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ORIGINAL ARTICLE

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Seeing what works: identifying and enhancing successful interprofessional collaboration between pathology and surgery

Katherine Carroll [a], Jessica Mesman [b], Heidi McLeod[c], Judy Boughey [d], Gary Keeney[e], and Elizabeth Habermann [f]

[a]School of Sociology, Australian National University, Canberra, ACT, Australia; [b]Department of Technology and Society Studies, Faculty of Arts and Social Sciences, Maastricht University, Maastricht, The Netherlands; [c]Center for Pharmacy Innovation, Geisinger Health System, Pennsylvania, USA; [d]Department of Surgery, Mayo Clinic, Rochester, Minnesota, USA; [e]Department of Pathology, Mayo Clinic, Rochester, MN, USA; [f]Department of Health Sciences Research, Mayo Clinic, Rochester, MN, USA

ABSTRACT

Utilising frozen section technologies, Mayo Clinic has one of the lowest reoperation rates for breast lumpectomy in the United States. The research reported on sought to understand the successful teamwork between the Breast Surgery Team and the Frozen Section Laboratory at Mayo Clinic. Researchers worked collaboratively with healthcare staff from breast surgery and the frozen section pathology laboratory to identify communication styles and strategies that contribute to the timely and accurate intraoperative evaluation of breast cancer specimens. Using the video-reflexive ethnography (VRE) methodology underpinned by a positive theoretical approach to researching quality and safety in healthcare, the researchers video-recorded the communications associated with specimen resections in surgery and the subsequent pathology diagnoses. Then, 57 staff from the breast surgery and frozen section laboratory teams attended video-reflexivity sessions to collaboratively analyse their communication practices and identify opportunities to optimize interprofessional communication. In this article, we focus on how the flexible, interdisciplinary, and cross-hierarchical communication within the frozen section laboratory supports a rapid and accurate intraoperative evaluation and communication, previously conceptualized by staff as being performed in a linear fashion. Moreover, we detail how the VRE methodology led surgeons and pathologists to implement new strategies and optimize their interprofessional communication.

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Introduction

The object of our analysis is the successful collaboration between the Breast Surgery Team (BST) and the Frozen Section Laboratory (FSL) at Mayo Clinic Rochester, USA. As a collaborating team of consultant surgeons and pathologists, resident and fellow trainees, and technicians and assistants, the BST and FSL have been able to keep the reoperation rate of women undergoing surgery for breast cancer extremely low (Boughey et al., 2014; Boughey, Keeney, Radensky, Song, & Habermann, 2016; Ferreiro, Myers, & Bostwick, 1995; Gal, 2005; Osborn, Keeney, Jakub, Degnim, & Boughey, 2011). This prevents women from undergoing additional surgery and saves additional healthcare costs (Heller, 2007). This result, as we will demonstrate, is not only based on the availability of high-tech diagnostic instruments and compliance with directives, but also on strong collaborative and communicative interprofessional practices.

In this article, we report on empirically based research that describes how the diagnostic work of the FSL in collaboration with the work of the BST in the operating room (OR) is realised thanks to a complex dynamic web of cross-professional and cross-hierarchical information exchange. In doing so we stress the role of context and therefore de-emphasize prescribed templates for collaboration that often ignore the contextualized processes of negotiation and organization (Finn, Learmonth, & Reedy, 2010). It is within this framework that our study of interprofessional collaboration between the BST (surgeons, trainees, and OR staff) and the FSL (pathologists, trainees, and pathology laboratory staff) aims to gain insight into ways of doing successful collaboration and communication.

To better understand interprofessional collaboration, a necessary passage point is to engage the health professionals and scientists involved in articulating how their own interprofessional collaboration works, including the right way to distribute tasks and responsibilities. These undergirding principles of contextual understanding, in-depth description, and participant collaboration in data analysis lend themselves to the deployment of the video-reflexive ethnography (VRE) methodology (Iedema et al., in press; Iedema, Mesman, & Carroll, 2013).

In the following section, we introduce each of the teams in our study before moving to explain our guiding approach called 'exnovation'. We then explain the specificities of the VRE methodology which we used to examine and optimize successful interprofessional communication at the study site.

CONTACT Katherine Carroll katherine.carroll@anu.edu.au School of Sociology, Australian National University, Hayden-Allen Building 22, Canberra, ACT 2601, Australia

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We then provide the results of our analysis of the communication within the FSL and how it interfaces with the BST, and how the FSL and BST collaboratively made changes to further optimize their interprofessional communication. In our final section, we will draw some lessons learned that may be applied beyond our case study of interprofessional communication.

Background

Today's healthcare is characterized by specialized professionals who are mutually interdependent. The integration and coordination of their activities is crucial for providing high-quality healthcare. Interprofessional collaboration is considered to solve the tension between the increasing specialization of healthcare practitioners and the need for their integration (Dingwall, 1980). This makes interprofessional collaboration one of the main pillars of quality and safety, which receives much attention in healthcare practice. As a result, team-training, like crew resource management or simulation-based training, is a priority for many hospitals.

Healthcare research recognizes the crucial contribution of interprofessional collaboration and tries to define and enhance its key features on interactional (e.g., trust, respect), organizational (e.g., structure, administrative support) and systemic levels (e.g., power and value systems, education) (San Martín-Rodríguez, Beaulieu, D'Amour, & Ferrada-Videla, 2009). A large proportion of studies have their focus on adverse events (Manser, 2009). They study, for example, poor coordination among providers resulting in delays in treatment and conflicting information. Or their focus is on communication breakdowns (Nagpal et al., 2010), obstructing hierarchical structures (Lancaster, Kolakowsky-Hayner, Kovacich, & Greer-Williams, 2015) or lack of organizational support and clear goals (Xyrichis & Lowton, 2008). Related to these concerns are many proposals for improvement along the line of interprofessional learning (Engum & Jeffries, 2012; McMurtry, Rohse, & Kilgour, 2016).

Other studies describe successes in improving interprofessional collaboration as a result of programmatic interventions (e.g. Burke, Grobman, & Miller, 2013; Manojlovich et al., 2014; O'Leary, Buck, Fligiel, Haviley, & Wayne et al., 2011), or the strength of teams due to personal qualities, commitment, and creative working methods (Molyneux, 2001), clear and shared objectives (Borrill, West, Shapiro, & Rees, 2000), a team's autonomy while understanding each professional's role (Cook, Gerrish, & Clarke, 2001), and respect and open communication (Dieleman et al., 2004).

Over time research on interprofessional collaboration has included new topics that acknowledge the wider context in which the collaborative actions take place, such as regulatory and economic incentives, complexity of patient cases, physical space, and staffing (Chang & Doucette, 2012). Interactional factors like communication, team climate, a shared purpose, awareness, and respect have been studied the most extensively, while studies regarding systematic factors remain scarce (Ibid). More critical reflections on collaboration stress the need to recognize the role of context (Griffiths, 1997; Proctor & Mueller, 2000). This critical perspective implies that patient safety studies interested in interprofessional collaboration should not pursue determining the 'valid' definition of teamwork or the ideal way to operate as a team. Instead, it should examine the way teams make choices, negotiate their division of task and responsibilities, and its effect on power relations and working conditions, professional identities and the delivery of healthcare (Finn et al., 2010). It is within this contextual framework that our study on interprofessional activities has been organized. We build upon these studies and contribute to their effort of unpacking the context in which interprofessional collaboration takes place. Moreover, differing from most studies on interprofessional collaboration, our study is in itself an interprofessional collaboration. The VRE methodology asks clinicians to act as co-researchers. This allows us to base our theoretical insights on clinicians' 'indigenous knowledge' and at the same time provide clinicians a fast-track for evidence-based practice optimization. Thus, our study moves beyond mere description and provides a theoretical contribution to the unpacking of interprofessional collaboration while facilitating tailor-made practice improvement for the teams involved.

Studying communication practices of successful interprofessional teams produces a profound understanding of how adequate levels of quality and safety are preserved. We sought to understand the communication and collaborative practices that underlie successful interprofessional work *between* the BST and FSL teams. While these specialists are both medically trained and frequently work together on patient care, their specialties are quite distinct. The BST focuses on the patient and the surgical resection of the specimen, meanwhile their colleagues in FSL focus on specimen evaluation and do not interact with the patient or enter the OR.

In order to establish a reliable and consistent base for research on interprofessional collaboration, Reeves, Lewin, Espin, and Zwarenstein (2010) stress the need for conceptual clarity and developed a conceptual framework (Reeves et al., 2010; Xyrichis, Reeves, & Zwanenstein, 2017). Following Reeves et al. we refer to the interprofessional activities *within* the FSL (or *within* the BST) as 'teamwork' while still referring to the other team to underline how their work is based on shared team identity, integration and shared responsibility. Unlike multiprofessional teamwork where teams may work in parallel with little interaction, the BST and FSL of this study have a common purpose (a timely and accurate evaluation of a specimen so a patient's suspected malignant breast lump may be fully and safely resected), regular points of contact, and a continuous need to temporally calibrate their activities with each other. A close examination of communication *within* the FSL is therefore required as it contributes to the rapid evaluation of breast specimens that is then communicated to the BST. In other words, we conceive of interprofessionalism as based on situated, relative and relational positions (Trodd & Chivers, 2011), which makes an exploration of the actual practices and experiences of working together a necessity for constructing insights into the causes of successful collaboration. Based on the taxonomy of Reeves et al. (2010) we consider the interprofessional activities *between* these two independent disciplines (surgery and pathology) as 'collaboration', or to be more precise as a

'collaborative partnership' (Xyrichis et al., 2017). Here collaboration denotes the interdependence and shared accountability (complete removal of the suspected tumour, with minimal loss of non-malignant breast tissue), while there is no need for a shared identity. We now provide some background of the teams' highly interrelated work environments.

Collaborative work in the Mayo context

Pathologists at Mayo Clinic Rochester (MCR) use intraoperative frozen section analysis to evaluate resected breast tissue specimens and mastectomies for malignant cells. With these intraoperative evaluations, surgeons can then, if necessary, re-excise tissue margins during the patient's first operation, rather than having a patient return days or weeks later for re-excision when remnant malignant cells may be suspected. Thus, pathologists serve as chief partners and consultants to surgeons by providing high quality, accurate and timely communications through intraoperative diagnostics in order to assist surgeons in removing adequate tissue during their surgical intervention (Heller, 2007). Moreover, the diagnoses that are made by pathologists during surgery are often acted upon immediately and may determine the course of surgery (Talmon et al., 2013). Thus, pathologists using frozen section techniques for intraoperative diagnoses can face significant pressure because an incorrect diagnosis can lead to a more extensive surgical procedure which may not be required and vice versa. Rapid evaluation and clear communication can be difficult as it takes time to make a margin assessment, and turnaround time can be influenced by the availability of laboratory staff and the volume of other specimens requiring frozen section processing (Heller, 2007; Renshaw, 2013; Somerset & Kleinschmidt-DeMasters, 2011).

Diagnostic communication between pathologists and surgeons requires more than a few words (Heller, 2007) and may be delivered over the telephone, an intercom, or person-to-person interaction (Somerset & Kleinschmidt-DeMasters, 2011; Talmon et al., 2013). Using intermediaries for relaying diagnosis and other critical communication can risk error through incorrect reporting or pronunciation (Somerset & Kleinschmidt-DeMasters, 2011), and technological issues have also been identified with regard to error, including poor connections and interference when using intercom or speakerphones (Talmon et al., 2013). The choice of modality for communication may be influenced by time constraints and physical layout of the OR and pathology departments, which in some laboratories may render face-to-face communication with surgeons more difficult. Yet errors cannot be attributed to modality or method of communication alone (Talmon et al., 2013). Other factors include omitting 'read backs' by surgeons to confirm understanding, or the use of particular words by pathologists such as 'no' rather than 'positive' and 'negative' in reporting diagnosis which has been shown to lead to misinterpretation of results (Renshaw, 2013; Talmon et al., 2013). Considering the number of instances that miscommunication could occur, we ask, 'what it is that these two teams do so well in their communication and collaboration?'. At MCR, between 2006 and 2010, there was only one reoperation case for breast lumpectomy out of 306 due to malignant margins not being identified intraoperatively. In the published literature this success is attributed to the use of frozen section analysis (J.C. Boughey et al., 2014). However, these technical achievements are only made possible through pathology and surgery teams enacting important social, communicational and organizational practices alongside correct technical procedure (Boughey et al., 2014; Gal, 2005; Osborn et al., 2011; Renshaw, 2013; Talmon et al., 2013). We contend that having only one reoperation case in four years at this particular study site is not only an outstanding example of successful diagnostics, but also of interprofessional communication, particularly given the contextual factors such as the pressure pathologists face with intraoperative decision-making and the multiple distractions and interruptions for surgeons that everyday work in the OR entails (Renshaw, 2013; Talmon et al., 2013).

Both the BST and FSL have their own hierarchies. The consultants leading their respective teams, and trainees often lead medical tasks under consultant guidance. Communication between the BST and FSL can occur from consultant to trainee and vice versa. Trainees changeover regularly (sometimes every 6–8 weeks) due to residency rotations. As each new set of trainees joins the BST or FSL, they must quickly assimilate into the patterns and culture of the teams. This adds an additional layer of communicational complexity between the teams, and the consultants on each team remain responsible for the ultimate decision-making and patient care. Understanding the capabilities of each trainee is important to determine the degree of oversight required. The trainees of each team are made aware of the complexities and importance of the intra-operative communication between the FLS and BST teams. Any communication that does not seem to fit with expectations usually results in the consultant rechecking with the other team to ensure the communication is correct. For example, when the FSL trainee calls pathology report over the microphone to the OR, the consultant pathologist listens to ensure the communication was delivered appropriately and understood. Similarly, the consultant surgeon will listen to the trainee receiving the information and if any concerns or queries will call back or walk to the FSL.

Several articles have provided glimpses into the importance of personnel, communication, and machine–person interfaces (Boughey et al., 2014; Gal, 2005; Osborn et al., 2011), yet we believe it is necessary to build on this in order to more closely examine and more fully describe the interprofessional team communications that construct these safe and highly successful aspects of patient care.

Methods

Methodology: Exnovation and video-reflexive ethnography (VRE)

This study's approach is based on 'exnovation' (Iedema et al., 2013; Mesman, 2011, 2015). Exnovation offers a positive perspective[1] that acknowledges that 'ordinary practices' are an extraordinary accomplishment and aims to excavate and articulate the existing strengths within practices (Wilde, 2000). By taking an exnovative approach, one attends to the

strength of existing, everyday collaborative activities which, because teams use them so often, are often overlooked as an extraordinary accomplishment. An understanding of the successful interprofessional collaboration between the BST and the FSL requires the explication of such 'invisible work' and the informal resources that contribute to their low reoperation rates. Thus, counter-intuitively exnovation explicitly aims to improve practices by paying attention to what is already in place.

In this study we use VRE, an exnovative methodology frequently used to make visible the mundane, implicit, and necessary routines of interprofessional teamwork and communication (Iedema et al., in press, 2013). Giving precedence to the complexity that unfolds in everyday practices in local contexts, VRE involves videoing in-situ work practices (video-ethnography). This footage is then edited to provide instances of pertinent work practices, and then played back to, and discussed with clinical teams for collaborative analysis (video-reflexivity). Video-reflexivity sessions discussions are video (or audio) recorded for analysis by the researchers. Here we see there are two levels of analysis in VRE. The first is that performed by participants during VRE sessions (Iedema et al., in press, 2013). The second, and optional secondary analysis is that performed by the researchers or 'Clinalyst' (Iedema and Carroll 2011). In addition, video-reflexivity engenders learning and sometimes practice change for both researchers and the team (Carroll & Mesman, 2018). Video-reflexivity sessions are video-recorded so that both the researcher and the clinical teams may use it as a resource in their quality improvement, education, or research initiatives. In this way, VRE is a collaborative, qualitative methodology that uses video-ethnography and reflexivity not only for academic purposes but also to engage hospital staff in bottom-up, meaningful practice optimization (Iedema et al., 2013). VRE has been used collaboratively with health professionals to better understand and then optimize inter-team collaborations, such as improving the quality of handovers between ambulance workers and the emergency department (Iedema et al., 2012) and optimizing computerized physician order entry between laboratory staff and physicians (Forsyth, 2009). Although VRE is a participatory methodology, it is distinct from other participatory models such as action research in terms of how issues for practice optimization are decided upon. Issues in VRE are emergent through and a result of collaboration, rather than stemming from particular critical paradigms of inquiry based on, for example, race, gender or sexual orientation (see Iedema & Carroll 2015).

Our study used the clinialyst mode of VRE (Iedema and Carroll 2011; Carroll & Mesman, 2018) which brings together social science researchers with clinicians which, in this study are members of the FSL and BST teams. Through the use of VRE, our study aims for the BST and FSL to view video ethnographic data of their interprofessional communication practices, engage in analytical work of these practices in video-reflexivity sessions, and identify areas of successful communication and collaboration that supports accurate and timely evaluation and diagnosis to ensure appropriate levels of breast tissue resection. The clinalyst mode of VRE involves collaborative agenda setting about the research focus, but researchers have substantially more control over the videoing of practice, and the editing and selection of footage for analysis by the clinical teams (Carroll & Mesman, 2018).

Study population and context

The BST includes four surgeons dedicated to breast surgery. For each OR the BST includes one consultant breast surgeon, one general surgery resident (surgeon trainee), one surgical assistant, and one certified surgical technologist. The FSL is constituted by a staff pathologist, pathology assistant(s), pathology resident(s), fellow in surgical pathology, several histotechnologists, laboratory assistants, and a reporting specialist.

Data collection and analysis

This study reports on a deductive thematic analysis of transcripts of four video-reflexivity sessions with 57 members of the FSL and the BST. The video-reflexivity sessions were used by the BST and FSL teams to identify and articulate successful areas of their practice. Thus, it is the discussion among the clinical teams and their analysis of the video-footage of their own practice that forms the data of this paper. Before returning to this in detail, we first outline the methods used prior to the video-reflexive sessions which form the data set of this study.

Phase 1: Video-ethnography

The study began with three days of camera-free observations of the daily work of participants in the BST and FSL, in conjunction with interviews with key informants who occupy specific roles within each of the teams (KC). The observations concentrated on critical inter-team communication touch-points to gain full orientation to the journey the breast specimen makes from the moment of specimen surgical resection through to communication of the pathologist's evaluation of the margins of breast cancer specimens to the surgical team. Video-recording then took place over ten working days. Two researchers each using a handheld video camera simultaneously recorded communications associated with the resection and diagnostic practices of breast specimens within the FSL and BST (KC and JM). This enabled detailed footage to be recorded of inter-team collaboration at the same points in time, but occurring in different locations. The researchers followed multiple specimens from surgical resection in the OR, through the evaluative work of the FSL, and then back to the OR where pathology results were received by the BST. JM videoed all communicational work associated with the OR and the delivery of the specimen to the FSL, and the report back in the OR from pathology. KC videoed all the evaluative processes and communication in the FSL, including the report back to the OR from the FSL. Thus, the video-recordings examined how two teams interface at the following five critical moments:

(1) the specimen making its way from the OR to the FSL
(2) the handover of the specimen from BST to FSL
(3) the passage of the specimen through the FSL
(4) the information flow from the FSL back to the BST
(5) the receipt of information by the BST from the FSL, and the BST's interpretation and subsequent actions.

A total of ten hours of video-ethnographic footage was generated. The ten hours of footage was then coded into the following researcher-derived categories that were designed to identify data that clearly aligned with the study's aim of understanding, from the viewpoint of FSL and BST clinical staff, what makes successful interprofessional communication practices between two teams:

(1) 'workflow and communication in FSL'
(2) 'specimen triage and prioritization in FSL'
(3) 'facilitating the other team's work (BST to FSL, and FSL to BST)'
(4) 'specimen delivery and handovers (BST to FSL)
(5) 'communication about margins and orientation (BST to FSL, and FSL to BST)'.

Phase 2: Video-reflexivity

Fifty-seven BST and FSL team members participated in a total of 4 video reflexivity sessions. A total of ten different clips depicting the aforementioned five critical moments of the two teams interfacing as the specimen made its way between the BST and the FSL. The clips were selected and edited by the researchers (KC and JM) for viewing by participating BST and FSL team members in alignment with the clinalyst approach to doing VRE (Carroll & Mesman, 2018). Two video-reflexivity sessions were jointly attended by the BST and FSL, and two sessions were attended separately by each team. Characteristics of video-reflexivity sessions are detailed in Table 1.

The edited video clips of the critical interprofessional touchpoints were introduced to reflexive session participants by the researchers (KC and JM). The researchers used the following discussion prompts derived from their open coding of the video-ethnographic data to help participants identify and articulate their various work practices at critical touchpoints of the two teams:

Table 1. Characteristics of the VRE sessions.

Participants	Duration (mins)	Edited video-clips	Themes explored
BST and FSL (8)	45	1 clip 8 mins	Successful facilitators of workflow in surgery Timing, content and mode of delivery of reports to surgeons Implications for workflow in pathology
FSL (16)	58	3 clips 4 mins 6 mins 2 mins	Evaluative process: using multiple senses and multi-tasking Triage in pathology The effect of in-person presence of surgeons on FSL workflow
BST and FSL (30)	73	1 clip 12 mins	Aspects of pathologists' work that facilitates surgeon's workflow Aspects of surgeons work that facilitates pathologists' workflow The role of communication about specimen margins across surgery and pathology
BST (3)	38	1 clip 12 mins	Individual differences among surgeons when handing over specimens to FSL Impact on workflow of in-person delivery of breast specimens

(1) the relationship between workflow and communication?
(2) how does specimen triage and prioritization work?
(3) What tasks facilitate the other team's work?
(4) What is needed for successful specimen delivery and handovers?
(5) Communication about margins and orientation maintains unity across the two teams

The team discussions generated by the reflexive sessions were audio- and video-recorded. This yielded a total of three and a half hours of data for transcription. Transcripts were deductively and thematically analysis by the researchers (KC, JM, HM). It is this deductively analysed data that is reported in this paper. The deductive qualitative analysis involved three researchers (KC, JM, HM) who watched the videos of the video-reflexive sessions along with reading the transcripts of the video-reflexive sessions, and then assigning transcribed data to the following five researcher-derived themes:

(1) successful collaboration
(2) new realizations about the other team's work
(3) appreciations of the other team's work
(4) new realizations of one's own team's work
(5) appreciation of one's own team's work.

Any coding inconsistencies between the three researchers were resolved through discussions to reach consensus. The researchers then identified exemplary participant quotes that typified the five themes. These quotations were utilized in this article.

Ethical considerations

The study was approved by the Mayo Clinic IRB 14–008673, and all participants consented to being video-recorded. Video and interview data is securely stored in password-protected files on a secure server and was accessed on password-protected computers by the study team for preliminary analysis. Researchers viewed the video- recordings in a private office where neither audio nor visual data were seen or heard by anyone other than the researcher herself.

Results

Figure 1 details how surgeons initially characterized their workflow. It begins with resection of the specimen, orienting it to the patient's body through the use of sutures, and then carefully labelling it before alerting the FSL that it is available for collection or alternatively, hand-carrying the specimen to the FSL. BST characterised the associated communication as a loop that was complete when diagnostic reports related to the specimen were delivered or "called-back" to the BST either in-person, via intercom, phone or pager from the FSL.

Figure 2 details how FSL staff initially characterized their own workflow. It begins with the specimen being received from the BST, upon which time it is labelled with patient information, and entered into electronic records. The pathology assistants then confirm the correct orientation of the specimen, inspect it for diagnostic information, and begin dissecting it for analysis and for slide preparation. The pathology assistants then select specific specimen margins and pass them to laboratory technicians

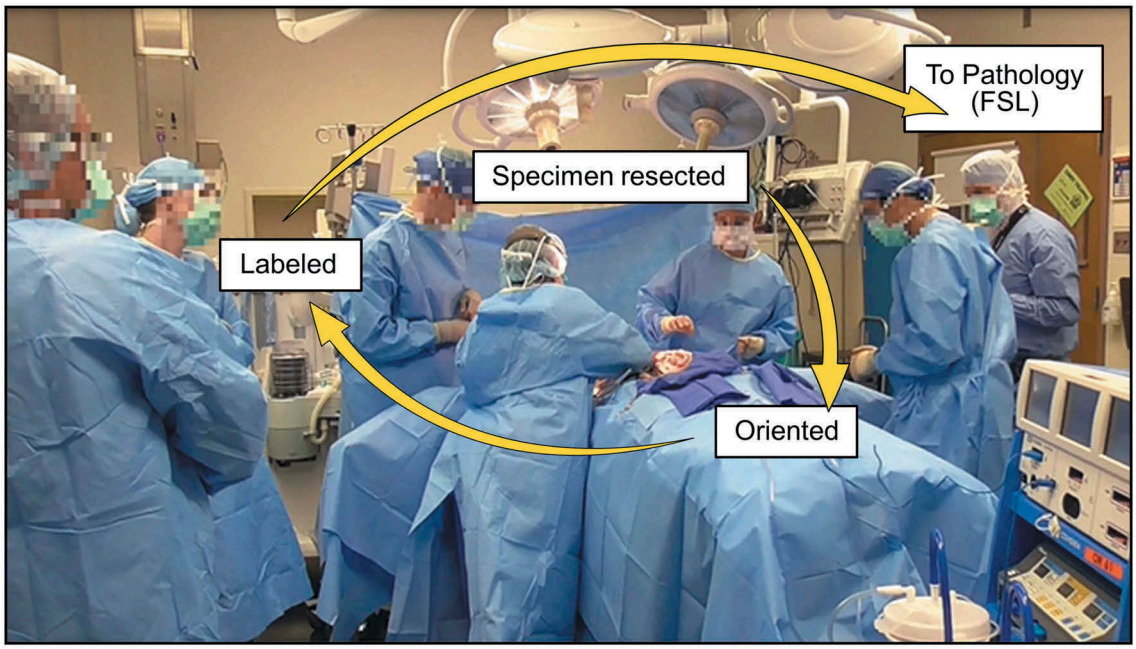

Figure 1. The Breast Surgery Team, Communication, and Workflow Loop.

Figure 2. The initial characterization of workflow in the Frozen Section Laboratory.

who prepare glass slides using the frozen section technique. The prepared slides are then passed on to the pathologist for evaluation. The pathologist or the pathology fellow will complete the workflow by calling the specimen evaluation report back to the BST who are awaiting the result in the OR.

Figures 1 and 2 show how the breast specimen's passage from the BST to the FSL was characterized linearly by BST and FSL staff members. This characterization was conveyed both through verbal explanations of workflow provided to researchers during their orientation to the BST and FSL, and again in the FSL's orientation materials, which were provided to researchers. Yet upon engaging in video-reflexivity sessions participants from the BST and FSL began to unpack their underlying communication practices, which they soon realized were highly non-linear:

> *"So even though the specimen flows linearly, actually I think the [spatial] design is so that we can cross those lines anytime that we want and this lab in particular lends itself very well for that." (FSL Team member)*

> *"I'd say my biggest impression from looking at this video is how complex it really is, and we do this every day and we just take it for granted." (BST member)*

It is this newly realized complex collaboration that we now seek to more fully describe. To do so, we have revised the initial representation of the FSL's work in Figure 2 to convey the complexity of the communication processes. By schematically superimposing this complexity on the previous characterization of the FSL's workflow, Figure 3 now portrays what we find to be the crucial interprofessional communication work that is supportive of the accurate and rapid intraoperative frozen section evaluation of breast specimens. We now explore these interprofessional team communications and map these on to Figure 3 with corresponding exemplary quotations from staff in the FSL and BST.

Interprofessional communication upon specimen delivery (Arrow #1 and #2)

Unlike the initial schematic diagram which shows the pathologist as having only final communicative involvement at the point of slide evaluation, the revised schematic reveals that the pathologist will often be involved in the initial assessment of the gross (pre-dissected) specimen when it first arrives in the laboratory, in collaboration with the pathology assistant or surgeon. Upon seeing this collaborative interprofessional practice in the video-reflexivity session, it was commended by both pathologists and surgeons:

"… the [pathology] consultant came up there [to the grossing station], I am really happy to see consultants up there looking at stuff and … guiding what needs to be done because I think the worst mistake that can happen is somebody just sitting at the [micro]scope and just focusing on the slides coming across their desk and not being aware of what's coming at them" (FSL Team member)

" … what we do when we are able to bring our own specimen is that we communicate with the person who is grossing the specimen and the pathologist, in terms of maintaining orientation and also triaging through all that, that's very important on both sides" (BST team member)

The initial schematic representation of the workflow (Figure 2) also depicts the pathologist as remaining at the microscope during evaluation. However, video-data revealed that while analysing a slide, the pathologist may return to the grossing station to either look at the gross specimen or speak directly with the pathology assistant who grossed the specimen:

"I mean it is very common that the slide that we are looking at does not show what we were expecting so that prompts rechecking the gross or even something as simple as asking, give me another section of this …" (FSL Team member)

This newly-identified communication work of the pathologist with pathology assistants and surgeons was deemed by both teams to be important to accurate and timely diagnostic work.

Interprofessional communication that triages specimens (Arrows #3, #4, #5, and #6)

In addition to receiving specimens from breast surgery, FSL staff are concurrently handling specimens from other medical speciality areas. This volume and variety of specimens entering the laboratory requires significant triage work that is replete with multitasking and interruptions. While watching the video of their practice, one FSL team member describes this triage work:

"…but most likely that [pathology] fellow over there was looking at another complicated … colon case 10 seconds before and was also being called to look at the colon from the other PA [pathology assistant] over there, so even though the initial thought process is very linear, in practice you couldn't work linearly because those lines are going to be interrupted every 10 seconds or so" (FSL Team member)

"So that second case was probably a different one, so you are multitasking, you got multiple cases coming through the system, so you are getting up to look at that other case and see what it was and then sitting back down again. I mean that's what I see" (FSL Team member)

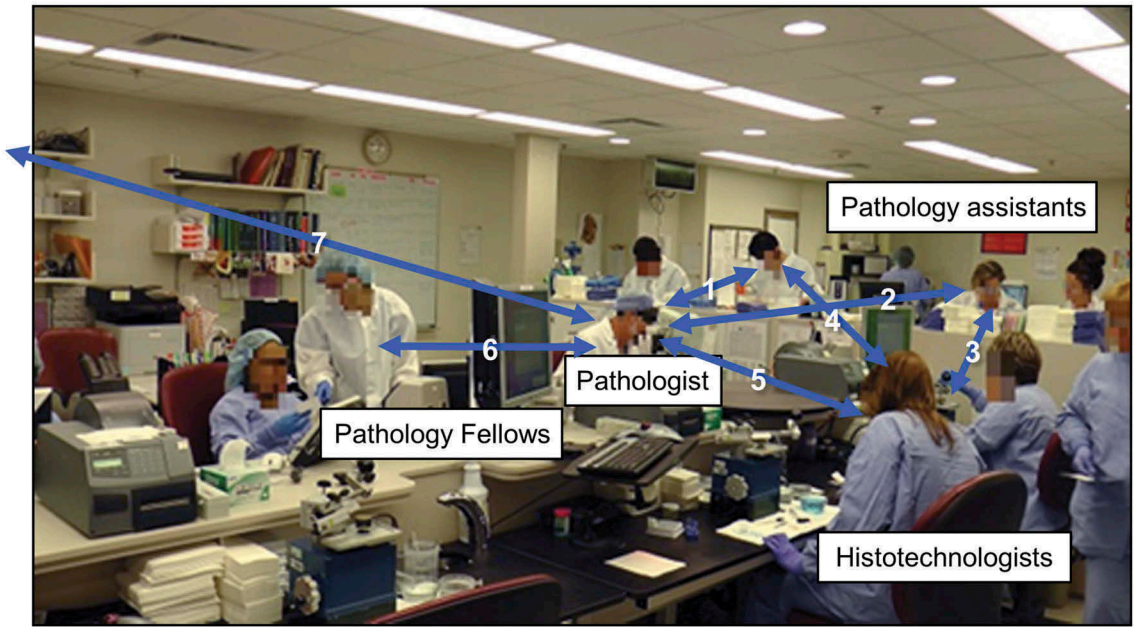

Figure 3. The complex web of intra- and inter-team communication in Frozen Section Laboratory.

It is not only the whole specimens from multiple specialities that are arriving into the laboratory concurrently. The pathology fellow (arrow #6) will also be receiving dozens of prepared slides from the pathology technicians from multiple different cases. As a result, the fellow needs to prioritize not only which cases but which slides the pathologist should read first. To communicate the results of this triaging process, the fellow will place the highest-priority slides closest to the pathologist to indicate which slides should be viewed first under their microscope. While watching the video-footage of their practice, an FSL team member explains this further:

> *"Well usually consultants do the roll [slides] that is closest to your [micro]scope. The fellow will … have to prioritize which one needs to be read first and which one can wait … see [pointing at the video] she is pushing [the slides] towards the consultants scope, [that] need to be read right away, so consultants know, the easiest to get is the ones we are supposed to read first, and communication of the two is very close because they are sitting right next to each other" (FSL Team member)*

This non-verbal communication between the pathologist and fellow is much more complex than the linear representation of workflow initially portrayed to the researchers during orientation and in the orientation materials.

Video-reflexivity sessions enabled the pathology and surgical team to newly "see" that while assigning priority to incoming BST specimens and conducting the necessary evaluative and communicative work with the BST, they were also enacting communications about other specimens for other speciality areas. BST gained a new appreciation of the busyness of pathology work:

> *"And the other thing … is how much more you guys are juggling in the lab, it's not just the [BST] specimen it's all these other specimens coming and going and colorectal cases and gyn, and you know it's amazing that we do as well as we do" (BST team member).*

To return to the original schematic diagram of workflow, we note that it features a singular (yellow) arrow to depict the flow of one breast specimen. Yet in practice this representation of the FSL's workflow should show the multiple specimens (for example, as multiple yellow arrows), each requiring discrete interprofessional communications about the specimen itself *and* its triage in relation to other specimens.

Interprofessional communication of evaluative results (Arrow #7)

Pathologists or pathology fellows from the FSL expeditiously "call back" diagnostic results to surgery. The FSL team highlighted the efficiency of call-backs as one way they facilitate successful collaborationwith the BST:

> *"Communicating critical information back as soon as possible helps the surgical team know what to do. They know whether they need to re-excise the case, they know whether they are good, they can close or have plastics come in to do their thing." (FSL Team member)*

Diagnostic reports are communicated to the BST via a variety of modes: phone, pager, an intercom, and in-person. Both teams embrace the flexibility that these multiple modes of reporting afford and acknowledged that their relatively proximity facilitates their interprofessional communication, yet it was the safety advantage of the intercom for call-backs that was highlighted as all members of the surgical team present in the OR at the time of the call back could hear the result, and thus could be called upon to verify what was spoken by the pathologist:

> *"What I like about the intercom over the telephone is that more than one person hears the result, because there are certain times I will look at my team and go did we all hear that the same and if everyone heard it a bit differently, ok then we need to call back and verify or you know if there is any hesitation but it's nice you know if everyone hears it" (BST team member)*

During video-reflexivity sessions, the BST surgeons, who normally work in separate ORs, were able to review footage of how other surgeons in their team received and recorded diagnostic call-backs from the FSL. This resulted in lively discussion and as we will see later became the basis for optimizing their interprofessional communication practice with the FSL:

> *"I have never been in X's OR, it was very fun to watch X and how X deals with X's pathology report because I looked at X and I said, 'I don't get them to write it on the board, that's kind of a neat idea, maybe I should do that'. We have never sat down among the surgeons and said, 'how do we communicate?', so that's what I'll do, I will try and get the marking pen and write on the drapes" (BST team member)*

In sum, we argue that the specimen flow from the ORs, through the FSL, and then back to OR as depicted by the yellow workflow loop is actually supported by a dynamic, non-linear, interprofessional communication which we depict through the use of blue arrows (Figure 4). This perhaps is no accident. As depicted in Figure 4, the purpose-built architectural design of the FSL is such that it supports this circular flow of the specimen from arrival into the lab, grossing, to slide preparation and evaluation, yet it also supports interprofessional, cross-hierarchical, spontaneous communication between the FSL staff, and between FSL and surgery. For example, the arrangement of the tables and benches in the FSL facilitates intra-team communication between pathology staff, meanwhile siting the FSL in close proximity to the OR enables in-person inter-professional communication. Being 'just around the corner' creates an easy access for surgeons to discuss particular cases despite the limited time available.

> *"One of the strengths of our practice is the close relationship we have with the surgical team…having us physically together facilitates communication on critical patient issues" (FSL Team member)*

Discussion

The BST and FSL's exnovation of their shared goal (and appreciation) of an accurate and timely evaluation of the specimen, and a timely and clear communication of that evaluation back to surgery is revealed by our study in two ways. The first way is as a simple description that adopts the initially linear viewpoint of the BST and FSL, which highlighted the efficient and accurate passage of the specimen across two teams. The second way was revealed through the use of the clinalyst mode of doing VRE, which brings together social scientists and clinical partners in viewing practice. This approach highlighted the social, collaborative, communicative

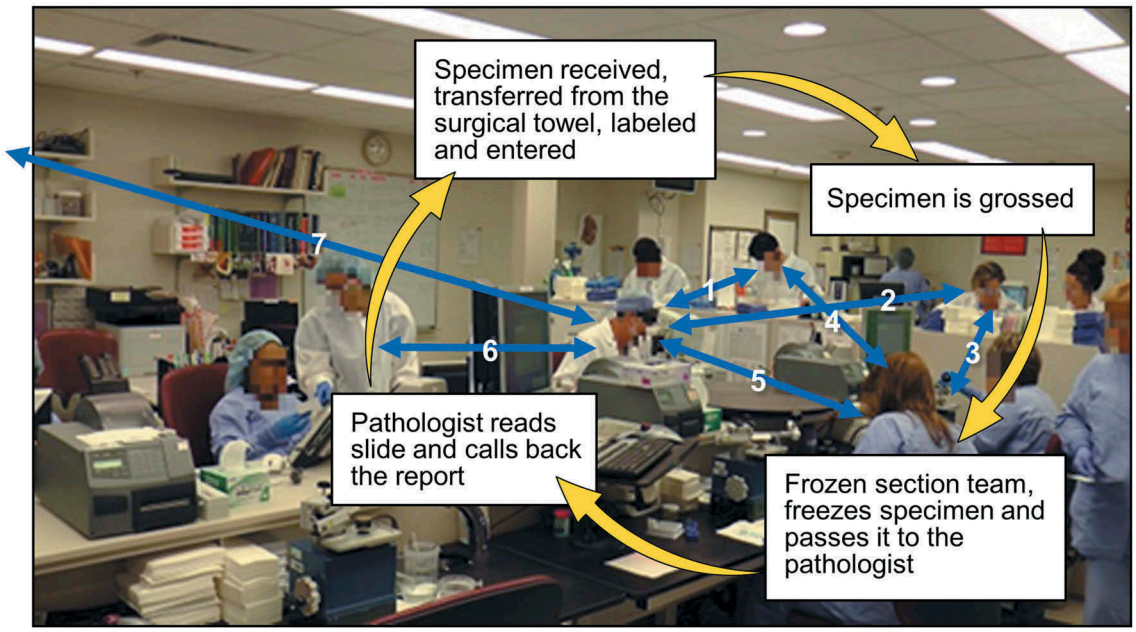

Figure 4. The linear and complex web of intra- and inter-team communication in Frozen Section Laboratory.

web of practice that supported the idealized linear travel of patient's specimen through the two teams. This web was not only described but validated by the BST and FSL as extremely important in meeting their shared goal of the two teams: an accurate and timely diagnosis. Importantly, the second rendering was previously unrealized, unarticulated, nor explicitly valued by the teams, even though it was felt.

Although this second rendering was a new realization for the participating team members, the illumination of the non-linear character of the interprofessional communication is unsurprising nor innovative in light of reading healthcare delivery through Complex Adaptive Systems (CAS) theory and resilience thinking (Braithwaite, Clay-Williams, Nugus, & Plumb, 2015; Dekker, 2011; Ellis & Herbert, 2011), 'Resilience Engineering (Hollnagel., Braithwaite, & Wears, 2015; Wears, Hollnagel, & Braithwaite, 2015) and 'Safety II' (Hollnagel, 2014). Collectively, these approaches explicitly acknowledge the diversity and multiple connections between the parts and aim to manage the system as interacting parts instead of "efficiently managing" separate entities (Edgren & Barnard, 2012). The CAS approach does not advocate a simple linear, top-down form of management or quality improvement, acknowledging that healthcare's complexity requires other ways of dealing with challenges (Braithwaite et al., 2017). We share with CAS theorists that healthcare is complex and therefore requires a non-reductionistic approach, but we stop short of advocating for system modelling and monitoring (Braithwaite et al., 2017). System modelling and monitoring does not sufficiently acknowledge the diversity of meaning, values, norms within practices and its power dimensions (Waring, 2015). Iedema et al. argue that systems approaches can dismiss the everyday and the local as being only a fragment in the larger complex system. Importantly, we do not locate the complexity in the system (and thus out of reach for clinicians), but in the 'here and now' of practice (Iedema et al., in press). Therefore, this leads one to ask, 'what is so novel and radical about this second rendering on the functionality of the complexity of interprofessional teamwork and communication in the BST-FSL collaboration?' In this setting, it is radical for two reasons.

First, during the video-reflexivity sessions, the BST and FSL teams made it clear that they highly value each other's communication work that is required to keep that specimen moving through the evaluative process. Thus, highlighting the interprofessional collaborative work revealed to the teams and to the researchers the value of each person involved—from specimen resection, through to grossing the specimen, through to preparing slides for frozen section analysis, and the evaluation work. This is novel because it displaces typical hierarchical thinking along lines of power and prestige being assigned to only certain professionals or certain processes (Haynes, 2003, p. 27), perhaps most obviously embodied by the evaluating pathologist at the "end" or "culmination" of the linear trajectory of the specimen itself in the laboratory, who at the end has the responsibilities of 'calling back' the evaluative result to the OR. This finding also displaces previous conceptualisations of successful FSL work that emphasized the frozen section technologies themselves. Ultimately, the functionality of the complexity of interprofessional teamwork means valuing each instance of communication that is typically cross-professional, cross hierarchical, and definitely non-linear to support the linear flow of the specimen itself.

The second reason this finding of non-linear communication is so important is that by limiting the teams' focus to the linear flow of the specimen itself, they would not have been able to unpack and optimize the important communicative work that supports their shared goal of overturning uncertainty through a rapid, accurate evaluative decision and report back to surgery. By raising the BST and FSL teams' attention to the communicative web, they saw their communicative processes as *vital* to the efficient flow of the specimen and diagnostic processes, and were also able to *optimize* their

communicative practices to continue to support their shared goal. We now turn to detail this optimization.

Through VRE as a methodology, the clinician is in the best position to unpack and intervene in their own work, including devising tailor-made solutions, because they are the ones who are entangled in it (Iedema et al., in press). After participating in video-reflexivity sessions, the BST and FSL staff optimised their interprofessional team communication by (i) enhancing the clarity and consistency of their communication through consistent specimen orientation practices in surgery (ii) implementing a new specimen orientation template for submission to pathology (iii) improving verbal call-back procedures by developing a script for call-back, and requesting both FSL and BST staff to "assure verbal confirmation and verification of reports" (personal correspondence June 12, 2017). Thus, VRE enabled the FSL and BST participants to tap into their own group wisdom (Iedema et al., 2013), and enabled the participants to identify, discuss and strengthen (in their own local parlance) their interprofessional verbal and written communication. This underlines the importance of a positive approach in combination with the VRE methodology. Improvement measures, which are solely based on error-analysis, do not take into account the well-functioning part of practices and can therefore seriously interfere with, or weaken existing but yet-to-be-explicated safety practices. For example, video footage shows the importance of the pathologist being immersed where the action is to enable them to know what specimen is coming their way and its position in the triage. The many 'communicative interruptions' from team members turn out to provide crucial information for the efficiency and accuracy of the final diagnosis. The VRE sessions underlined the importance of the spatial layout of the pathology lab and the proximity of the OR to facilitate face-to-face communication in an era were a multitude of digital modes of communication are available.

Thus, acknowledging the importance of local actors includes acknowledging the importance of local knowledge, socio-material and spatial circumstances. This finding aligns with the conceptualization of a network and its performativity in Actor Network Theory (ANT) (Latour, 2005; Law, 2009). Similar to ANT's 'network' our notion of a generative communicative web stresses its performativity of shaping interprofessional communication. However, in doing so we do not dissolve the distinction between human and non-human actors as ANT scholars do. Moreover, Latour (1996) conceptualizes a 'network' as something that is everywhere: here, now, in the past and future. We differ. In following the specimen, we do not provide a view on infinity. Instead, we bring forth a communicative web with clear boundaries based on local interaction between two teams.

This focus on the local is important. The involvement of BST and FSL participants in VRE was not expertise-based in relation to a critical task, but team-based related to a particular location. The joint activity of collaborative video-analysis that VRE instigates, resembles other approaches. Take, for example, the 'Change Laboratory', an intervention for developing work activities to generate a transformation in order to solve a problem (Engeström, 2008; Virkkunen & Newnham, 2013). Central to this intervention is the concept of 'knotworking' - a short-time collaboration to accomplish a critical task (Engeström, 2014; Kerosuo, 2015). Knotworking involves a temporary group of representatives (so-called 'knots') with relevant expertise from different parts of the organization, working together to deal with disturbances. When the problem is solved, the knot is untangled. Their joint effort requires 'boundary crossing' (Virkkunen & Newnham, 2013), meaning, navigation through different languages, registers, and cultural issues (Katz & Shotter, 1996). So, too, does the use of VRE. Through the use of VRE, it was revealed that FSL and BST communication involves several forms of boundary crossing: disciplinary (social), vertical (hierarchical) and horizontal (workspaces and workstations). The traces of these crossings themselves constitute the web in which their information exchange is suspended. Although the Change Laboratory shares important characteristics of VRE (e.g., use of observation and videoing work practices for data collection; analysis of practitioner's conceptions of work; openness to other's opinion), there are also some fundamental differences. For example, VRE is not limited to disturbances and problem-solving or to the study of change, but very much geared to learning in the here and now, which may or may not result in research output and practice optimization (Carroll & Mesman, 2018; Iedema et al., 2013).

Strengths and limitations

The strength of this study is in its methodological design. VRE in combination with a positive, exnovative approach to researching interprofessional communication captured the richness held in the broader context of surgery and pathology and provided more comprehensive insights into the interprofessional team communication that supports achieving extremely low reoperation rates for women with breast cancer. Moreover, the positive approach, in this instance, facilitated a re-appreciation of both team's work, which furthered their positive interprofessional work relations. One limitation, however, is the limited footage of the intra-team communication performed by the surgical team. As we focused on following the resected breast specimen across the BST and FSL in order to capture the interprofessional communication associated with each specimen, after the specimen was resected and was transported to the pathology lab filming ceased in the OR until the pathology report was called back into the OR. Although this approach facilitated a key outcome from our own study, which is to highlight the importance of the FSL's intra-team communication which is integral in supporting the broader inter-team communication and collaboration, we still recommend further attention be paid to the intrateam communications within the OR and how this may relate to interprofessional communications with the pathology laboratory. Further, this work was limited to the interprofessional interactions between two specific teams (BST and FSL) at one institution. It is unclear how our findings may apply to communications and working relationships between other sets of teams. However, the VRE methodology and process itself is transferable and may be used to enlighten successes and opportunities for improved patient care.

Conclusion

This study set out to analyse the communication that supported the success of the FSL-BST collaboration at MCR. The interprofessional communication work that supports the transformation of resected breast tissue into an intraoperative evaluative report, which then directs the actions of breast surgery requires important teamwork that was yet to be fully described. The VRE methodology revealed insights to both researchers and study participants regarding the everyday work practices of teams of surgeons, surgical nurses, surgical trainees, pathologists, pathology trainees, assistants, and technicians. In particular, it was used to understand how interprofessional communication and collaboration enabled the breast specimen to transform into an accurate evaluative report that saves patients the cost and hardship of reoperation.

Our study shows how rapid, accurate diagnostic work involves more than a set of cognitive skills of a pathologist and the correct use of instrumentation. In order to see, observation is embedded in an informative assemblage (Büsher, Goodwin, & Mesman, 2010; Forsyth, 2009). Collecting information requires a situational awareness of what is going on in the laboratory, which itself rests upon a rich set of collaborative and dynamic inter-team communicative practices. Our analysis shows how the trajectory of the specimen from surgery and into the pathology lab, and then back to surgery in the form of a "call-back" is supported by a web of cross-professional and dynamic information exchange. We found that these implicit communication skills performed by laboratory staff, previously deemed as mundane or invisible, is an example of a learned skill that is at the crux of successful intraoperative evaluative work.

Yet this study does not aim to prescribe a template for teamwork. Instead, we emphasised gaining insights into the competences of interprofessional teams that have been overlooked or forgotten because they belong to the day-to-day routines. Exnovating 'invisible' work practices turns out to be crucial and deserves attention so we can learn about informal resources and how they actually afford strong teamwork. Important to the principles of exnovation and its positive approach to the study of patient safety, is that this complex communication, despite requiring immense skill, had hitherto been taken-for-granted and unrealized as a crucial skill set for ensuring the success of the evaluative work of the FSL. Exnovating the complexity of the hidden work to facilitate the tasks of interprofessional team members leads to mutual re-appreciation. Awareness of such strength and collaborative work in the face of complexity is an important boost for morale. In sum, we argue that this crucial skillset has now been identified. Consequently, this skillset can accompany the scientific and technical information in future training of staff.

Note

1. Other examples with a positive perspective can be found in 'Appreciative Inquiry' (Cooperrider & Whitney, 2005; Reed, 2007), 'Positive Deviance' (Baxter, Taylor, Kellar, & Lawton, 2016; Bradley et al., 2009; Lawton, Taylor, Clay-Williams, & Braithwaite, 2014), and the 'Safety-II' approach (Hollnagel, 2014).

Disclosure Statement

The authors report no conflict of interest. The authors alone are responsible for the content and writing of this article.

ORCID

Katherine Carroll http://orcid.org/0000-0002-9110-1354
Jessica Mesman http://orcid.org/0000-0001-6721-2719
Judy Boughey http://orcid.org/0000-0003-3820-3228
Elizabeth Habermann http://orcid.org/0000-0002-1140-003X

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