one	Cost-effectiveness: substitute for costlier alternatives International partnership	Usability issues Legal issues for international projects
Centralized	Full coverage within a region/organization Economies of scale	Acceptance Usability issues
Decentralized	Multiple, diverse and emergent Open access	Devise a viable business model Organize workflows effectively

Legal barriers - Telepathology also raises a series of legal issues and challenges significant enough that as much as “58% [of pathologists] felt that the medico-legal implications of duty of care were a barrier to [telepathology] use.”(Dennis et al. 2005). Further, “telepathology, as seen by the lawyer, is characterized by a geographical distance between the tissue or specimen to be evaluated and the pathologist himself.”(Dierks

2000). This raises the question of which regulations to apply between the consulting or referring sites. Constituencies with an interest in telepathology, such as rural regions with underserved populations, have more advanced laws, while other places are lagging behind (Leung and Kaplan 2009). Another essential legal challenge is related to remuneration, as current regulations do not always allow telepathology reimbursement (Weinberg 1996; Wiley et al. 2011). Other legal issues include licensing requirements,(Ranson 2007; Wiley et al. 2011) data protection and privacy laws, and consent rules (Dierks 2000). While several researchers have described and commented on various telepathology rules and regulations,(Dierks 2000; Isse et al. 2012; Kldiashvili 2008; Leung and Kaplan 2009; Pantanowitz et al. 2011; Williams et al. 2010) we recommend for a recent status update on this topic.

1.4 Comment

This review reveals that managerial issues associated with the acquisition and usage of telepathology in healthcare organizations are multifaceted and multilevel. It also highlights the diversity of telepathology initiatives and contexts and the importance of considering these distinctions when interpreting empirical findings. Of utmost importance, various network structures are associated with different benefits. The nature and complexity of the challenges also seem to evolve and increase with the complexity of the underlying networks.

In terms of telepathology impacts, in single location projects, the dominant rationale is financial, with telepathology being considered as an equal quality substitute to more costly solutions such as having a resident or roaming pathologist. Larger centralized and decentralized networks, on the other hand, are targeting a more diverse set of benefits, including extending access to pathology to a whole region, achieving substantial economies of scale in workforce and equipment, and improving quality by standardizing care. Conclusive empirical evidence remains to be gathered about these preliminary findings and, more generally, about the role of context in telepathology projects. As shown earlier, solid and rigorous evaluation studies remain rare as of today. As potential benefits are a key motivator leading to individual and organizational adoption, rigorously evaluating their nature and extent represents an important endeavor for future research.

In terms of challenges, in smaller telepathology networks, organizational concerns are less prominent, and implementers are more focused on usability issues. As the project scope widens, organizational issues such as workflows, accountability, and business models gain prominence, as well as organizational structures set up to support end users and the project teams. This echoes Broens et al.'s layered model for telemedicine implementation, with an implementation focus gradually widening from technology issues to user acceptance, to organizational concerns, to societal issues, as the technology matures and the project stage moves from prototype to pilot, to full deployment and to the professional norm(Broens et al. 2007).

To move forward, managerial telepathology research needs to distance itself from anecdotal evidence and descriptive accounts, to leverage existing theories and to investigate a series of unanswered questions pertaining to telepathology implementation challenges and impacts. More rigorous evaluative studies should be conducted to provide solid evidence of individual and organizational outcomes associated with the deployment of various telepathology configurations and networks. In terms of accessibility to care services, for instance, future studies ought to quantify the cases where telepathology provides care otherwise unavailable to patients. They should do this by assessing the variations in terms of the number of surgical procedures cancelled, medical complications or surgical procedures performed in two stages owing to the absence of pathologists, and the extent to which telepathology actually substitutes for a local pathologist (Trudel, Paré, Têtu, et al. 2012). Future studies may address the question of the conditions under which telepathology is recommended, versus alternatives such as couriers and in-house pathologists, and what type of benefits to pursue under these conditions. Research comparing multiple telepathology settings and networks will also help refine under which conditions (network structure, distance to the nearest pathologist, medical conditions treated or level of activity) telepathology is most beneficial.

Moreover, between the individual and organizational levels, telepathology is also the endeavour of a group of people: pathologists, surgeons and laboratory technicians. Success implies close collaboration and coordination between those healthcare professionals. We propose several theories that could serve as potential conceptual lenses for studying that group dynamic. As a geographically distant group, telepathology could be investigated as a particular form of virtual teams. The multiple dimensions of virtual team configurations such as those proposed by Dubé and Paré might allow for a deeper understanding of this form of work arrangements in the healthcare sector (Dubé and Paré 2004). Another promising research avenue is related to the notion of mutual trust, which has also been extensively investigated in prior research on virtual teams (Jarvenpaa and Leidner 1999). As explained earlier, the role of mutual trust among pathologists, surgeons and technicians during intraoperative telepathology exams, for instance, becomes even more central.

Another take at addressing group dynamics would be by adopting a socio-technical lens or framework, as suggested by Orlikowski and Iacono (Orlikowski and Lacono 2001). It would definitely help in understanding several of the challenges associated with telepathology implementation, such as the emergent changes in technology, workflows, roles and accountability (Davidson and Chismar 2007). We posit the more complex forms of telepathology networks represent appropriate settings for investigating these topics more deeply. Finally, given the idiosyncratic nature of telepathology projects dynamics, we argue that the concept of mindful organizing could also contribute to a deeper understanding of how healthcare professionals collectively enforce an environment conducive to patient safety in a context of uncertainty and complexity reinforced by telepathology (Trudel, Paré, and Laflamme 2012).

To conclude, this review article provides a clear indication of the size and nature of the available knowledge about the impacts and implementation challenges associated with the deployment of telepathology in healthcare organizations. Among others, it reveals that various telepathology network structures exist and, hence, conclusions and recommendations should not be generalized across all initiatives. Instead, we encourage researchers to adopt a multidimensional view of telepathology projects in order to compare empirical findings, accumulate knowledge and, ultimately, provide practitioners with useful guidelines and recommendations.

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Chapter 2
Essay 2: Impacts of a Large Decentralized Telepathology

Abstract

Background: Telepathology is one of the fast growing segment of the telemedicine field and Canada is recognized as a world leader in this particular domain.

Introduction: We report a benefits evaluation study of a decentralized telepathology network deployed in Eastern Quebec. The project involves 18 hospitals, making it one of the largest telepathology networks in the world.

Materials and Methods: We first conducted 43 semi-structured interviews with telepathology users and managers. Hard data on the impacts of the telepathology network (e.g. the number of service disruptions, the average time between initial diagnosis and surgery) was also extracted and analyzed, where available.

Results: Users found the system to be easy to use and the quality of the virtual slides and images was also considered satisfactory by pathologists. A key objective was to provide continuous coverage of intraoperative consultations in hospitals with no pathologist. Our findings show that no service disruptions were recorded in these sites. Surgeons agreed that the use of telepathology helped avoid second surgeries and improved accessibility to care services. Telepathology was also perceived by respondents as having positive impacts on remote hospitals' ability to retain and recruit specialists.

Discussion: The observed benefits should not leave the impression that implementing telepathology is a trivial matter. Indeed, many technical, human and organizational challenges may be encountered.

Conclusions: Telepathology can be highly useful in regional hospitals that do not have a pathologist on site. More research is needed to investigate the challenges and benefits associated with this growing form of telemedicine.

2.1 Introduction

Telepathology is defined by the American Telepathology Association as “the electronic multimedia communication across a network of pathology-related information, between two or more locations for use-cases between pathologists and/or qualified laboratory personnel, and may include involvement by clinicians and/or patients” (“Clinical Guidelines for Telepathology” 2015:5). This particular form of telemedicine has several applications; it can be used for distant primary diagnoses, expert referrals, quality assurance, and education (Furness and Bamford 2001). For distant diagnoses in the absence of a local pathologist or a telepathology system, slides must be physically sent to another facility, hence delaying the diagnoses. With telepathology, the slides are examined remotely, either statically or dynamically, and diagnoses are swiftly provided. In some particular instances, however, pathology examinations are performed while the patient is still under anaesthetics and undergoing surgery, and the surgeon needs a pathology diagnosis to properly resume his procedure. For these specific examinations, called intraoperative frozen sections, delays are undesirable. When there is no pathologist on site and a surgical procedure requires an intraoperative consultation (IOC), either the patient is transferred to another hospital, a visiting pathologist is called on site, or a procedure is performed in two steps (creating time for the slides to be sent and read elsewhere). Put simply, IOC via telepathology refers to a preliminary diagnosis rendered from macroscopic and/or microscopic images of a frozen tissue section that has been processed rapidly during surgery (Têtu and Evans 2013).

Telepathology is currently one of the fast growing segments of the telemedicine field. Indeed, recent figures show that its market is expected to grow from $2.2 million in 2013 to nearly $4.5 billion in 2018 (BCC Research 2014). It has been implemented in many countries in Europe, Asia and North-America. Canada is recognized as a world leader in this area with several telepathology projects being deployed nationwide. The large geographic size of the country combined with a dispersed population and a shortage of pathologists in several remote regions have contributed to the development of telepathology in Canada (Trudel et al. 2012).

The province of Quebec, where the present study was conducted, is the second most populated province in Canada with its 8.2 inhabitants (Institut de la Statistique du Québec 2015). In this article we report a benefits evaluation study of the Eastern Quebec telepathology network. The project, which has been initiated with the financial support (CAN$ 6.2M) of the Quebec government and Canada Health Infoway, currently involves 18 operational sites, making it one of the largest telepathology networks in the world. Of those sites, four have no pathology laboratory, four have a laboratory but no pathologist and there is only one practicing pathologist in four other hospitals. A vast majority of the 48 pathologists involved in this project are concentrated in the teaching medical center located in Quebec City. The telepathology network covers a broad territory of almost 410,000 km^2, with a population of more than 1.7 million inhabitants that ranges in density from 0.4 and 9.1 inhabitants per km^2. The equipment and software were deployed in late 2010 while clinical activities began in January 2011. Each participating site was equipped with a whole-slide scanner, a macroscopy station and two videoconferencing devices equipped with a drawing tablet. More details about the equipment and software can be found elsewhere (Têtu et al. 2014).

While the telepathology network covers the full range of applications mentioned above, its primary objective was to provide IOCs to community hospitals lacking onsite pathologists. In this regard, IOCs are performed on a regular basis; they are originating from 13 of the 18 operational sites and there are seven referral sites. Most IOCs are from breast cancers (sentinel lymph nodes, margin close to breast cancer), lung cancers (bronchial margins, mediastinal lymph nodes), ovarian, pleural, peritoneal, omental lesions, or from stomach and head and neck cancers (Têtu et al. 2014). As per January 2015, a total of 1733 IOCs were performed via telepathology across the network. The second goal of the project was to achieve substantial gains in terms of speed and quality of surgical services in remote areas. Last, the telepathology network also aimed at facilitating the recruitment and retention of surgeons in remote regions.

Besides its size and scope, another distinctive characteristic of the telepathology network in Eastern Quebec is the decentralized organization of the IOC service (Meyer and Paré 2015). Indeed, in contrast with telepathology projects elsewhere in Canada and abroad, there is no single responding site to which community hospitals without pathologists turn for pathology services. Each requesting hospital is responsible for identifying one or more partner institutions with which it can sign service agreements. It was also initially decided that the teaching hospital located in Quebec City would be most helpful at providing expert opinions to pathologists working alone and to act as a safety net for regional hospitals with temporary interruption of IOC service.

In short, the main objective of this study is to provide a deeper understanding of the actual and perceived impacts of the telepathology network on clinicians and on the overall organization and delivery of care services in Eastern Quebec.

2.2. Research Objectives, Theoretical Framework and Methodology

The objectives of the current study were to understand how telepathology was being used in the Laval UIHN and evaluate the extent of the impacts or benefits associated with implementing this state-of-the-art technology. We used a theoretical framework proposed by DeLone and McLean (1992) to guide our evaluation process. This model is frequently used in studies on the impacts of information technologies in organizations. As shown in Figure 3, the framework uses various constructs to characterize the success of a technological project.

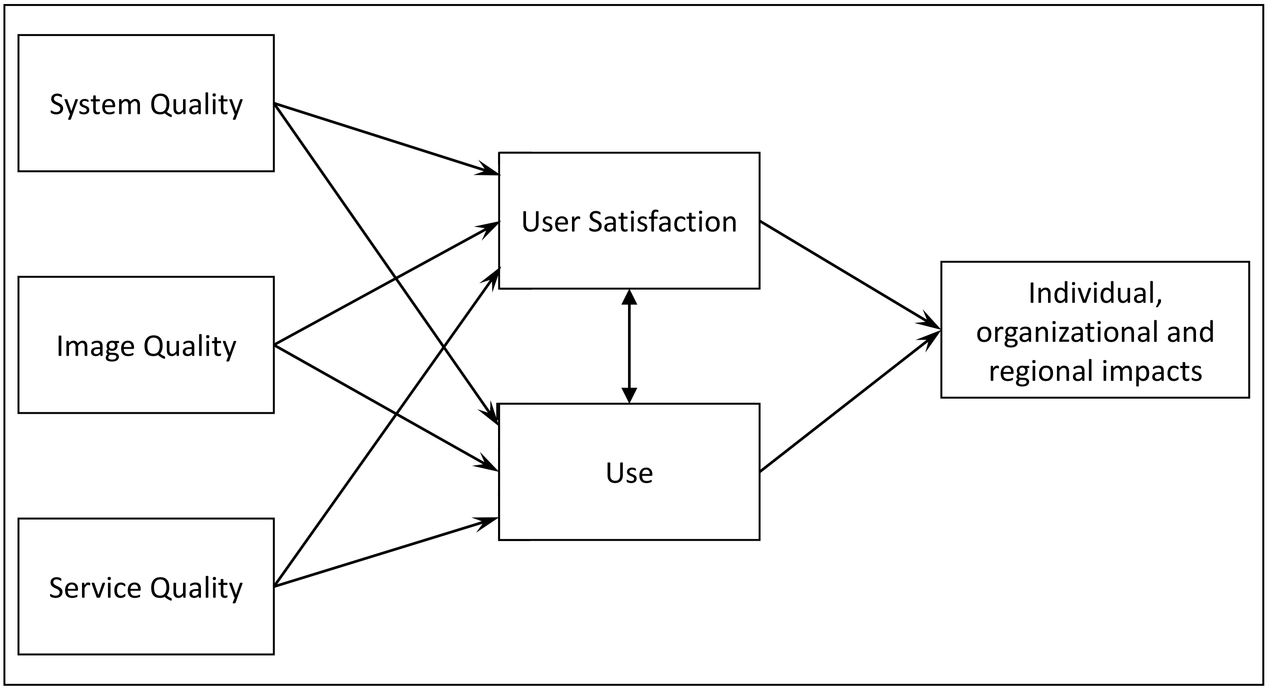

Figure 3 Theoretical Framework (adapted from DeLone and McLean, 1992)

This theoretical model, as applied to the specific case of telepathology, suggests that expressed satisfaction with a system and its use is influenced by three factors: the perceived quality of the system (user friendliness, reliability, response time, etc.), the perceived quality of the images generated by the system (and the reliability of the resulting diagnoses) and the perceived quality of the technical support (e.g. the call centre) and the organizational support (training and coaching) provided. The model then suggests that the more that users are satisfied with the system and the more they use it, the greater will be their personal benefits (e.g. better clinical decision making) and the more positive will be the impacts of system use on the institution (e.g. staff retention) and the region as a whole (e.g. better patient accessibility to specialized care).

As shown in Table 4, the methodology entailed three case studies[1]. The first case involved a requesting site, the regional hospital (RH) at Sept-Îles (the Sept-Îles RH), and a responding site, the Baie-Comeau RH (Le Royer Hospital). The available pathologist at

[1] These cases are representative of the different contexts in which the telepathology system is used in the Laval UIHN. Each of the cases features health facilities that have signed pathology service agreements.

the responding site used telepathology to provide services to the requesting site. The two institutions are 230 km apart but are both in the Côte-Nord administrative region.

The second case involved three health facilities: two requesting sites and one responding site. The two requesting sites, the Gaspé RH (Hôtel-Dieu Hospital) and the Maria Hospital are in the Gaspé region, while the responding site, the Rimouski RH (the Rimouski-Neigette CSSS) is in the Bas-Saint-Laurent region. As with the Sept-Îles RH, telepathology was introduced at the Gaspé RH when its pathologist left. The Maria Hospital had no pathologist on site. At the time of our study, the Rimouski RH had four pathologists.

The third case involved two health care institutions that also have a service agreement. The requesting site is the Thetford Mines RH (Thetford Mines Hospital) and the responding site is the Saint-Georges RH (Saint-Georges de Beauce Hospital). In contrast with the requesting sites in the two preceding cases, the Thetford Mines RH is located in a more densely populated area close to large urban centres and the distance between the requesting and consulting sites, at 64 km., is much less. Another feature that sets this case apart from the preceding cases is the presence of a visiting pathologist at the Thetford Mines RH one day per week. The Saint-Georges RH had 2.5 pathologists at the time of this study; one of the three pathologists works part-time from home.

Table 4 Configuration of the Case Studies

	Case 1	**Case 2**		**Case 3**
Requesting Site	Sept-Îles RH	Gaspe RH	Maria Hospital	Thetford Mines RH
Number of beds	96	56	77	96
Number of pathologists	0	0	0	0.2
Number of surgeons	3	7	4	13
Number of surgeons using telepathology	1	3	4	1
Consulting Site	Baie-Comeau RH	Rimouski RH		Saint-Georges RH
Number of pathologists	1	4		2.5
Distance between the two sites	234 km	386 km	205 km	64 km

2.3 Materials and Methods

From a methodological standpoint, we adopted a mixed-methods approach. We first conducted a series of semi-structured interviews with telepathology users (pathologists, surgeons, laboratory technologists) and managers. Interview guides containing the specific issues to be discussed with each group of respondents were developed and used during the data collection phase. The data collection process continued until theoretical saturation (Dubé and Paré 2003) was reached; i.e. when additional data no longer contributed anything new. All in all, 43 interviews, 34 with clinicians and 11 with managers, were conducted during seven field visits.

The interviews were tape-recorded and then transcribed verbatim, producing about 1,110 pages of transcripts. These were then coded and analyzed using a grid of success indicators for telepathology projects developed by a pan-Canadian committee of experts (Infoway 2011). Open coding was also performed so that any unforeseen themes that emerged from the data was also captured (Miles and Huberman 1994). Data analysis was performed using the NVivo software package. Ethics approvals for this study were obtained from the lead author's academic institution.

Second, pre–post quantitative data on the impacts of the telepathology network (e.g. the number of service disruptions, the average time between initial diagnosis and surgery) was collected and analyzed, where available. These data came from the clinical-administrative information systems (e.g. OPERA, Omnitech, paper registers, etc.) of the hospitals involved. Table 5 summarizes the context and the quantitative data gathered from Case A and Case B (not available for Case C).

Table 5 Summary of quantitative data for Cases A and B

		Case A		Case B	
Types of uses	**Indicators of ability of patients/providers to access services**	**Pre: 1/6/10 - 30/09/10**	**Post: 1/4/11 - 30/09/11**	**Pre: 1/09/2011-28/022012**	**Post: 1/9/2012-28/02/2013**
IOC	Coverage of the resident pathologist in the referring site	Yes	No	No	No
	Telepathology coverage at the referring site	No	Yes	No	Yes
	Number of intraoperative consultations performed / Total count of surgeries performed at the referring hospital	26 / 1 507 (1,7%)	23 / 1 581 (1,5%)	Not applicable	26
	Count of breast surgery with search for sentinel node			11	10
	Number of surgeries cancelled because of an absence of pathologist (breach of service) at the referring hospital	N/A	0	Not available	0
	Average delay between diagnosis and first surgery at the referring hospital (in days)	77	62	Not available	Not available
	Average delay between specimen extraction and the preliminary pathology report (in minutes)	N/A	21	Not available	Not available
Second opinions	Number of second opinion requested by the pathologist	51 cases	16 cases	Not applicable	Not applicable

2.4 Results

Prior to system deployment, the clinicians we interviewed had some concerns about system reliability. As one of the surgeons said, *"I had no problem with the remote pathologist reading the slides, but I was a little concerned that the technology wouldn't* *work."* Following some initial technical problems during the start-up period, the system and technological infrastructure deployed in the various sites proved to be highly reliable. One of the most serious technical problems caused a 30-minute delay during a planned IOC, which had no consequences for the patient. As for system friendliness, most users had only positive comments to share. Overall, they found the software to be both simple to learn and easy to use.

The quality of the virtual slides and images generated by the system was also considered satisfactory by pathologists. A quality assurance investigation conducted by a small group of pathologists showed a 98% concordance rate between the 104 diagnoses made on the frozen material of the IOC cases and the corresponding final diagnoses rendered on paraffin material (Perron et al. 2014). For the more complex or ambiguous cases often seen in hematopathology or pulmonary pathology, however, many pathologists mentioned that they couldn't have a precise diagnosis with a digital slide. When faced with complex cases, they would rather follow the "normal" procedure as one pathologist reports below:

> *"I send all my consultations on complex cases by mail for the simple reason that the first thing that a pathologist working remotely will do is ask for special colorations or additional ones."*

The first objective of the telepathology network was to provide continuous coverage of IOC in regional hospitals that do not have a pathologist onsite. A disruption in pathology services can have several negative impacts on surgeries which can either be cancelled or performed in two separate interventions because it takes time for the requested diagnosis to arrive by mail. A service disruption can also cause some anxiety *"on a human level, particularly if the patient is not up to a second surgery,"* said one pathologist. Alternatively, a more invasive surgical intervention may be performed to avoid a second procedure, or the patient may be transferred to another hospital that has a pathologist on staff.

In this respect, the three cases analyzed in this study produced inconsistent results. Whereas the surgeons at the Sept-Îles RH (Case 1) and those at the Gaspé RH and the

Maria Hospital (Case 2) regularly used telepathology for intraoperative examinations, surgeons at the Thetford Mines RH (Case 3) rejected such use. There were two main reasons for this difference in the surgeons' willingness to "adopt" telepathology. The first reason relates to the fact that the problems and lengthy delays initially encountered at the Thetford Mines RH quickly helped place serious doubts in the minds of several surgeons, one of whom was very influential in his health facility. Under the advice of this opinion leader, the vast majority of the surgeons quickly refused to use telepathology for intraoperative examinations. Similar technical problems were also encountered at the requesting sites of Cases 1 and 2, but they were quickly resolved and failed to dampen the enthusiasm of the medical staff at these sites.

The second reason relates to the existence (or not) of a viable alternative. At the Sept-Îles RH, as at the Gaspé RH and the Maria Hospital, there is no alternative to telepathology since, without it, many surgeries could not be performed on site or would have to be performed in two stages, with all the side effects that this would have on the health care staff, the heads of operating rooms and the patients themselves. Consequently, in spite of the inherent limitations of the technology, surgeons at these sites reacted very positively to using telepathology for intraoperative examinations. At the Thetford Mines RH, in contrast, having a visiting pathologist was seen as a satisfactory alternative, one that was also deeply rooted in the facility's work habits. Any constraints associated with having a visiting pathologist seemed to the surgeons to have fewer consequences than the risks inherent in introducing telepathology (e.g. intraoperative delays, risks for patients, lower productivity and the need to change work habits).

Overall, based on the data that we extracted from administrative systems, it is clear that telepathology assured continuous IOC coverage. In fact, no service disruptions were recorded in the requesting sites that used telepathology. As one surgeon noted:

> *"When our pathologist left, we already had telepathology in place, so we had no cause for concern. And my patients didn't need to wait four weeks for a visiting pathologist to come to our hospital. As far as I know, not a single surgery was cancelled since telepathology was introduced."*

In one of the requesting sites, we also measured the average wait time between initial diagnosis (leading to the decision to operate) and the day of the resulting surgery. The available data was mainly for core needle biopsies and endoscopic biopsies. These analyses are performed on permanent sections prepared after processing in formalin and paraffin and not on frozen section material processed during a surgery. They must be interpreted within 24 to 48 hours because they are used to determine whether cancer is present or not and to schedule surgery. A total of 16 cases were found in the pre-period (when the analysis were performed by an onsite pathologist) and 12 cases were found in the post-period (when the analysis were performed remotely by a pathologist using telepathology). The average wait time for all these cases declined from 77 days (pre) to 62 days (post). Based on these results, it appears that performing diagnoses at a distance does not add to the wait time, as might have been previously thought. Despite such encouraging sign, more data needs to be collected and analyzed to confirm this result.

Importantly, the level of satisfaction with regard to IOC via telepathology was high among the surgeons we met. One explanation is that the wait time added by using telepathology is considered acceptable: *"Telepathology adds about five or six minutes per report compared with when our pathologist was on-site,"* one said. The data we extracted from administrative systems at one of the requesting sites showed that IOCs via telepathology took an average of 21 minutes compared with an average of 15 minutes for IOCs performed on site. This result was also supported by the quality assurance investigation (Têtu et al. 2014).

The second objective of this project was to reduce delays and increase the quality of client services in remote regions, in particular by avoiding the need for second surgeries and the transfer of patients to urban centres. While no reliable hard data was available with regard to these particular indicators, all the surgeons we interviewed agreed that the use of the technology helped avoid second surgeries and improved accessibility to care. As they see it, the added value associated with telepathology is mainly due to improved quality of care, as one explained:

> *"Without telepathology, there may be two surgeries instead of one for the same patient, meaning more invasive surgeries than*

we would have performed if we had received the opinion of a pathologist in a timely manner. This means a lot for our patients, and it can also make all the difference in the surgery itself."

According to the pathologists we met, telepathology helps prevent medical errors as one mentioned:

> *"I send a request for a second opinion to a colleague in Ottawa, for example, and he quickly confirms the diagnosis. This way, you protect yourself [professionally], because these are cancer cases."*

The third objective of the project was to ease the recruitment and retention of surgeons in remote regions. During our interviews, we encountered at least one case of recruitment and one case of retention. Telepathology is perceived by our respondents as having positive impacts on an institution's ability to retain and recruit specialists. As two surgeons working in remote hospitals noted:

> *"Telepathology ensures that the pathology service is maintained, which is essential for surgeons and specialists. There are more specialties in hospitals that have pathologists than in those that don't. Telepathology should therefore help us keep specialists here, such as gynecologists. When you're thinking of putting down roots somewhere, you can be sure that whether or not the hospital has a pathologist is part of the equation."*

> *"It's our luck that we have access to telepathology. In my case, if we didn't have it, I definitely wouldn't have come to work here. I am an oncologist surgeon, so I simply wouldn't have."*

With the increasing complexity of medicine in general, and pathology in particular, one pathologist explained that such specialization runs the risk of contributing even more to the current shortage of pathologists in remote regions, justifying the continuous investments in telepathology:

> *"Young pathologists are specializing more and more. I'm a product of the 90s, a time when we did everything. Nowadays, pathologists are often better in one specific branch within our field. In this context, sending a pathologist to a remote region is not very appealing."*

For technologists, it appears that telepathology can also add value to their day-to-day jobs:

> *"We play a more important role, especially since we are responsible for manipulating large specimens used during intraoperative examinations. The pathologist is at the other end of the camera, and we have the specimens in front of us; we cut them and prepare the slides that are electronically sent to the pathologist. These are new and major responsibilities that enrich our job."*

For some technologists, however, telepathology is perceived as somewhat of a threat. *"My fear is that one day our work will be transferred elsewhere, and then we'll be nothing more than specimen wrappers,"* said one technologist. In an environment characterized by limited resources, some technologists working in requesting sites also fear additions to their workload.

2.5 Discussion

The primary aim of this study was to better understand the actual and perceived impacts of one of the largest telepathology networks in the world. Our findings clearly reveal that telepathology is highly useful in regional hospitals that do not have a pathologist on site. Telepathology helps ensure coverage of IOCs that improve quality and access to care for populations living in remote areas. As stressed earlier, however, certain limitations inherent in the available technology mean that telepathology cannot be substituted completely for diagnoses performed under a microscope.

The benefits highlighted in this study should not leave the impression that implementing telepathology is a trivial matter. On the contrary, many problems may be encountered (Meyer and Paré 2015). On a technical level, it is vital that the technology and software components perform well and are reliable once the system is up and running. When the first technical disruptions do occur, they must not be allowed to undermine user buy-in into the system. There needs to be a breaking-in phase and some experimentation before telepathology can be used for intraoperative exams. As for the post-deployment phase, our interviewees often remarked that quality technical support is another critical success factor.

From a human perspective, one should not underestimate the effort required to learn how to use the technology and the effect that this has on clinical practices. We observed deeply rooted work habits that lead to some resistance, mainly among technologists. As stressed by Meyer and Paré (2015), the success of a telepathology project is often associated with the development of a relationship of trust between the various stakeholders. For example, the surgeon must trust the pathologist taking part in an intraoperative examination, and the pathologist, in turn, must trust the technologist preparing the slides or handling large specimens. In this regard, the effort required for change management should not be underestimated. Expectations also need to be well managed. Failing to do so may create an unfavourable situation. The presence of a clinical champion is another key condition for success at both the requesting sites and the responding sites.

Implementing telepathology also carries many challenges for hospital administrators such as identifying partners and signing contractual agreements between institutions, harmonizing clinical practices between partners (e.g. the cutting of specimens), building a medical laboratory (if required) and reorganizing work, both at the requesting sites and the responding sites. Several committees played key roles in implementing the telepathology project in Eastern Quebec. For instance, a project management committee was formed of a medical director for the project, a project manager and an IT specialist. The committee's main responsibilities were to plan deployment of telepathology on the area served, to coordinate and oversee collaboration on the work in accordance with the plan, to prepare a risk and change management plan and to report periodically on project progress to the ministerial authorities. During the pre-deployment phase, committee members visited each of the teams responsible for implementing telepathology in each site. As another example, a steering committee, made up of 18 pathologists from all the concerned regions, was also formed. The committee had a mandate to propose organizational models, draft a clinical protocol guide, advise the executive committee and the management committee, and monitor network deployment activities to ensure a coherent implementation. This committee also took part in the final selection of equipment and software, assisting in clinical and technical assessments.

To conclude, the deployment of the telepathology network in Eastern Quebec has helped to ensure continuous coverage of IOCs in regional hospitals that do not have a pathologist on site and, consequently, prevent service disruptions. Surgeons who used telepathology during IOCs believed that this approach helped them to improve the quality of care they provide to their patients, in particular by reducing the number of second surgeries and patient transfers. From an organizational perspective, telepathology has also contributed to the recruitment and retention of surgeons in remote regions. Despite these positive findings, more research is needed to investigate the challenges and benefits associated with the implementation of large and decentralized telepathology networks.

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Chapter 3
Essay 3: The Transformative Role of Telemedicine on Coordination: A Practice Approach

Abstract

By abolishing distance between patients and healthcare practitioners, telemedicine is one of the solutions put forward to address issues of accessibility and increasing costs of care in health systems. But delivering care at a distance also means changing work practices and reorganizing inter-professional coordination. Using case study methodology, we explored work practices, intraoperative consultations and expert opinions of three occupational groups (pathologists, technologists, and surgeons) in the deployment of a major telepathology network in eastern Canada. The primary objective of this study was to determine the extent to which and how telemedicine modifies coordination.

The introduction of technology may highlight the shifting boundaries between professional groups, revealing transformations in coordination practices. Telemedicine has a transformative role in coordination. This study's findings suggest there are four main transformations in implementing telepathology: 1) predictability through plans and protocols; 2) maintaining familiarity through common understanding and standards of practices; 3) facilitating proximity to promote accountability; and 4) shifting from collective to individual accountability. These findings suggest a redefinition of predictability, common understanding and accountability as dimensions of coordination. Moreover, our findings highlight differences in transformations between inter-professional coordination and coordination within the same professional group. With telemedicine, inter-professional coordination evolves by redefining the boundaries between the groups, while the transformations in coordination within the same professional group are less visible because of the absence of such boundaries.

3.1 Introduction

Telemedicine, the use of telecommunications to diagnose and treat diseases and ill-health, has become a multibillion dollar business in recent years. Worldwide total revenue is poised to grow from $19.2 billion in 2014 to $43.4 billion in 2019 (BCC Research 2014). One of the reasons for this growth is the potential of telemedicine to address some of the key challenges facing healthcare systems in developed countries, such as controlling the spiraling costs of care and improving accessibility of care. To harness potential benefits, healthcare organizations and care providers need to understand and adapt to this new way of delivering care services (Nicolini 2006).

Most research on telemedicine adopts a clinical, technical or cost/benefit approach (Nicolini 2006), but telemedicine is more than a faster way to access existing health care resources; it also represents an organizational and social innovation (Bashshur et al. 2000) that brings with it several organizational challenges (Aas 2007). Telemedicine can be conceived as a collaboration platform connecting experts to non-experts (Brauchli et al. 2004), and as a consequence, health care providers need to build mutual trust (Medeiros de Bustos et al. 2009), remotely coordinate (Nicolini 2011), and more generally integrate telemedicine activities into existing models of care (LeRouge and Garfield 2013). In short, coordinating the provision of care services may constitute a major challenge when telemedicine is introduced in the health care sector.

Coordination, which is defined as "a temporally unfolding and contextualized process of input regulation and interaction articulation to realize a collective performance" (Faraj and Xiao 2006:1157), is essential to the effective delivery of care services. The quality of coordination is associated with patient outcomes and the overall performance of health systems. Achieving better coordination has drawn growing interest from researchers and health care accreditation bodies (Gittell et al. 2010; Young et al. 1996). Coordination plans and protocols are essential but under-specified, because it is impossible to account for all real life events. Effective care service delivery often requires tight coordination among diverse stakeholders including physicians as well as nurses, allied professionals, technicians and administrators. In addition, care coordination may be complex due to environmental uncertainty that often results in emergent work practices. For example, in a medical trauma centre, physicians and nurses, faced with recurring emergency situations, not only rely on formal rules and structures but also on a set of emergent coordination practices. An emergent coordination practice in an emergency ward could be the rapid set-up of ad hoc teams made-up of surgeons, nurses and other required specialists available, instead of resorting to hierarchical decisions. This enables the ward to quickly react and adapt to unexpected events and difficult dialogic situations (Faraj and Xiao 2006). A practice approach, that focuses on activities and actions, rather than on formal decision-making structures is appropriate in environments where there is uncertainty and complexity, such as in complex health care organizations (Chua and Yeow 2010; Faraj and Xiao 2006; Xiao et al. 2007). It draws attention to the human interactions during coordination.

Coordination unfolds at the level of routinely articulating a set of interdependent tasks, as well as at the level of "adjusting to change" and unexpected real life events (Schmidt and Simonee 1996). The introduction of a new information system into a workplace may be classified as adjusting to change. Indeed, information systems not only facilitate communication and the exchange of the information necessary for coordination, they also alter coordination processes and strategies (Malone and Crowston 1994). Physical artifacts afford flexible coordination in health care settings, such as flexibility in organizing the information to share, which may be difficult to replicate through technology (Xiao et al. 2007). Thus, coordination routines may need to adapt to the affordances and constraints of digital artifacts over physical ones.

Prior research in the particular field of telemedicine reveals the influence of personality, personal interaction and experience on coordination (Aas 2001). Also, the concept of trust is associated with performance within interprofessional coordination contexts (Paul and McDaniel 2004). One of the necessary adaptations in the ehealth models of care is establishing new professional roles, new divisions of tasks and new patterns of interactions among different professional groups (Barrett et al. 2012). Professional groups play a key role in determining the processes of coordination, and technology can transform the relations between different occupational groups within a hospital and over time reconfigure their boundary relations (Barrett et al. 2012). In a seminal paper, Barley

(1986), shows how the introduction of an IT-based artifact (a CT scanner) triggered a significant transformation in the interactions between technicians and radiologists, and a change in institutional roles and responsibilities. His findings suggest that unintended consequences can lead to new patterns of action (scripts) that subsequently reify into structural transformations, such as in roles and status. Because actions follow a contextual logic, identical technologies can generate similar structuring processes, yet lead to different structural outcomes. In one hospital, technicians were empowered and became the experts in handling the new device, while in the other, the radiologists developed the expertise, relegating technicians to an unskilled, supporting role (Barley 1986).

Telemedicine, by enabling coordination across organizational boundaries, initiates such a structuring process. Medical work remains largely organized around the premise of colocation of patients and of all the professionals involved, and this has cultural, legal and practical ramifications (Nicolini 2007). Telemedicine challenges two cornerstones of medical practice: the patient-clinician encounter and the assumption that an episode of care takes place within a single organizational site (Bashshur et al. 2000).

Accountability, the assignment of responsibility for each element of the task to collectively achieve, is crucial for coordinating work (Okhuysen and Bechky 2009), and impacted when implementing telemedicine. Indeed, telemedicine often requires the transfer of some medical tasks from doctors to allied professionals. For instance, in a home telemonitoring program for cardiac patients, one of the responsibilities of nurses in charge of monitoring patients from a distance was to transfer information from patients to physicians. However, their role as an intermediary also extended to interpreting clinical information, a task physicians traditionally manage. For instance, nurses ignored impossible vital signs mistakenly recorded and transmitted by patients. As the home telemonitoring system essentially replaced some doctor-patient encounters, nurses had to make concerted efforts to account for their work and the doctors' prescribed treatment, thus stretching to its limits the principle that "a doctor is always in charge" (Nicolini 2006).

Telemedicine may also alter the meaning and purpose of medical roles. In a telecardiology project conducted in Italy, the initial goal was to provide patient access from home to cardiology specialists in order to prevent and deal with cardiac emergencies. Instead of achieving this goal, the telecardiology project reoriented to a social practice of reassuring patients about their condition and reassuring general practitioners about their decisions (Gherardi 2010). These findings suggest that telemedicine is associated to a shift in task assignment and accountability, but the role and extent to which co-presence structures accountability remains unclear, as well as what role different professional groups play in these transformations.

In sum, prior research provides us with some insight into how telemedicine transforms the fabric of work practices in healthcare organizations, but there still lacks a clear account of the transformations as they relate to coordination in particular. Hence, the main objective of this study is to develop a theory of how telemedicine transforms coordination practices. We focused on stakeholders' actions and on understanding the context of coordination. To achieve our main research objective, we analyzed the changes in coordination as perceived by three key occupational groups: pathologists, technologists, and surgeons, within the context of a major telepathology initiative in Canada. To understand the role of professional groups, we investigated two major telepathology usages, one involving coordination across professional groups (intraoperative consultation) and one involving coordination within a professional group (expert opinion). In short, our empirical study attempts to provide an answer to the following research question: To what extent and how does telemedicine influence coordination among health care professionals?

The remaining of this paper is structured as follows. In the next section, we present the research methods. This is followed by a presentation of the coordination mechanisms used in traditional and telepathology settings for two major usages, intraoperative consultation (IOC) and expert opinion. We then analyse the transformations that occurred with respect to three dimensions of work coordination, namely, the shift from routines to plans and rules to achieve predictability, the shift from familiarity between stakeholders to standards and protocols to achieve common understanding, and the shift from collective to individual accountability. We conclude by discussing the main contributions of our study, its limitations and implications for both research and practice.

3.2 Methodology

We employed an inductive approach of analysis on a single case study (Eisenhardt 1989; Paré 2004; Yin 2014). We focused on the everyday practices used to coordinate pathology-related work before and after the introduction of telemedicine. Our respondents were the clinicians involved in telepathology episodes, namely, pathologists, surgeons, and technologists.

3.2.1. Research setting

The particular application of telemedicine that we investigated in this study is called telepathology. Pathology is the branch of medicine that studies the nature of diseases and their causes. There are two main occupational groups involved in pathology: laboratory technologists and pathologists. Pathology frequently requires laboratory technologists to prepare human tissue samples into slides so that pathologists using microscopy may examine them. Pathologists examine tissue slides in order to detect and diagnose disease, notably cancers (Weinstein 2008). These diagnoses orient surgeons' decisions, which may include surgical intervention. In traditional settings, technologists, pathologists, and surgeons work in close collaboration with each other in the performance of interdependent yet sequential tasks. At times, pathology work requires rapid and novel responses to clinical necessities. In telepathology, instead of using microscopes, pathologists examine and diagnose scanned tissue sample slides using high-resolution computer screens (Weinstein et al. 2009). The College of American Pathologists defines telepathology as "the practice of pathology, in which the pathologist views digitized or analog video or still image(s), and renders an interpretation that is included in a formal diagnostic report or documented in the patient record'' (Williams et al. 2010). With telepathology, instead of being examined through a microscope, the slide is scanned, pathologists view the virtual slide using a high-resolution computer screen and then they perform a diagnosis from the image rather than from the physical artifact (Weinstein et al. 2009). Telepathology requires a high level of coordination and confidence between these professionals to ensure quality and reliability (Bernard et al. 2014). More details of the practical aspects of a telepathology environment are provided in the results section.

We chose a project that was particularly revealing of transformations in coordination and critical in that it constitutes a major telemedicine project in scope (Yin 2014). The telepathology project under study was deployed in Eastern Quebec, Canada. The region provides health care services for a territory the size of Germany, but is inhabited by only 1.7 million people. The population density of this region varies with a densely populated urban centre with a university hospital, and sparsely populated remote areas served by small regional hospitals. In total, 48 pathologists and 17 sites work in the region targeted by the project, which makes it one of the largest telepathology projects in the world. Although 33 of the 48 pathologists are located at the university hospital site, the project has no central location responsible for providing pathology expertise throughout the network. In other words, each site is responsible for developing and negotiating service level agreements. These agreements are contracts signed between hospitals where one of the hospital (consulting site) agrees to provide pathology services to the other (requesting site). See Figure 1 for the links within the network and beyond. Due to the fragmented manner in which hospitals in this region operate, the current project constitutes a decentralized type of telepathology network, which is associated with heightened coordination challenges (Meyer and Paré 2015).

Importantly, the integration of telepathology into the pathologists' work practices is highly discretionary. Indeed, pathologists cannot be forced to adopt telepathology. For their part, surgeons are often motivated to adopt the technology, since it improves their access to pathology services, and they are involved during system implementation to ensure that the project meets their expectations and reassures them, and to obtain their support, which facilitates the material changes required at the referring site. Surgeons also have the choice of using or not using the technology, and in some instances where the system faced technical issues, they actually stopped using it (Pare et al. 2016). Finally, technologists have little choice but to adapt to the new technology when pathologists and surgeons decide to implement it.

The telepathology system was gradually deployed across the network in late 2010 and early 2011. In each participating hospital, a range of appropriate equipment was installed (Pare et al. 2016). The equipment included is described in Appendix A.

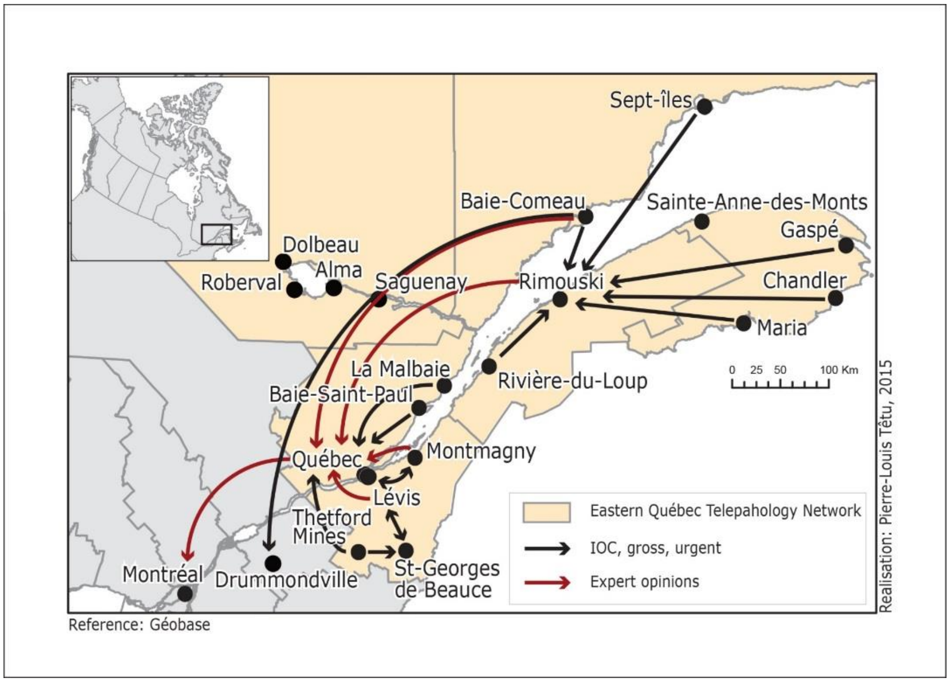

Figure 4. The Telepathology Network (as of March 2015)

3.2.2 Data collection and analysis

We used multiple instruments and sources during data collection and analysis to facilitate the development of theory (Eisenhardt, 1989). Our data collection process involved a total of 60 interviews, conducted between 2012 and 2015 with 51 different participants drawn from 14 different hospitals, leading to over 44 hours of recorded material. Using a semi-structured interview guide, 51 interviews were conducted face-to-face and nine were conducted over the phone. We had the opportunity to interview some participants multiple times at different stages of the project. Participant recruitment was a mix of snowball sampling and maximum variation method, in order to get access to new participants, and to corroborate our findings under different circumstances (Paré 2004; Patton 2002). We asked the initial participants (e.g., clinical champions, leading technologists) for other potential participants with experience in the telepathology system, emphasizing that we were recruiting clinicians who might have different experience with the system, such as different coordination mechanisms, issues, or contexts, or participants in favor or reluctant to use telepathology. Interviews were conducted until we reached theoretical saturation (Eisenhardt, 1989).

An interview guide (see Appendix B) was used to elicit the coordination practices in use with and without the telepathology system. It includes open-ended questions when participants could describe their personal experiences with telepathology and their interactions with the other stakeholders in coordinating their work. The interview guide was developed iteratively during the interview process so emergent insights and new concepts about transformations could be captured. We also spent several days in hospital laboratories, enabling us to directly observe stakeholders coordinating in situ, and interactions. Last, we gathered relevant documents, such as monthly statistical reports of system usage and project manuals.

In terms of data analysis, we followed the principles of positivist case study research for theory development purposes (Dubé and Paré 2003; Paré 2004). The first step was to write field notes about interviews, site visits and observations, and to develop an understanding of how coordination was achieved. The interviews were transcribed verbatim and we initially oriented our analysis towards describing the case, in terms of coordinating in traditional pathology settings and in telepathology settings (Yin 2014). One of the interviewers developed a coding scheme to capture the transformations in coordination, i.e., any type of change in the material arrangements, the process, the people or the knowledge involved in coordination when performing IOCs or expert opinions. Using the NVivo software, the coding scheme was further developed as new themes emerged in our analysis. Coding terminology was oriented towards action and the verb form rather than substantive form, in accordance with the practice perspective that highlights what stakeholders actually perform.

In short, coordination-related actions were identified and grouped based on: 1) what activity, performing an IOC versus providing an expert opinion (more details on these later) they helped perform; 2) what stage of the process they were used (e.g., planning versus providing the final diagnosis); and 3) whether they were used in traditional settings, in telepathology settings or both. In the following section we describe how telepathology has materially transformed the laboratory work environment. We then explain and illustrate how two telepathology usages, namely, IOCs and expert opinions, influence coordination practices within the health care network.

3.2.3 Material transformations in the work environment

Telepathology introduces substantial material changes to the pathology laboratory environment. These changes are both mechanical and digital (Barrett et al. 2012). As shown in Figures 5 and 6, mechanical changes involve the introduction of new equipment: in the laboratory, there is a telemacroscopy workstation, a scanner, a computer station, and. In the pathologist's office or on a mobile cart transported to the pathologist on duty, there is a high definition screen dedicated to viewing what happens at the telemacroscopy station. During the system installation stage, a dedicated space is cleared to accommodate the new devices. The macroscopy workstation is typically installed in the laboratory itself, as it allows the handling of patient specimens. The technologists stand when they operate the workstation. Local laboratory technologists are responsible for keeping the telepathology material operational, along with the rest of the laboratory equipment.

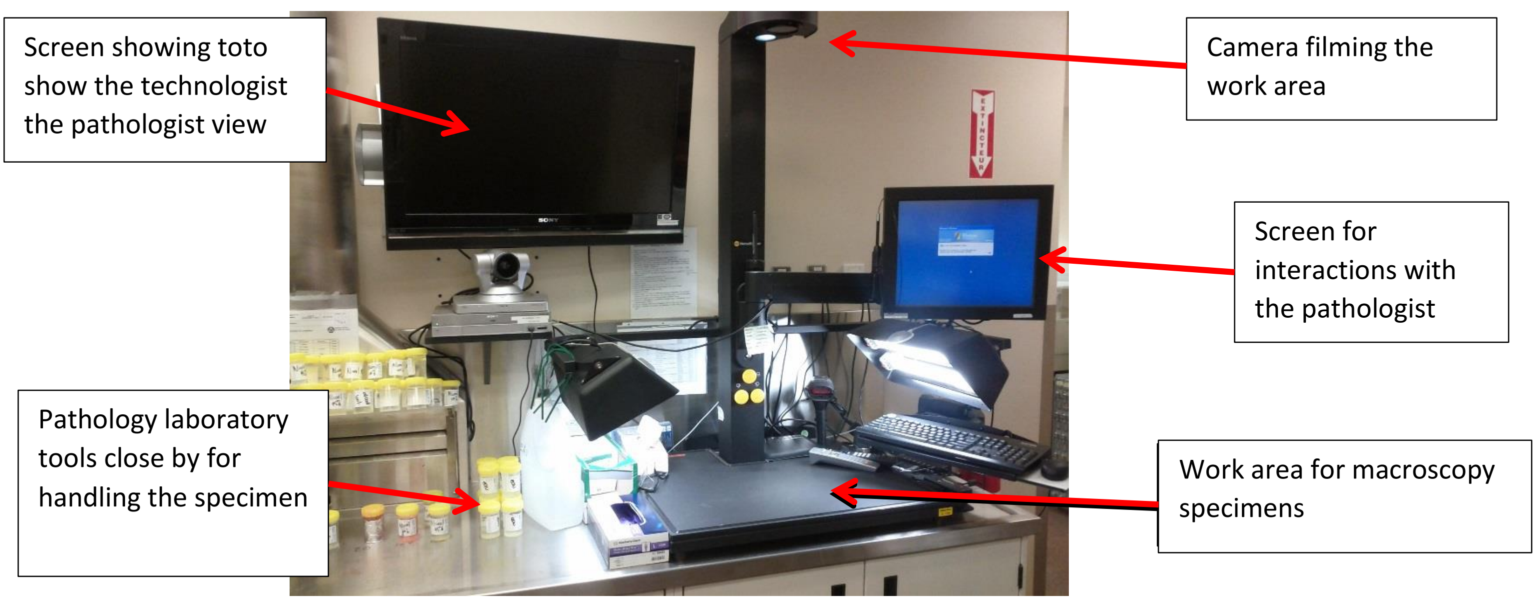

Figure 5. A telemacroscopy station

The scanner and computers loaded with the telepathology application are located slightly apart from the other laboratory equipment. They are often located in a separate room, in a setting more reminiscent of office work. Technologists insert the glass slides in the scanner, remove their gloves, and operate the scanner through a computer.

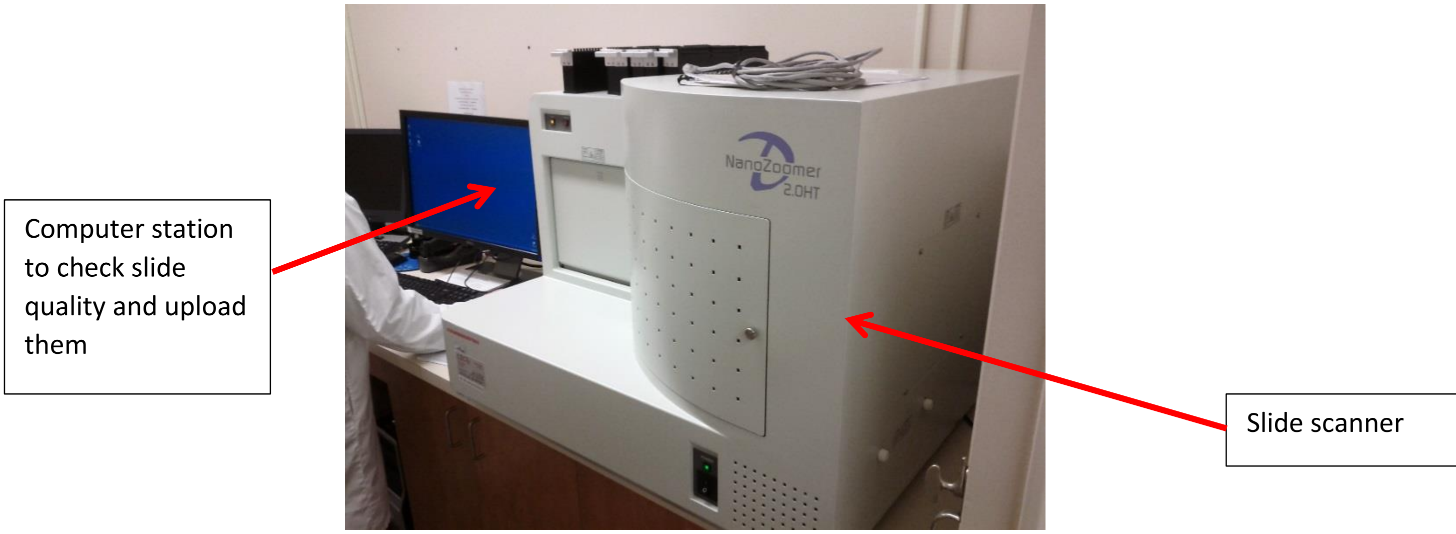

Figure 6. A scanner

The digital materiality consists of the telepathology software applications that are used to scan and consult the slides, as well as, provide communication about the process between pathologists and technologists. These are proprietary interfaces designed by the system providers. As detailed in the following sections, the software features differ significantly from the handling of glass slides, in terms of accessing, sharing and/or displaying the slides. Both mechanical and digital materialities are intertwined. The macroscopy station allows the technologists to manipulate the specimen under the supervision of the off-site pathologists using the communication system.

As shown in Figure 7, the laboratory environment revolves around the manipulation of physical artifacts: specimens, tools to manipulate them, and chemical components to alter their properties. The activities of pathology have implications on health and safety practices in the laboratory. As a technologist puts it: "*The specimen arrives in a specialized room (…), a kind of kitchen, in a way. The floor can be washed, the surfaces are contaminated, so to speak. We can't do things such as eating there. There are security and hygiene rules*". In contrast, the computer and the scanner are used for uncontaminated activities (i.e., not in contact with biological material that may transmit diseases or be altered by the environment) and can be installed inside the laboratory or in any room nearby.

Figure 7. A view of a typical pathology laboratory work environment

In most hospital settings, the pathologist's office is usually located across the hall from the laboratory where technologists work; thus, verbal exchanges are frequent between team members. The pathologist office is uncontaminated as well. There are two main material devices in a pathologist's office: the computer and the microscope. Traditionally, the microscope is used to interpret the slides, while the computer is used for the pathologist's other tasks, such as email or updating electronic records (or physical ones through printing). With the digitization of physical slides, pathologists interpret digital images from a computer interface (as radiologists do with picture archiving and communication systems). Nevertheless, microscopes remain the preferred medium over digital images for local, routine slides, as it is broadly considered faster and more convenient in the current state of the technology (Meyer et al. 2014).

Slides are produced by physical manipulations in the laboratory. They are "fixed", which means that they have lost their properties of contamination, as well as - to a large extent - its biological propensity to degradation. Coloured and reduced to two dimensions slides are formatted solely to be observed under a microscope. This comes at a cost though as the possibility of further altering the original specimen, for instance by cutting it differently, is limited. The digitization of slides is another step towards rendering the slides easier to access, share and store. Simultaneously, multiple users may access digital slides at an instant, from anywhere. Also, slides do not degrade over time. The drawback of digital slides is that one cannot use biological manipulations, such as modifying colorations. In some cases, pathologists may need the original specimen to provide a reliable diagnosis.

3.3 Case findings

Although non-digital pathology is still the dominant mode for pathology services, even when telepathology systems are available, the versatile nature of digital slide technology has led to emergent applications. Indeed, telepathology has been used for various purposes including: IOC, expert opinion, macroscopy, routine diagnosis, teaching and training, and replacement work when pathologists are absent (Meyer and Paré 2015). Clinicians are continually finding emergent applications for telepathology. There are 18 different applications of telepathology in the current project. As mentioned earlier, in this study we focus on two of the most important ones: IOC and expert opinion. In the following section, we examine each of them in detail.

3.3.1 Coordination in traditional and telepathology settings

Intraoperative Consultation (IOC) in traditional settings

In an IOC, the whole process of extracting, preparing and diagnosing a sample is performed during the timeframe of a surgery. Typically, the goal of an IOC is to inform the surgeon whether a cancerous tumor has been fully removed and the surgery can be terminated, or if not, an IOC will inform the surgeon on how to proceed with the surgery (Pare et al. 2015; Têtu et al. 2014). In the absence of an on-site pathologist, the surgeon has three options: 1) to assume the worst and perform a more aggressive surgery; 2) to transfer the patient for surgery to a hospital with a pathologist; or 3) to operate in two steps, so that the slide can be sent to a remote pathologist and then a second surgery may be performed if necessary. IOCs are generally planned ahead of time but may also be unplanned, i.e. when unexpected developments during a surgery pushes the surgeon to request pathology expertise. As explained below, each IOC represents a highly collaborative process that requires a high level of coordination and includes the following steps: planning the surgery, extracting the specimen in the operating room, and providing diagnoses to surgeons under stringent time constraints.

The first step in an IOC is to plan it. Planning ensures the availability of laboratory resources during the surgery. In traditional settings, planning is generally performed in the laboratory by interpreting schedules *(see labelled coordination mechanism A. in Table 3)*, because incoming pathology requests can generally be deduced from operating room schedules. For instance, if a lobectomy is scheduled, the surgeon will likely require an IOC. Operating room schedules are examined and interpreted by technologists, pathologists or laboratory secretaries in some cases, who infer IOC cases and plan further action without consulting the surgery team. For example one pathologist we interviewed describes the IOC planning process:

> *"Basically, the day before, we receive the operating procedure. It is the list of all the surgeries planned for the day after, with the name of all patients and the surgeons who are going to perform those surgeries. According to the type of surgeries that are going to be performed, we are able to guess which ones will require an IOC."*

Surgeons may phone the laboratory to inform them in advance, but overall, they don't need to formally request pathology support. In many cases, technologists may not even inform the pathologists, who wait for the slides to arrive to their office, ready to be read. The day of the surgery, an operating room nurse signals the start of the process by warning the laboratory that the surgery has started *(C)*. IOC planning is done well before the surgeon extracts a specimen from the patient and has it transferred to the laboratory. After extracting the specimen the surgeon typically phones the technologist, who in turn phones the pathologist.

Upon reception, small specimens (e.g., brain specimens) are directly sliced into slides ready to be handed to the pathologist. Small specimens can be handled by technologists without any supervision. On the other hand, large specimens (e.g., an intestine section) need to be handled, oriented and coloured, to produce blocks of tissue in a process called macroscopy. For the more complex specimens, such as full breasts or intestines, macroscopy requires medical expertise. Macroscopy is a task shared between technologists handling the simple cases, and pathologists handling the complex ones. The technologist receiving the specimen in the laboratory determines whether an expert intervention *(D)* by a pathologist is required for the macroscopy. If that is so, the technologist stages the specimen on a macroscopy workstation, and calls the pathologist, who comes to the lab, manipulates, orients and describes the specimen, and sometimes clarifies issues with the surgeon over the phone.

Specimens require substantial physical processing to turn into physical slides amenable to analysis by pathologists. Once the blocks have been extracted from the macroscopic specimen, the next step is to prepare the glass slides to be examined microscopically. In a nutshell, the process is: 1) freezing a block; 2) slicing it; 3) performing chemical manipulations to color it, in order to highlight the elements of interest; and 4) fixing it to prevent deterioration (Pare et al. 2015; Têtu et al. 2014). After a glass slide is prepared, it is ready to be examined through a microscope by the pathologist.

IOC slides are a part of the daily work that comes from the laboratory to the pathologist office. In traditional settings, physical slides (IOC and routine) are usually carried to the pathologist by the technologist. To make this transfer less time-consuming and disruptive, technologists organize batches of slides through a directed folder (see Figure 8) before handing them over to pathologists *(F)*. In a folder, all the slides from a patient are stored on the same page, and within a page, slides are ordered in the logical order in which they should be viewed, such as by the area they were extracted from. Coloured stickers on the folder's edge denote the nature of the case or the level of urgency. Non-urgent, routine slides are gathered in batches of multiple patients, and delivered to pathologists following a routine schedule every day. IOC (as other urgent cases) are generally brought individually, but still organized in folders following the same logic. A technician describes the IOC slide delivery interaction:

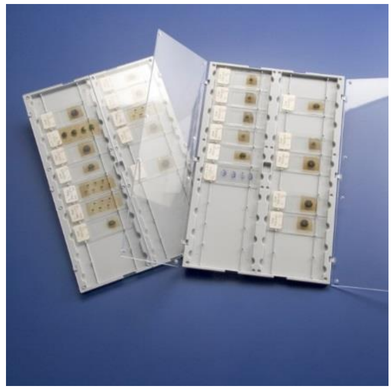

Figure 8. Glass slide folders

> *"We used to carry the [IOC slides] to [the pathologist's] office. He was at his desk doing microscopy and other routine daily cases. We brought the slides and told him: "This is your IOC". So he dropped his business and started immediately [working on the IOC] and communicated directly with the operating room to provide the results. In some cases, he could come back to us to request another cut because he couldn't see enough specimen."*

Alternatively, the pathologist may already be working in the laboratory (staying after performing the macroscopy step for instance) doing other activities. Technologists then directly hand the slides over to the collocated pathologist *(G)*, who examines the slides through a microscope located in the laboratory.

Once the pathologist has examined the slides, he or she generates a diagnosis and then calls the surgeon waiting in the operating room *(I)*. Once the diagnosis is communicated, the surgeon may request additional exams, or terminate the surgery. After the IOC, the technologist prepares the sample for the final diagnosis. Frozen section, the process used for IOC, is the "quick and dirty" way to prepare a glass slide. Freezing makes it possible to immediately slice the specimen, but at a cost in quality. A pathologist likened examining a frozen section to "*driving under a heavy rain*". It is still possible to drive, but mistakes, although rare, are more likely. To make sure no mistake has been made, after the IOC diagnosis, the technologists unfreeze the specimens and prepare the slides using traditional methods that involve overnight chemical processing. The day after surgery, a final diagnosis can be provided; however, since the surgery is completed, the final diagnosis matters only if it differs from the IOC diagnosis. In these rare instances of discordance (Perron et al. 2013), the pathologist can either simply mention it in the final report provided to the surgeon, or call the surgeon if he or she feels there may be potential patient safety implications.

Expert opinions in traditional settings

Expert opinions occur when a pathologist requests the opinion of another pathologist, either to get a second opinion from a peer on ambiguous cases, or because the consultant has expertise in complex cases. In order to obtain an expert opinion, a pathologist may informally consult a local colleague, or formally share the glass slides with a local or distant pathologist. In general, pathologist prefer to consult their immediate colleagues first, either formally or informally.

Informal expert opinions are generally oriented to local colleagues, and requested orally. The referring pathologist may informally take the slide to the consulting pathologist's office to seek a second opinion *(J).* The referring pathologist hands over the slides to the consultant, or the consultant goes to the referring pathologist's office and uses his microscope. Unofficial expert opinion practices can also be formally structured. In larger laboratories, pathologists may hold slide sessions with fellow pathologists *(P)* where difficult cases are presented and discussed. These sessions are generally held outside of regular clinical activities. Expert opinions are unofficial as peers do not sign-off on their opinions, their consultations are non-committing, and the consulting pathologist cannot be held liable for the diagnosis provided *(O)*.

Alternatively, the referent pathologist may fill-out an official expert opinion request form *(K)* and submit it to a colleague. The consulting pathologist signs-off on their diagnosis; thus, may be held accountable for their opinion. Whether a request is official or unofficial depends on the degree of doubt of the referring pathologist (the more doubt, the more formal), as well as, the severity of clinical impact of diagnoses. While local expert opinion may be sent to a peer with equal expertise, in order to get a second opinion, distant expert opinions are always directed towards an expert of the slide being shared. Distant expert opinions are always formal and traceable. Referring pathologists usually write a formal expert opinion request and courier it to the consultant, but may also ask permission by phone first.

Distant expert opinions are sent to consultants that a pathologist knows will help him or her. They are usually part of a referring pathologist's professional network, mostly within the province. There are over 220 pathologists registered in the province of Quebec. Within this small community, pathologists build their own networks of consultants with complementary expertise, colleagues they learned with, worked with or share similar interests with.

After the consult request has been accepted by the consultant, the referring pathologist transfers a request package *(M)*. The referring pathologist is expected to provide a comprehensive package containing the slides that are already prepared to be examined, information about the patient, and a reason for the request. The referring pathologist is expected to indicate a possible diagnosis in order to guide the consultant. At the consulting site, the package is opened either by technologists or laboratory secretaries and then transferred to the consultant pathologist's inbox. Referring pathologists sometimes send the slides without first requesting the consultation, so they usually enclose a request letter with the slide package. The consulting pathologist accepts the request and may view the slides immediately, collapsing the process into a single step. Sending the slides without seeking the consulting pathologist's acceptance first makes it difficult for the consultant to refuse the case, since this would considerably lengthen the time of diagnosis.

Telepathology-based Intraoperative Consultation (IOC)

A key driver for adopting and using telepathology is the fact that it is the only way for a surgeon to obtain an IOC when there is no pathologist on site. Between January 2011 and March 2015, 1,843 slides were scanned for IOC purposes in the network. Telepathology-based IOC process usually involves a surgical team, a technologist in the local laboratory, and a distant pathologist.

At the planning stage, surgeons must make a specific formal service request *(B)* for an IOC at least one day in advance of the surgery. A pathologist explains this process as follows:

> *"We ask [the surgeons], as part of our clinical protocols, to indicate the cases for which they believe they will need an IOC. The on-duty pathologist receives the list of IOC cases the day before to be able to plan his work".*

As detailed above, the telepathology system includes a dedicated videoconference system to support technologists while performing a macroscopy. The pathologist sees the specimen, talks to the technician handling it, and can even draw indications of where to cut or colour over an image of the specimen. However, the system has constraints, such as a local technologist needs to physically handle the specimen and the pathologists are unable to palpate the specimen, which is sometimes necessary to identify a cancerous node. One pathologist describes this process as: "*technologists become our hands*".

The physical absence of pathologists creates ambiguity about who should physically manipulate specimens in complex cases. The regional health network established an expert committee to define telepathology protocols. The committee recommended that surgeons be available for the macroscopic examination (Bernard et al. 2014) because surgeons are more competent than technicians in palpation skills and know the location of tumors. Technologists are expected to perform macroscopy with supervision in complex macroscopy cases, but rarely rely on surgeons. In addition to prior experience working with consulting pathologists, technologists are always in the laboratory and have experience with macroscopy. On the other hand, surgeons are not readily available to perform macroscopies as they are usually in the operating room and face time constraints.

Telepathology adds extra steps to the slide preparation stage. Before a technologist can hand over slides through the system *(H)*, they go to the scanner room, log into the system, load the slides into the scanner, scan, check the image quality, upload the digital slides to the pathologist, and finally inform the pathologist when the slides are ready. Then, the pathologist has to log into the telepathology system, select the case and the slides before consulting them. The system notifies the pathologist when digital slides become individually available. The case priority is managed either by the technologist tagging a slide as "urgent" in the system, or by phoning the pathologist to inform them of the online availability of urgent slides. Alternatively, the pathologist may keep an open phone line, while muting the phone's microphone, with the laboratory during macroscopy to keep track of the slide preparation process.

The telepathology system automatically attaches the metadata to the digital slide. The metadata includes information about the slide itself (i.e. patient name, time of collection, the slide's nature and priority). The pathologist clicks on an incoming case and sees the digital slides displayed in the order dictated by the application. This process leads to an extra task of sorting them for viewing after the diagnosis as one pathologist describes below:

> *"When I receive glass slides, they are already sorted. The slides go from A to A1, B1 to B20, etc. and I look at them in order, I have the sequence of the examined case. When I receive [complex cases] by telepathology, often, they are not in order and I can't rearrange the pictures."*

The pathologist then phones the surgeon waiting in the operating room to inform him or her of the diagnosis. A direct verbal exchange with the surgeon is critical. Not even a nurse present in the operating room may relay the diagnosis. It must be the surgeon himself or herself (with the exception of a resident) who receives the diagnosis.

After the IOC, the unfrozen slide is shipped to the consulting site where chemical processing of the slide takes place. The technologist receives the specimen and prepares the slides for the pathologist in charge of the case.

In short, in traditional and in telepathology settings, there are four steps involved in the coordination of an IOC: 1) planning the IOC before the day of the surgery, and just before the surgery starts; 2) Coordinating surgeons, technologists and pathologists when the specimen arrives from the operating room to the laboratory; 3) Preparing the slides from the specimen and handing them from the technologist to the pathologist; and 4) Sharing the diagnosis with the surgeon. Table 6 presents a summary of the key coordination mechanisms in traditional settings and in telepathology-based settings for each step of an IOC.

Table 6. Traditional versus telepathology-based coordination mechanisms in the practice of IOC

Step/Setting	IOC in a traditional setting	Telepathology-based IOC
1. Planning IOC	*A. Schedules interpretation* Technologists and pathologists take the initiative of anticipating and planning IOC from the operating room schedule	*B. Formal request* Surgeons are responsible for requesting impending IOC from the laboratory at least a day before the surgery
2. Macroscopy	*C. Direct information by phone* Technologists are informed of IOC by surgeon/nurses. Technologists phone the pathologists when they get the sample.	
	D. Expert intervention Pathologists come to the laboratory to perform macroscopy on complex cases	*E. Expert supervision* Technologists, under surgeons' supervision physically handle complex cases using the macroscopy station and the videoconference system
3. Slide preparation	*F. Collocated Handover* *G. Handover through a directed folder* Technologists personally give the slides, organized in a folder, to the pathologists	*H. Handover through system Upload* Once technologists have uploaded the digital slides in the telepathology system, the pathologists are notified by the telepathology system and they sometimes receives a confirmation by phone from technologists
4. Diagnosis	Pathologists diagnose the slide using their microscope	Pathologists diagnose the slide via their computer screen
	I. Expert conclusion sharing The pathologists phone the diagnosis to the surgeons, then writes the full report	
	Technologists prepare the final sample right after the IOC for examination the day after	
		Technologists ship the physical slide to the distant pathologist
	I. Expert conclusion sharing Pathologists confirm the telepathology diagnosis with the physical specimen, and contact the surgeon directly in cases of significant discrepancy with the initial diagnosis	

Expert Opinions

The second major application of telepathology is called expert opinion, where pathologists share digital slides with other pathologists using telepathology. Between January 2011 and March 2015, more than 3,290 slides were digitalized for expert opinions between pathologists involved in the regional pathology network.

In telepathology, expert opinions have *de facto* an official status. The system tracks requests, rendering the request official and the consultant accountable. A referring pathologist will generally choose a consultant, request his or her help, and afterwards send the case (a set of slides assigned to one patient). Requests generally start with a phone call, as the referring pathologist normally seeks the consultant's agreement before sharing the digital slides. Not all pathologists will accept expert opinion requests through telepathology; therefore, a list of pathologists accepting such requests is available in a centralized system. Also, pathology laboratories may keep a more limited list of pathologists that expert opinions are usually referred to. A consulting pathologists describes the referral process as follows:

> *"[The telepathology system] sends [the request] to my email account. As soon as I receive it, I log into the system and I say Yes or No. I accept or not a request depending on the specialty involved in the case. But normally, when it is sent to me, it's because it is a case that I can handle".*

An innovation made available by telepathology is the possibility to create open-ended requests for expert opinions *(L)*. One of the features introduced with the telepathology system is the possibility to upload slides without assigning them to a specific consultant, an 'open case' (as opposed to a closed case that is visible only to the assigned consultant). Open requests are made available to the entire community of pathologists within the network. They are displayed in a particular section of the telepathology viewer application. All pathologists who connect to the application can view information about the open cases, such as the nature of the case and who the referring pathologist is. Any pathologist may accept open cases on a voluntary basis.

That open case application was not planned during project implementation, nor did pathologists expressed a need for this functionality. According to the pathologists we interviewed, there were no issues with finding consultants. Although unanticipated during project implementation, the open case feature's improvised usage may be evidence of an unstated need (Orlikowski and Hoffman 1997). Instead of accessing their personal network to identify an appropriate consultant, pathologists have the ability to passively find a consultant within the entire telepathology network. However, open case consults remain exceptional. One of the consulting pathologist we observed accepting open requests did not purposely search for open cases, but cast a cursory glance at them while logging to the system for other purposes. Pathologists are rarely looking for additional work. As one of them states: "*Some hospitals have a shortage of pathologists, so we try to help them. But [at the same time] I have enough work in my hospital, I can make a living with only that*." We found pathologists accept open cases mostly because of their specialization as one of them explains: "*Mostly, it's the nature of the [case] that is of interest to me. Or if the case has been [in the system] for a while and nobody takes it, so it means the patient has been waiting [so I will take it]*."

After accepting a case, the referring pathologist creates a system request *(N)*, including the slides and the metadata available in the system files. Telepathology requests differ from traditional ones in two ways. First, the slides go straight to the pathologist, completely bypassing the "central" technologists at the consulting hospital. Second, only the slide is uploaded, while in traditional settings, the referring pathologist may send both the original slides and the "blocks", i.e. sections of the specimen used to produce the slides (*M)*. If the consultants need extra colourations, they will request them from the referring centre, or have the blocks sent to them.

In sum, in traditional and telepathology settings, there are three key steps involved in the coordination of expert opinions: 1) The referring pathologist needs to find a suitable consultant; 2) He or she needs to share the slides and the necessary information; and 3) The consultant needs to send the diagnosis with the referring pathologist. Table 7 summarizes the key coordination mechanisms in traditional settings with informal requests for expert opinions, in traditional settings with formal requests for expert opinions, and in telepathology-based practices.

Table 7. Coordination mechanisms in the practice of expert opinions

<table>
<tr><th>Step/setting</th><th>Traditional setting - informal requests for expert opinions</th><th>Traditional setting - formal requests for expert opinions</th><th>Telepathology-based expert opinions</th></tr>
<tr><td rowspan="2">1. Selecting and contacting a consultant</td><td rowspan="3">J. Informal expert opinion request
Referring pathologist asks an on-site pathologist for a second opinion. Hands or shows the slides to the consultant
P. Slide session Difficult cases are presented and discussed amongst a group of pathologists</td><td colspan="2">K. Formal expert opinion request
Referring pathologist contacts potential consulting pathologists</td></tr>
<tr><td></td><td>L. Open request
Referring pathologist uploads an open request in the system</td></tr>
<tr><td>2. Sharing the slides</td><td>M. Request package
Referring pathologist sends the glass slides and the blocks to the consultant</td><td>M. Request package
N. System request
Referring pathologist shares the digital slides through the telepathology system</td></tr>
<tr><td>3. Providing a diagnosis</td><td>O. Noncommittal conclusion
Consultant either provides an oral or informal diagnosis</td><td colspan="2">I. Expert conclusion sharing
Consultant phones the referring pathologist to provide a committing diagnosis, later sending a written report</td></tr>
</table>

In the following section, we analyze the major transformations in coordination that occurred during the shift from traditional to telepathology-based settings and develop a series of research propositions around these issues.

3.3.2 Extent and nature of changes in coordination practices

Telepathology transforms the epistemic object of pathology, the very object of focus and investigation. Traditional setting practices are based on diagnosing physical artifacts as physical slides are prepared out of actual human tissues. With telepathology, the digital slide (i.e., the digital representation of the physical slide) becomes the epistemic object. It is the digital slide that technologists aim to produce, that pathologists analyze to reach diagnoses, and on which surgeons base their clinical decisions. The digitization of slides contributes to decoupling tasks related to handling physical specimens from tasks related to analyzing them.

The importance of this transformation is illustrated by the requirement that pathologists, after a telepathology diagnosis, also view the original physical slides in order to validate the telepathology diagnosis, even though the quality of diagnoses produced using digital images is similar to that using microscopes. This practice highlights legal and symbolic considerations about the physical slide, which remains the "gold standard" of pathology. The physical manipulation of slides is so ingrained in current practice that pathologists cannot conceive of completely removing microscopy from their work, and solely relying on virtual images. Medical specialists who traditionally require physical manipulations, such as pathologists, are less likely to change their routines and find utility in telemedicine, than specialties that primarily deal with images or numerical data (Lehoux et al. 2002).

Against this background of work practices in telepathology, how stakeholders coordinate in traditional and telemedicine settings may be categorized into four major transformations: 1) the predictability necessary to coordination shifts from a reliance on routines to a reliance on plans and rules with the introduction of telemedicine; 2) a decline in familiarity between stakeholders is offset by efforts to build standards and protocols to restore a sense of common understanding and trust; 3) stakeholders exhibit more accountability for collocated than for distant work to coordinate, regardless of organizational arrangements; and 4) accountability evolves from local and collective to contractual and individual. Each of these transformations will be discussed and illustrated in turn.

Notion 1: Coordination through planning instead of routines

Pathology laboratories, faced with huge amounts of repetitive tasks, rely heavily on routines, which can be defined as "repeated patterns of behaviour that are bound by rules and customs" (Feldman 2000: p.611) to coordinate work. In all hospitals, anticipating the workflow is essential because of the large number of specimens that need to be processed. The bulk of activity in laboratories is repetitive and relies primarily on structured practices so that workflow is predictable and efficient. Laboratory practices require frequent interaction between pathologists and technologists. Even rare variations in hospital practices and in people render routines unreliable. Two surgeons may differ on requiring an IOC for a specific type of intervention. Coordination is largely informal and is the result of negotiated and proven routines including: technologists referring macroscopy to pathologists (D), taking slide folders to the pathologists (F), and handing slides directly to the pathologist within the laboratory (F). Routines also work to shape objects, such as the glass slides technologists and pathologists work with. The format of the glass slides, their colouration, slicing and arrangements in folders, are standardized and organized in an effort to facilitate efficient interpretation by pathologists (G). Likewise, consultation requests rely on predictable physical or digital packages, including the slides themselves, information on the case and the patients, and a tentative diagnosis (M). Their purpose is to provide information and guidance about the glass slides being transferred. Routine aspects of these tasks is essential in establishing the predictability necessary for coordination and the management of uncertainty (Gittell 2002).

Through the experience of daily, repetitive requests for IOC, technologists and pathologists have learned to predict incoming IOC requests from viewing the local operating room schedules. However, this is not the case in telepathology-based IOCs as noted by a pathologist:

> *"In [our hospital], we know what the surgeries the next day will be. We are used to them, we know what types of surgeries will be done for what diseases, and that for that type of surgeries, the surgeon will want to ask this or that question. And to have that answer, an IOC needs to be done. By habit. (…) [With the distant hospital], I am not able to say that there may be a need for an IOC. I don't have the operating room schedule, and maybe, too, there won't be a need either."*

Slide sessions (P) are a good example of the coordinating power of routines. The coordination of slide sessions is built on the process of pathologists who meet at an appointed time, in an agreed upon location, and a routinized style of slide sharing and discussion. Slide sessions are technically possible and maybe even easier to conduct online using digital images. Actually, pathologists scan slides for collocated slide sessions, because digital images are easier to share and display. Nevertheless, without the co-location of stakeholders, slide sessions are less a collective event. With telepathology, pathologists send slides to multiple consultants, but asynchronously and individually. As one of them states: "*With telepathology, I can send the same slide to up to three different colleagues. I simply check three names, and eventually I receive three opinions*."

At a distance, setting up routines for infrequent and complex tasks may be difficult. Laboratory work becomes less predictable as there is more variance in the stakeholders involved, as the pathologist involved may change from one day to the other. There is also increased variance in slides. In the case of expert opinions, telepathology is used primarily for unusual cases. Rare specimens that may have been shipped to another hospital in traditional settings are turned into slides to be scanned locally. Uncertainty hinders the likelihood of routine development. Working with team members at a distance means that physical cues are not available. For example, the presence of the pathologist in the laboratory is necessary for a collocated handover (F).

Pathologists try to restore the routine aspect of coordination in IOCs by having technologists frequently practice macroscopy and slide scanning and sharing. IOC training and mock sessions with dummy specimens artefacts, such as large fruits, are conducted to ensure technologists are not only able to operate the system and perform macroscopy, but that they are also able to seamlessly understand the pathologists who monitor them during macroscopy and the process of expert supervision (E). Rehearsing over and over has been shown to enable smooth coordination during action in a wide range of eventualities (Okhuysen 2005). Some technologists spend up to three months in the consulting laboratory to learn how to do macroscopy work, before returning to the consulting hospital and telepathology-based macroscopy sessions.

In spite of the extra steps taken to plan coordination in telepathology, pathologists still struggle with the unpredictability of the work. One pathologist describes the unpredictability involved in IOCs as follows:

> *"People are afraid because they can't escape accountability. They need to be sure of the process and of the quality of the work done on the other side. Because it is a black box for us."*

It limits the ability to set up routine cases in a flexible manner. The telepathology system imposes its communication protocols to the exchange of slides, setting the rules for slide transfers, overrides the routines of traditional settings and, overall, becomes much more structuring. For instance, the macroscopy station with its live communication features becomes the locus of macroscopy coordination, limiting other forms of coordination.

One of the major adaptations we observed associated with the unpredictability of the environment in a telemedicine setting, and to the difficulty of setting up routines, is the increasing reliance on formal plans and rules. A pathologist describes formal planning as follows:

> *"We write down the process from start to end. We map it. The department head is held responsible with the [distant] consulting pathologist for writing down everything that is required for the pathologist to deem the tissue [the slides] satisfying. Then, pathologists validate the whole process, the quality, the information to share and the timelines. Everything needs to be listed and written. Once it's written, we validate and check that nothing was forgotten or doesn't work. That's how we ensure that everything works well."*

In sum, pathology work in a traditional setting is more repetitive than in a telepathology setting. This enables stakeholders to rely on reliable routines to coordinate. This is challenged by the variance in people and tasks of telepathology. To restore the necessary predictability of laboratory work, technologists and pathologists strive to formalize coordination processes. From this shift away from routines to formal plans and rules, we deduce a transformation in how predictability is achieved in order to better coordinate.

Proposition 1: *The introduction of telemedicine leads to a shift from routines to formal plans and rules which create the predictability necessary to coordinate effectively.*

Notion 2: Coordinating with unfamiliar stakeholders

Telepathology not only influences the predictability of tasks but also how stakeholders understand each other. Indeed, physical proximity between pathologists and technicians facilitates coordination during IOCs because seeing others work aids mutual understanding and allows the monitoring of work (Klein et al. 2006). Co-presence allows greater visibility. For example, physically seeing the pathologist can negate the need for any other coordination mechanism, as illustrated in handovers within the laboratory (G). During expert consultations, co-presence enables informal coordination mechanisms such as handing over slides within the laboratory (G), or sharing unofficial expert opinion (O, P), because less context about the case and the process is needed to ensure mutual understanding.

The visibility of other stakeholders appears to be the first casualty of telepathology coordination. However, visibility goes beyond physical co-presence. In both traditional and telepathology settings, clinicians resort to phones to communicate important information, such as communicating the start of the surgery and the diagnosis itself (C, I). Using the phone, a synchronous, rich communication device (Daft et al. 1987) creates visibility, reassures that proper action will be taken and that accountability for the following step has been transferred. The adoption of telepathology did not significantly alter this practice, even though alternative modes of communication are available (i.e. e-mail). Stakeholders phone each other at critical points in order to foster a sense of presence. That use of the phone creates a sense of proximity in addition to the exchange of information. For example, pathologists sometimes stay on the line with technologists after the macroscopy. Pathologists are able to hear what goes on in the laboratory while staying in their office, something they are not able to do in traditional settings. This maximizes proximity as a coordination mechanism. Proximity in terms of visibility may be replicated or even improved at a distance with technology.

More importantly, telepathology reduces familiarity between stakeholders. In addition to visibility, familiarity is another mechanism enabling coordination through proximity (Okhuysen and Bechky 2009). Familiarity relates to the relational aspect of coordination, conceptualized as “the role that frequent, timely, accurate, problem-solving communication plays in the process of coordination, but it also captures the often-overlooked role played by relationships" (Gittell 2002: p.1410). Familiarity enables anticipating the need or dynamically adjusting to the needs of other stakeholders without concertation between them (Bruns 2012), which can play a decisive role in collective performance (Lowry et al. 2009). Familiarity is prominent in traditional settings, allowing people in the laboratory to interpret schedules (A), or to facilitate informal exchanges (O, P). It also enables coordination between pathologists and technologists, such as handing over slides within the laboratory (G). A pathologist describes the role of familiarity and trust in the context of IOCs:

> *"[The technologists in our hospital] make more IOCs and we can interact directly with them, I trust them more, which doesn't mean that the others don't do a good job…"*

Familiarity enables people to locate others' expertise, which is particularly important in routing expert opinions requests to qualified experts (J, K), and also largely determines the choice of consultant for expert opinions. For expert opinions, pathologists first turn to local colleagues, even if they are not the best experts to address their request. Only when no expert can be found in their peer networks do pathologists look elsewhere, such as semi-official lists of experts (K). Stakeholders may also prefer physical proximity because collocation has been shown to reinforce "social similarity, shared values and expectations, and increases the immediacy of threats from failing to meet commitments" (Paul and McDaniel 2004: p.185).

In telepathology settings, the level of familiarity decreases. The informal practices, the knowledge and the trust created by working in proximity are not easily replicated in telemedicine settings. An extreme example of non-familiarity is the open request (L), where the referring pathologist doesn't even know what consultant to refer to. But even in open cases, consultants often will only accept cases from familiar pathologists. Lack of familiarity between stakeholders may be a major hurdle for the wide adoption of telepathology. Informal coordination (K, O, P) is unlikely in a telepathology context. Informal consultations only occur locally because they require trust and familiarity that usually develops due to proximity and familiarity. Sharing slides online is always traceable, and traceability implies some accountability on the consultant side. Familiarity may exist in some formal referral cases, but it is either the result of previous proximity (former colleagues, or former students and mentors), or the result of a long period of time working with each other at a distance (reinforced by occasional meetings in person). A pathologist recounts his experience with a resident: *"[Doctor X] is a resident coming from our program, and he copied many things from the different centres he worked at during his training. And he took good care of his laboratory. I trust him".* Familiarity can help determine which pathologists are covering IOC for which sites. *"We [pathologists] said: 'if you have problems, we can do the IOCs'. It's better if we take care of them. It is always better to develop a proximity link. People know each other, are used to work together"*.

Technologists experience conflict coordinating with unfamiliar, distant pathologists who are essentially new members of their team. Some technologists have expressed fears of having to work with pathologists they barely know and with whom they have limited common understanding. Thus, this fear may lead to tension in relationships.

Lack of familiarity may also mean that basic processes and terms of reference become ambiguous. For example, the notion of "urgent" changes meaning when used across organizational boundaries. At a distance, slide packages arrive with multiple other specimens sent to the laboratory from various sites and for various reasons. Because they arrive from outside the consulting hospital, there is no standardized system to prioritize them. The package may be marked as "urgent", but since there are several packages coming in, it may take days before the package is actually opened and the slides analyzed. Senders may tag packages as "urgent", but this has little currency in the consulting laboratory, since there is no agreed upon definition between different hospitals as to what qualifies as urgent. Moreover, some external pathologists, and some surgeons, may overuse the term on cases that are not truly 'urgent' so their samples are processed more quickly. Thus, laboratories are less confident about the urgency of external packages than they are with internal "urgent" packages.

Although some research suggests that telemedicine leads to a better knowledge of what others do (Aas 2001), telemedicine may actually lead to less understanding that may further reinforce organizational silos. When digital slides are sent directly to the pathologist, the technologist in the consulting centres are bypassed because they no longer receive the slides, rendering it unnecessary for the technologist to be aware of the pathologist's preferences and schedules. There are limited ways in which the technologist can tailor a digital slide presentation to the pathologist's needs and preferences.

Familiarity is essential to coordination in traditional settings, but is not as important in telepathology contexts. This has two negative consequences on coordination. First, distance makes it more difficult for stakeholders to understand and trust each other, creating ambiguity and stress. Second, distance prevents the sharing of expertise, as the lack of familiarity between stakeholders from different organizations may lead to fear and lack of altruistic behaviour.

To ensure common understanding despite the lack of familiarity, pathologists focus more on standards and protocols in comparison to traditional settings. A pathologist describes the need for formal agreements:

> *"For a long-term service level agreement, we need to organize ourselves and adopt standardized processes. Knowing what phone number to call in case of problems, like the scanner doesn't work (...). When there are few stakeholders, one-to-one, it is easier. But when there are 10 people on the other side and we are 20 here, it is worth writing things down and reaching a clear agreement."*

In addition to formal agreements, like Service Level Agreements, pathologists may work together towards the development of common work protocols. For example, pathologists in two different hospitals may exchange different types of colorations and decide together which ones to apply. A consensus between pathologists at different sites allows standardization of the work performed by technologists at both sites.

The wider adoption of standards may also depend on the nature of the telepathology network. In a decentralized network like the one being investigated here, there is no central authority deciding what standards to implement across the network. Standards mostly stem from pathology best practices, relayed by consulting pathologists to referring laboratories. But the decision to implement these best practices is made locally i.e. at the laboratory level. A technologist from the central laboratory describes how best practices and guidelines are being communicated:

> *"Pathologists learn the [pathology] standards. They meet and collectively decide which guidelines [will be used]. After that, they inform us. We apply them into our own protocols. From there, we inform [distant labs] about our requirements."*

In sum, people working in traditional settings know each other well and what the best practices in use in their organization are. This enables a common understanding necessary to allow effective coordination among stakeholders. With telepathology, that familiarity is much lower. This creates ambiguity and building trust between actors is more difficult. To compensate, stakeholders in telepathology settings put more emphasis on the adoption of common standards and clinical protocols across organizations.

Proposition 2: *The introduction of telemedicine leads to a shift from a reliance on familiarity to an emphasis on standard protocols to ensure common understanding among clinicians and, hence, effective coordination.*

Notion 3: Shifting forms of accountability within and between professions

Telemedicine also subverts the role of proximity in medical practices and reframes the way in which activities are made accountable (Nicolini 2007). Accountability enables coordination by clarifying who is responsible for what aspect of collective performance, and the nature of relations between stakeholders (Okhuysen and Bechky 2009). The input may not be standardized or otherwise predictable, but stakeholders know who is responsible. In most organizations, assigning accountability is the traditional role of hierarchy, but it can also be achieved through non-hierarchical communications. For instance, by providing a status report on the advancement of work, stakeholders enable collaborators to align and be aware of who is accountable for what.

The stickiness of local accountability

Traditionally, accountability in pathology laboratories is determined locally. Pathologists are accountable for cases from their own institution. Only when a hospital lacks the required expertise, it will refer cases to other institutions. Referrals typically occur in a tiered system where pathologists from larger hospitals are responsible for referrals coming from smaller satellite hospitals. The spirit of telepathology projects is to abolish distance as the source of accountability. In telepathology, distance as a barrier for accountability is overcome thanks to technology. For example, a few pathologists from remote sites were relocated to a regional centre to provide pathology expertise to a range of isolated hospitals based on a rotation duty plan, where each pathologist is responsible for all IOCs for a certain week and assigned to other types of cases the following weeks. One motivation for this reorganization was to shift the personal accountability each pathologist has for a single hospital and its surrounding area to a collective form of accountability that encompassed a larger region. All cases, across a region, can in theory be processed according to their priority and the pathologists' skills, rather than individual sites processing cases. One of the proponents of the telepathology project articulated a regional objective: *"We are going to set up priorities for a set of laboratories. For instance, we are going to say: the first thing to do are urgent biopsies. Currently, this is not what is going on"*. However, some pathologists described how regional priorities conflicted with their perceptions of local accountability. For some pathologists, despite the introduction of telepathology, accountability remains local and telepathology must help serve local needs better. A pathologist describes below his views of telepathology:

> *"When we learned that in order to get the technology, we would have to support another centre, we were much less excited. We thought: "We are interested in getting helped, but we have nothing much to gain at helping others."*

Both referring and consulting hospitals involved in the telepathology project signed service level agreements to ensure distant accountability for IOCs. Despite formal agreements, pathologists may not feel as accountable towards distant cases as they feel towards local ones. In one instance, a surgeon experienced an excessive delay (up to two hours) in getting the IOC while operating on a patient. Upon investigation, the hospital discovered the pathologist in the consulting center gave distant IOC lower priority than less urgent local cases; thus, resulting in excessive delays. It has been suggested that local patients are likely to have a higher priority than those referred through telepathology (Cartwright 2000).

Further, the presence of objects and digital mediation may reduce the need for face-to-face engagement, leading to greater distance and neglect (Barrett et al. 2012). This particular problem was solved in the present case by assigning a dedicated pathologist to address IOCs from that hospital. Faced with neglect from pathologists for distant IOCs over their local cases, accountability was restored by making IOCs less anonymous and collective, suggesting limits to the "commoditization" of IOCs as a generic, anonymous service. Even a simple phone call can create a greater sense of accountability through greater proximity. A pathologist noted the consequences of receiving phone requests for expert opinions: *"My priorities changed (...) a case, which should not be a priority, now becomes a priority."*

The geographical barriers, removed by telepathology, may play a regulating function. Even though distance is not supposed to matter in a telepathology setting, proximity keeps reappearing as a principle of accountability. For example, the newly created regional center did not have enough pathologists, so it was decided that the center would stop serving two of the regional or satellite hospitals, which were left to fend for themselves. And in another hospital, the pathologists, who were overloaded, refused to adopt telepathology. In other words, telepathology makes it possible to reduce physical distance and provide pathology services regardless of where slides are located. Proximity, however, plays a structuring role in determining accountability. Pathologists are responsible for cases in their vicinity, and this regulates and limits the extent of their accountability. This function does not depend on the material ease of addressing distant cases.

Proposition 3: *while coordinating, greater accountability in coordination practices is displayed to local than to distant tasks.*

Redefining roles and boundaries within and between professions

Proximity plays a key role in defining the extent of accountability and in enabling overlaps of accountability between professions. In traditional settings, technologists and pathologists take the responsibility for anticipating IOCs. They are familiar enough with local practices to interpret operating room schedules, feel accountable for local pathology activity, and take the initiative for anticipating needs (A.). Telepathology-based IOCs overshadow a sense of collective performance and implicit understanding in coordination activities amongst professions. Distant pathologists don't interpret operating room schedules. Accountability for scheduling IOCs shifts from the laboratory pathologists and technologists in traditional settings to the requesting surgeons in telepathology; thus, redefining the roles and responsibilities between surgeons and pathologists. Although pathologists are accountable for their diagnoses, they need to delegate the task of macroscopy to technologists and supervise them (E). Pathologists who are unfamiliar with the distant laboratories, the technologists and the processes involved in producing the digital slides may feel uncomfortable about this arrangement; thus, they may feel a lack of control in slide preparation and the accountabilities that accompany this output. A consulting pathologist describes his experience:

> *"We have our own laboratory, we see what is produced here and if certain things are not correct, we try to settle the problem. These are our problems. But with distant laboratories, this is not my problem. I do business with them during telepathology, but for the rest, I have nothing to say. If I receive slides from another laboratory, and if there is a problem with that specific case, it will be their problem. I will call them to settle it, but we can't control what is happening in every hospital around us."*

Telepathology also redistributes accountability to a different set of actors in different settings. Experts, who previously performed physical manipulations themselves operate at a distance in a telemedicine setting; therefore, requiring local non-experts to perform those tasks for them (Paré et al. 2015). A technologist describes this shift in tasks: *"telepathology led technologists like us to perform tasks normally dedicated to pathologists"*, corroborated by a pathologist:

> *"At the referring hospital X, a technologist has that training, can do all major specimens descriptions. She selects specimens to be examined by the pathologist. Therefore, more and more, pathologists focus on microscope work."*

Also, division of roles and responsibilities that may have traditionally been implicit, such as technologists performing macroscopy under the supervision of pathologists, suddenly become visible. This new level of responsibility poses new, potential issues in inter-professional relations. For example, it remains unclear whether technologists are authorized to perform macroscopy, and as such could be held liable in the case of medical error. The profession of technologist, in Quebec as in many jurisdictions in the world, is a regulated profession. The *Ordre Professionel des Technologistes Médicaux du Québec* defines what clinical actions technologists can perform, and activities outside these professional standards are illegal and technologists are also personally liable. It sets strict limits on the scope of practice in macroscopy, notably on some complex specimens, to protect technologists and patients (Ordre professionel des technologistes médicaux du Québec 2014). By performing such macroscopy activities anyway, technologists may put themselves at risk, although no instance of actual legal issues was reported in this project. This misalignment between actual practice and professional standards is creating tensions, causing some technologists to be reluctant about performing macroscopy. As a pathologist explained: "*the main fear of technologists is to have to perform acts for which they don't have the competence, notably manipulating macroscopic specimens. That's a real fear*."

Technologists may request the local surgeon to perform macroscopies in circumstances such as: when the task is too difficult, when surgeons make special requests, when technologists lack experience with complex cases, or when they feel uncomfortable with performing a particular macroscopy. A technologist explains how a surgeon may intervene for a mascoscopy: *"sometimes, if I am unable to do it, I can call the surgeon to go down to the pathology lab. I tell him to show me what he wants. Do you want this margin? Or that other margin?"* Having a surgeon perform the macroscopy only occurs in exceptional situations. Experienced technologists are so used to the work that they rarely need the assistance of a physician. Distant technologists develop new skills in macroscopy or telepathology systems, which central technologists often do not develop. As noted by Aas (2001), new distinctions within professions emerge, with upskilling of some professionals. In a sense, telepathology undermines the "circulating accountability" held collectively in a setting (for local care), and enables a shift of medical tasks to technologists; thus, potentially challenging the principle that a doctor is always in charge (Nicolini 2006). Telemedicine has the potential to redefine the practices and boundaries between professions at delivery sites (Robinson et al. 2003).

Expert opinion, for their part, require a network of diverse experts and a clear accountability between pathologists as well. Unlike service level agreements, accepting expert opinions relies mostly on a sense of accountability, mutual respect and collegial support towards the wider community of pathologists. A pathologist describes his attitude towards performing expert opinions:

> *"The technologist or the pathologist sends the case. They do it impeccably. Generally, the pathologist does it himself by email, with the pictures. There is mutual respect, I request an expert opinion. Therefore, I provide the best possible images."*

Before telepathology was deployed, inter-organizational consultation was rare because it was time consuming, and it generated long delays. As technology reduces the efforts and delays required for expert opinions, the number of consultation requests has multiplied. Moreover, while some referring pathologists accept longer delays (i.e., transportation and sorting out packages) in traditional settings, they expect immediate responses in telepathology because slides are delivered virtually. Such transformation has strained professional solidarity and duty towards the pathologist community. The seldom-used open request (L) illustrates how tenuous the sense of collective obligation has become.

Proposition 4: *Telemedicine coordination renders accountability less collective and more individual than in a traditional work environment.*

3.4 Discussion

Telemedicine disrupts the work arrangements and collaboration practices of health care professionals (Kayser et al. 2012; Têtu et al. 2012, Aas 2001; Tanriverdi and Iacono 1999). It also conflicts with the scripts embedded in organizational practices (Nicolini 2006). This has transformative effects on coordination practices. In this section, we first review the key transformations of coordination, the challenges they create, and the possible solutions to these problems. We also discuss the differences between coordinating within and across professional boundaries. Finally, we highlight the contributions of our study for research and practice as well as its limitations.

First, Proposition 1 suggests that while routines support effective coordination in traditional settings, they are much less powerful in telemedicine contexts. Faced with a more diverse and less predictable environment, the routine arrangements that facilitate coordination in a pathology laboratory are less likely to apply to telemedicine work. To address this lack of predictability, stakeholders specify coordination more formally, through planning and establishing specific rules and protocols.

Second, telemedicine requires stakeholders to coordinate with unfamiliar people whom they have no informal relationships with, an important aspect of building common understanding and trust in collocated work environments (Proposition 2). This lack of familiarity can create ambiguity in work processes as tasks may vary and terms may not have the same meaning across organizations. One way to cope with this and to ensure common understanding is to standardize work practices. Indeed, the convergence of standards and protocols remains one of the key means to facilitate coordination in telemedicine contexts. Scholars have suggested harmonizing techniques for physicians and technicians within and between organizations (Picot 2000; Têtu et al. 2012; Weinstein et al. 2009). In some telemedicine projects, the standardization of practices is even an explicit goal (Dietel et al. 2000). However, the responsibility of determining standards is not equally distributed. The regional centre, where the consulting pathologists are located usually dictates the standards while the technologists located at the peripheral sites must adapt and adjust their work practices. This highlight an asymmetrical interdependence, where all the coordination effort and adjustment is conducted by a single party involved in the coordination process, a phenomenon often observed in stable contexts, such as a laboratory (Chua and Yeow 2010). The other consequence of this lack of familiarity is the low levels of access to the potential expertise available across an entire telemedicine network.

Third, telemedicine also transforms the notion of accountability. For one thing, proposition 3 suggests that, location is a powerful organizing principle in traditional settings, and it is challenged in a telemedicine context. Despite formal inter-organizational agreements, the local dimension of accountability persists. Pathologists tend to prioritize local accountability over accountability towards distant sites, especially when they are overloaded with work. In addition, accountability shifts from a collective sense, usually observed in traditional settings, to being more individual and contractual in telemedicine coordination, with the help of more defined professional boundaries (Proposition 4). The collective responsibility in collocated coordination (pathologists accountable for all the local laboratory activity) shifts to a more formal, arm's length accountability, often in the form of rules. Roles help coordinate expertise and knowledge dependencies amongst professions, by helping to locate expertise when it is needed and bringing expertise to bear (Faraj and Sproull 2000). The differing perceptions of accountability may explain the importance of defining professional roles (Brauchli et al. 2004; Linderoth 2002), for instance by formalizing system responsibility and allocating it to specific physicians (Aas 2001). Forms and procedures, embedded in the new information system, may prove useful to manage accountability (Nicolini 2006). Even ambiguous terms can be leveraged to let each specialist group align its use of the technology into their work practices. Pathology diagnosis reports are generally a long text describing in detail the nature of the specimen observed. But the physicians who need these diagnoses, especially surgeons in the operating rooms, need a simpler, actionable answer, such as: "is this margin cancerous or not?" In laboratory information system, pathologists usually tick boxes in a report for other physicians to understand, even though the pathologists' understanding of a diagnosis is much more complex and ambiguous (Oborn et al. 2011).

Stakeholders adjust to telemedicine by relying on formal processes with familiar colleagues whom they trust, so they know who to reach out for help. The importance of a personal dimension in telemedicine has been identified in the extant literature. More precisely, face-to-face introduction of stakeholders working through telemedicine is necessary for professional rapport (Wiley et al. 2011). Also, capping the number of health care entities a single expert interacts with, in a telepathology project, has been shown as beneficial (Carter 2011). The benefits of personal interactions conflicts with predictions of large-scale, anonymous telepathology services of the kind observed in teleradiology projects (Johnson 2008). Questions remain as to how large-scale anonymous teleradiology networks may work while the anonymity proved a major hurdle for the decentralized telepathology project we investigated in the present study.

Telemedicine may lead to critical changes in organizational roles (Aas 2001). Because of telemedicine, patients or local care providers may bypass local experts in favor of distant experts. This may lead to the emergence of expertise centers, or to the reinforcement of power of existing centers (Aas 2001; Nicolini 2006). Telepathology has made possible for hospitals to not recruit pathologists because surgeons can be supported remotely. Telepathology could lead to radical structural transformations in the industry, such as the closure of small pathology laboratories (Cornish et al. 2012; Leong and Leong 2005) and the disappearance of organizational or even national borders (Aas 2001). The emergence of technology-based communities of physicians, where institutions are linked together (Ayad and Yagi 2012) is associated with a shift from an organization-centric view to a system-wide perspective (Kldiashvili 2008). This shift is consistent with the spirit of telepathology, but not with existing work practices and norms. In-house pathology remains the gold standard for local surgeons and pathologists. Local accountability is deeply ingrained in the culture of pathology as reported by a pathologist: *"for sure, the virtual will never replace the "real", I mean, having a colleague. Ideally, our hospital would recruit a new pathologist [instead of investing in telepathology]".* The implementation of telepathology may be perceived as a threat to some hospitals because it may be the first step to losing their pathologist(s).

3.4.1 Coordinating within versus between professional groups

Coordination mechanisms involved in telemedicine vary by clinical activity In IOCs, individuals from different professions (and possibly different organizations) need to coordinate their work. Depending on the activity, different challenges emerge and affect the development of coordination mechanisms. In IOCs, surgeons, technologists and pathologists develop trust in each other based on prior collaboration. Successful coordination is based on familiar relationships, and routine practices. One of the main challenges of inter-professional work is establishing a common frame of reference when it comes to terminology. For example, the intense rehearsing and training of technologists in IOC support is intended to develop a common understanding amongst physicians and technologists. With accountability, telemedicine leads to a redefinition of the boundaries of professions. In collocated settings, accountability tends to be more collective. The accountability of technologists is linked to that of the pathologists under a form of circular accountability (Nicolini 2006). In telemedicine, inter-professional accountability needs to be more formally defined and enacted. Pathologists are responsible for their diagnosis, technologists are in charge of laboratory processes, and surgeons are responsible for requesting IOCs. Service level agreements clarify the new, non-location based rules of accountability. In sum, coordinating telepathology-based IOCs effectively relies mostly on creating a clear division of tasks and building a predictable environment and common understanding.

The dynamics of professionalism in expert opinion coordination differs significantly from those in IOCs. Expert opinion requires intra-professional (and inter-organizational) coordination. In a traditional setting, coordination relies on a close network of professional acquaintances. Often these types of networks do not scale up well to a large, decentralized regional network because inter-organizational boundaries become unclear. In traditional settings, pathologists form a closely-knit community of experts where there is mutual understanding and a sense of belonging. The hospital and laboratory do not formalize the interactions between pathologists. This community informally self-regulates members' interactions. In a telemedicine context, the lack of familiarity amongst pathologists limits these informal aspects of coordination.

Telemedicine activities are unlikely to foster relationships within professional communities. Previous research in telepathology revealed professionals experience a conflict between collective and individual interests (Obstfelder 2003). We suggest that this type of challenges is associated with coordination among members of the same profession. The implementation of practice standards means more formal accountability for professionals. Technology may help collaboration by enabling some non-traceability, and purposely forgetting certain requests, in the way that some messaging applications automatically delete past messages, to replicate the informality of co-presence. Possible solutions may involve formalizing professional obligations to provide expert opinions.

Improving coordination across professional boundaries requires greater clarity in accountability in the form of formal arrangements such as practice standards and protocols, and clearer boundaries between professions. On the other hand, improving coordination within the same profession requires greater group accountability that includes the use of common terms and a sense of collective responsibility. Our study contributes to research on how technology transforms the boundaries between professions work by suggesting that these boundaries are also a means to articulate the new needs for coordination. As technologists, pathologists and surgeons work out who is responsible for what, they laid the foundations of coordination in a telepathology context. Coordination between pathologists at a distance, for expert opinions, seems similar to traditional settings, even if it's not, because it doesn't imply a redefinition of professional roles and boundaries with other professions. In that sense, professional boundaries make visible the need to adjust coordination to telepathology.

3.4.2 Contributions to the literature

Our study contributes to the literatures on information technology and coordination because unlike previous research that focused on identifying separate coordination mechanisms (Malone and Crowston 1994; Thompson 2011), we went beyond categorization of activities and looked at the organizational implications of these activities. Similar to previous research on coordination, we found that predictability, accountability, and common understanding are key constructs to analyze coordination. Okhuysen and Bechky (2009) define them as integrating conditions for coordination, i.e. requirements that coordination mechanisms fulfill to achieve effective coordination. Like them, we observed different coordination mechanisms based on routines, plans, roles, proximity or objects that aim to achieve these conditions. However our study found that accountability, predictability and common understanding are better defined as dimensions of coordination instead of as competing or complementary conditions. Indeed, coordinating activities always involve some level of predictability, understanding and accountability; thus, we used them as sensitizing devices to identify their dynamics and roles in a telemedicine context.

Another contribution is our focus on technology and boundary-spanning coordination. Prior research suggests that technology presents an opportunity to reconfigure boundaries between professions (Barley 1986), that may lead to cooperation, neglect or strain between occupational groups (Barrett et al. 2012). We found that technology can also be an opportunity for revealing boundaries, such as macroscopies that pathologists are allowed to perform, but that technologists were performing anyway under close supervision. It can also create boundaries amongst different professions within a previously homogeneous group, such as the central versus the peripheral technologists, the technologist able to perform macroscopy or to use the telepathology system versus those who can't.

Beyond telemedicine, other forms of research on distant or remote work may benefit from these findings. Researchers have studied whether information systems made the world flat or spiky, and noted how proximity still matters (Friedman and Wyman 2005; Mithas and Whitaker 2007). Our finding that despite eliminating distance, proximity is still at play in accountability and coordination, suggests a relationship between accountability and information systems. In the outsourcing literature, scholars have investigated the relational aspects of offshoring projects, such as the ability to modularize tasks, provide feedback or enact tacit coordination mechanisms between the stakeholders (Srikanth and Puranam 2011). Our findings indicate the ability to locate expertise, or the shift from collective to individual accountability, may apply to other settings. Future research could investigate other forms of telework where similar coordinating challenges may emerge.

3.4.3 Contributions to practice

Our findings provide valuable insights into the experience of switching to IT-based distance coordination. The introduction of distance technology may mean a shift from routines to plans and rules for users of the system; thus, Proposition 1 suggests that it is important to understand pre-existing routines before the technology is deployed. The development of new processes and protocols should focus on key routines and provide predictability and clarity in roles. Familiarity-driven work practices amongst stakeholders are important in traditional settings but remote work and coordination require standard protocols to ensure shared understanding among stakeholders. Proposition 2 suggests that coordination challenges, in the context of telemedicine, are less about enabling proximity (through elaborated communication systems) than they are about managing the relational aspects of coordination, including building trust between stakeholders, notably through the establishment of mutually agreed upon standards. Expertise will not be automatically leveraged because of access to a telemedicine system. Fostering relationships and a sense of community are also necessary.

Our findings and, especially proposition 3, also indicate that stakeholders display more accountability for collocation than for distant coordination, regardless of organizational arrangements. Additionally, proposition 4 suggests that the introduction of telemedicine redefines the roles and responsibilities between professions, and reshapes professional accountability from a collective characteristic to more individual logic. A key factor for success in telemedicine projects is to establish clear principles of accountability. Healthcare managers must consider the important role of proximity in accountability, and also the cultural and organizational barriers to establishing distance-based accountability. For centralized networks (Meyer and Paré 2014), a tier system, where larger institutions are accountable for the complex cases that smaller institutions cannot handle, may be an effective solution to challenges related to coordination. For decentralized networks, the spontaneous emergence of an effective inter-organizational system freed from the constraints of distance cannot be taken for granted. Possible needed changes could include: regional governance structures dedicated to managing telemedicine, incentives for pathologists to accept cases, or rotating duty plans set by groups of pathologists accountable on a regional basis.

3.4.4 Limitations

Our results must be interpreted with caution considering the following methodological limitations. For one thing, the complexity of pathology coordination practices is difficult to represent simply (Hodkinson and Hodkinson 2001). Although we took into account all of the interviews and reported our findings in detail, we could not present all of the details and nuances from the field and had to summarize the data collected. We had to streamline, summarize and present what we considered as the most relevant information in light of answering the research question. Another limitation is that we relied mostly on the accounts of interviewees. Our data may be biased towards the recollections and personal perspectives of our participants. We tried to limit such bias by triangulating our data sources, interviewing multiple participants from each site and using multiple data collection methods. Future research could attempt to confirm these findings. Replicating this type of approach, and comparing how similar telemedicine systems transform coordination in different settings would provide further validity and reliability.

Our findings have face validity but are also limited since it is based on a single case study (Hodkinson and Hodkinson 2001), examining one specific form of telemedicine. Theoretical replications to similar forms of telemedicine such as teleradiology or teleconsultations between clinicians may reinforce external validity to other telehealth applications, such as home monitoring where patients are actively involved (Yin 2009). In short, we must be cautious with regard to the generalizability of our findings.

3.5 Conclusion

As telemedicine challenges traditional forms of coordination, we need to understand and theorize the nature and extent of these transformations, at the level of work practices. Four major transformations in coordination practices occur between traditional and collocated settings in a telemedicine context. First, predictability is ensured through plans and protocols rather than through routines. Second, the lack of familiarity between stakeholders in telemedicine needs to be overcome with clear standards that ensure common understanding. Third, even with the introduction of telemedicine into a setting, proximity still plays an important role in accountability. Finally, coordination in traditional settings relies on forms of collective, inter-professional accountability, which does not transfer well to a telemedicine context where individual accountability is more prevalent and the maintenance of boundaries between professional groups more relevant. We suggest that rehearsing, standardizing and formalizing can support the development of appropriate coordination practices, as well as building stable and trusted processes are necessary for optimal coordination in telemedicine environments. In conclusion, effective coordination relies on fostering an environment where stakeholders are committed to support and capable of supporting each other.

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Conclusion

This thesis gives a holistic vision of an important part of telemedicine, seen from an information systems research perspective. Essay one, which takes the form of a scoping review, gives an indication of the extent and nature of knowledge available about the benefits and implementation challenges associated with telepathology. For one thing, our review highlights the overall lack of compelling evidence on the impacts and transformations of telemedicine. Moreover, our findings reveal the importance of differentiating between various telepathology network structures, some being one-to-one systems, while others are centralized around a consulting centre, or decentralized. Such network structures may be associated with different contingencies, in terms of impacts, as well as in implementation challenges. Current telepathology research remains focused on clinical and technical questions, and issues pertaining to the social and organizational contexts have never been systematically investigated up until this point. Essay two brings an important empirical contribution to the telemedicine literature in general, and to the subfield of telepathology in particular. This study is original because it applies a proven theoretical framework from information systems to health informatics. It provides an insightful and rigorous understanding of questions essential to the justification of telepathology adoption, namely focused on health and economic outcomes. For its part, the contribution of essay three is theoretical. Previous information systems literature on work practices has mostly focused on the role of human agency in IT appropriation. This essay suggests that the redefinition of the role of proximity in coordination practices also emerges from technology's material constraints, and from distant coordination.

This thesis suggests that a comprehensive and systematic approach is necessary to understand the transformations associated with the introduction of information technology in organizations. One of the contributions of this thesis lies in how the multiple aspects of IT-induced transformations, and associated complexities, can be identified and explained by investigating a specific technology. Our comprehensive work combines a literature review, an evaluative analysis and an inductive theory development paper focusing on work practices. These different approaches complement each other conceptually and methodologically, and generate a rich and useful set of conclusions. The three essays converge to highlight the network dimension of telepathology. Indeed, telepathology is a form of telemedicine connecting several health care professionals together. To effectively route consultations to appropriate experts, efficient and reliable networks are necessary. Professional networks at a distance and across organizational and jurisdictional borders, entail a new and diverse set of challenges and transformations highlighted in the three essays. They create a need for rule setting, accountability, centralized or decentralized structures, and governance bodies. Thus, jointly, the three essays offer a clear and more comprehensive vision of a particular technology, and the format of this thesis may serve as a template to analyze and articulate the multiple aspects of the transformative role of other technologies enabling collaboration at a distance, such as teleconsultations or 3D printing. Our findings also call for further investigation into the transformative role of telepathology as we are only at the beginning of the diffusion curve. In the coming years, digital slides will be used for routine cases, aid-to-diagnosis algorithms will automate the analysis of all or a part of slides, and even organizations dedicated to providing pathology services to distant patients may emerge. Such disruptions will reinvent the nature of the work performed by pathologists and technologists, change pathology laboratory environments and alter the notions of territorial borders and organizational accountability. The business models, processes and structures associated with this new paradigm remain to be designed.

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Appendix A: The Pathology Equipment of the Eastern Quebec Telepathology Project

1. A macroscopy stations (PathStand^{TM} 40; Diagnostic Instruments, Sterling Height, MI),
2. A videoconferencing system (PCS-XG80DS Codec; Sony, Tokyo, Japan), equipped with a drawing tablet (Bamboo CTE-450K; WACOM, Saitama, Japan).
3. A scanner, either a Nanozoomer 2.0-RS or -HT digital whole-slide scanner (Hamamatsu Photonics, Hamamatsu City, Shizuoka Prefecture, Japan)
4. A local dedicated telepathology server hosting the images.
5. mScope version 3.6.1 (Aurora Interactive Ltd., Montreal, QC, Canada), a software application to visualize whole-slide images at 1680 x 1050 pixels resolution

Appendix B: Interview Guide

Introduction

- How long have you been working as pathologist/surgeon/technologist?
  - If more than 10 years : do you feel that your profession experienced major changes since you started? Explain.
- To what ends do you use telepathology? Is there cases in which you prefer not to use telepathology? If yes, which ones and why?
- How do telepathology expert opinions **differ** materially from a microscope-based consultation? From **local** consultations? From expert opinions with someone within the same hospital? From distance expert opinions without telepathology?

Questions on coordination

- Explain the importance and role of coordination in your work? Illustrate with examples.
- To what extent does telepathology transform coordination in your work?
- What do you need from your colleagues/ from the hospital/ from the technology, to perform your work?
  - What do you do in case of a problem? Who do you talk to?
  - How do you ensure that you will get it or that you got it? How do you control the quality of what was provided? Of what you provide?
- What are you accountable for?
  - What do you need to provide? To whom?
  - What do surgeons/technologists/pathologists/administrators, expect from you?
- How does working with telepathology change work coordination between pathologists, surgeons and technologists? In terms of :
  - Accountability?
  - Interactions between other stakeholders?
  - What you, pathologists, surgeons and technologists do?
  - What you and others need to know?
- How does the presence or not of a pathologist transform how a laboratory works?

To go further, investigate the previous questions based on :

- Routine versus rare/difficult/extreme/urgent/unexpected cases
- Stakeholders (pathologists, surgeons, technologists), internal or external to the hospital, known versus unknown
- Telepathology applications : IOC, expert opinion, training
- Stages in the process : slide digitizing, case communication and management (priority, inbox, archives), browsing the slides