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Working and knowing in technology-mediated environments: the case of the telecardiological consultation

Laura Lucia Parolin
University of Southern Denmark
Email:parolin@sdu.dk

Abstract

Comprehensions of how technology-mediated environments work are marked by a lack of theoretical sophistication about how expertise emerges and develops. Using a practice-based approach to workplace learning and knowing, a case of telecardiological consultation is discussed, where a dedicated call center works by connecting general practitioners (GPs) with remote cardiologists. The service allows GPsto send electrocardiogram traces (ECGs) and discuss the needs of patients with a cardiologist. The role of materials (ECG traces, the recording machine, infrastructure), and communication (synchronous communication in the form of a phone call) are considered in the practical application of the service. It is argued that being an expert telecardiologist entails the ability to align heterogeneous elements, and co-construct, a reliable interpretation of the patient's situation alongside a doctor. To do that when the situation is not immediately clear, necessitates both doctors discursively mobilize different bio-physiological, chemical, material, social and psychological aspects of a patient's condition, in order to arrive at a reliable interpretation. Thanks to a practice-based sensitivity, I analyze the case study reading these interactions as competent material-discursive practices.

Keywords

1   Introduction

Contemporary workplaces are increasingly characterized by immaterial activities taking place in technology-mediated environments, resulting in space-time compression (Giddens, 1990; Harvey, 1990; Castells 1996; Heath, Knoblauch and Luff 2000; Váquez and Cooren, 2013). Simultaneously, life and work environments are increasingly entangled with communication infrastructures that are able to connect actors from a distance as Information and Communication Technologies (ICTs) create spaces of interaction that generate new practices and ways of working. Work activities take place in areas where humans and nonhuman actors (material artefacts, codes, standards, texts, etc.) collaborate and coordinate with each other in time and space. The mediation of ICTs implies the fragmentation of spaces; therefore, a reconfiguration of knowledge and skills is required to act professionally in new mediated environments (Bruni et al. 2007). Working in these technologically dense environments (Heath, Luff, 2000; Bruni, 2005, Bruni and Parolin 2014), implies being able to mobilize artefacts, texts, discourses (Bruni et al. 2007; Cooren 2012; Váaquez and Cooren, 2013) and other fragmented knowledge to interpret the situation. Working in technologically mediated settings also means being able to unfold attention and cognition, and to coordinate actions with others in conjunction with the artefacts present in the workplace.

How can the complexities implicated in the mediated work environments of ITC be accounted for? To do this, requires a recalibration of existing analytical categories. Conceiving of work in the traditional way, that is to say the execution of previously planned activities, misunderstands that nature of work in technologically mediated work environments (Gherardi 2012). Recent scholarship coming from Practice-Based Studies' (Corradi et al. 2010; Nicolini 2012; Gherardi 2012), looks instead at how work is performed as a practical accomplishment within skilled practices (Nicolini 2012; Gherardi 2019). Rather than understanding work as a task to be performed, this stream of research interprets it as a situated practice. This practice-based perspective on work and organization (for an overview see Nicolini 2012) is open to contributions from other disciplines such as cultural psychology (Miettinen at al., 2012: Sannino and Engestrom, 2017), ethnomethodological studies (Lynch and Woolgard 1990; Suchman 1987), anthropology (Chaiklin and Lave 1993; Inglold, 2000; Schatzki et al. 2001), and Science and Technology Studies (Latour and Woolgar 1979; Latour 2005; Pickering, 1990). In particular, a practice-based approach to learning and knowing in organizations has its root in traditions that lead to theoretical approaches that do not make an epistemological separation between knowing and doing. As Gherardi (2019) highlights, several strands of research contribute to this ongoing conversation:

- *A cultural-aesthetic approach,* which views knowledge as embedded in social interaction mediated by language. Aesthetic understanding is the form of knowledge that persons acquire by activating the specific capacities of their perceptive-sensorial faculties while they are engaged in the task at hand.
- *Situated learning theory,* which values learning as competent participation in a practice, and stresses that learning constitutes social systems and social identities.
- *Activity theory,* which focuses on objects of activity as partly given and partly emergent and maintains that knowledge and acting are always and necessarily embodied in particular, historical and culturally constituted settings.
- *Actor-Network Theory,* which illustrates how knowing is enacted in sociomaterial networks of human and nonhuman actants.
- *Workplace Studies*, which are interested in the 'naturalistic' study of work settings, paying close attention to interactions and 'technology as practice', or technology-in-use. (Gherardi 2019, pp. 235-236).

Focusing on work practices, it is possible to reconfigure the challenge of understanding technologically-mediated and distributed dimension of work which is characteristic of the contemporary era. Doing so, demands unpacking the wealth of scholarship that hints at such strategies.

2   Literature Review: workplace and practice-based studies

In the last thirty years, authors from diverse social theoretical traditions, such as American symbolic interactionism (Star, 1996), Ethnomethodology (Suchman 1987), and Activity Theory (Engestrom, 1987; 2000), have been interested in studying work as performance that emerges from human and nonhuman actors, knowledge, and the space of interaction (Luff, Hindmarch & Heath 2000). Beginning in the late 1990s, a stream of literature labelled 'workplace studies' (Heath & Button 2002; Heath, Hindmarsh & Luff 2000; Luff & Heath 2000; Heath, Knoblauch & Luff 2000; Heath, Luff, & Knoblauch 2004; Parolin 2008), has focused on the study of work by undertaking detailed analyses of naturally occurring work activities. These authors consider the workplace to be an ecological environment; one where situated practice takes place. They consider work as being socially constructed through interactions among participants, and the use of artifacts and technologies that inhabit and constitute the work setting. As argued above, this performative

conceptualization of work entails shifting the focus from work conceived as the result of the execution of planned tasks, to work understood as the practical accomplishment of the activities through local articulations, disarticulation, and agreements (Corbin & Strauss, 1993). Corbin and Strauss, for example, consider the performance of work in an organization as a coordinated collective act:

> "Since there are many different people doing many different types of work there must be *arrangements* in place about what work is to be done, to what standards, in what space, during what time period, with what resources, by whom, and with what pay-back, in order for articulation to occur." (Corbin & Strauss, 1993, p. 74, emphasis in the original).

Despite the variety of approaches (ethnomethodology; conversational analysis; activity theory and courses of actions analysis), all of them consider situated analysis to be the only possible way to fully comprehend the activity of working, taking account of its collective actions and situated practices. Recently acknowledged under the umbrella of practice-based studies (Nicolini 2012; Corradi et al. 2010; Reckvitz 2002), these studies have contributed to the erosion of the faith in positivist rationality of social action (Gherardi 2000) by shifting the focus of research to the result of negotiations in situations. In this view, practicing is "knowing how" and knowing "what next" in order to contribute to ongoing situated working practice. Thus, even when performed by a single social actor, practice is always something more than their activities or courses of action. As Gherardi (2019) highlights, practice is socially sustained by a normative base (ethical, affective and aesthetic) and continually reproduced and/or contested within the community which sustains it.

The methodological consequence of this approach is the primacy of studying naturally occurring activities in a work setting. Using detailed analysis of actions and interactions that take place in work settings, workplace studies seek to account for the 'taken-for-granted', tacit knowledge and routines which participants often do not perceive as constitutive elements of work but pertain to expert knowledge. Concerning technological mediated environments these studies

> " … look for the *missing what* that ordinary histories of the relationships between people and technologies have taken for granted but forms the basis for the subtle and complex web in which the functioning of the technology itself is possible." (Fele, 2002, p. 192, *my translation, emphasis in the original*).

Workplace studies are interested in technology as a constitutive element of workplaces, considering it as technology in use or 'technology in action' (Heath & Luff 2000). Thus, they "re-specify" many of the key concepts of technology in work and organization (Rawls 2008) and challenge the idea of the 'user' underpinned by the Human-Computer Interaction tradition (Suchman 1987; 2007). Furthermore, they demonstrate that individual actions are produced through the real-time contribution of the others.

Drawing on this scholarship, I advocate a conceptualization of technology and information systems in organizations as inseparable from their uses in work practices and their body of local knowledge. As highlighted by Luff and colleagues it is this practical knowledge which generates technologically informed activities and makes them intelligible (Luff, Hindmarch & Heath 2000). Technologies are therefore not perceived as entities *per se* but conceived in the context of the practical circumstances of their use during the working activity. As Heath and Button (2002) point out, "mundane" and practical uses of technologies such as computers, information systems, formal protocols, technical specifications, depend on a complex body of socially organized practices.

With a logic similar to "laboratory studies" (Latour & Woolgar, 1979; Latour, 1987; Knorr-Cetina, 1983), workplace studies focus on everyday work contexts with a distinctive approach to understanding the use of tools and technologies in organizations (Heath & Button, 2002). As science is studied by laboratory studies as a product of laboratory practices, these scholars consider work activity as an emerging product of coordinated practices *in situ*. In other words, for workplace studies, work is an activity that arises from the relationships between humans and non-humans in the particular environments where work practices take shape. Work emerges in this perspective, from a technical and social system that takes shape in a physical place mediated by technology. Through their interest in work practices, workplace studies scholars explore how everyday work is performed, and what competencies are required of the participants in technological mediated services.

2.1 *Situated action paradigm*

Workplace studies, and other streams of research under the umbrella of practice-based studies (Nicolini 2012), (or situated action paradigm[1]) are positioned in a theoretical tradition that emphasizes the importance of the sociomaterial

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[1] As Gherardi (2019) notes, some French scholars refer to this tradition as the *situated action paradigm* (Conein & Jacopin, 1994).

context of social relations. This literature aims to replace the objective rationality of social action, represented by the performance of tasks as an optimizing logic, with one that is embedded in the situation and therefore in a regime of contextual rationality[2]. The conceptualization of context is actively constructed in "situational frames" that interpret a specific part of reality; almost carving them from the environment. Defining an action as situated, means to conceive of it as a *performance* that emerges *in situ* from the dynamics of interactions (Conein & Jacopin, 1994). This dynamic is the result of two processes:

- the understanding that each participant has of the action of the others;
- the perception and interpretation of indicators that come directly from the environment

The theoretical roots of the situated action paradigm can be found in the writings of interactionist authors such as Mead (1934) and Schütz (2007). In particular, Lucy Suchman (1987; 2007) refers to these authors when she emphasizes the importance of language, and the mutual understanding between participants and the actions of others. The concept of situated action proposed by Suchman represents a continuity with Mead's thought and the conception of the idea of the other (Mead, 1934). Suchman conceives situated action as oriented toward, and dependent on, the action of the recipient. In this way, she unfolds the concept of situatedness as an element of the communicative situation. When two communicating agents share a space of attention, their activities are situated because they are oriented and dependent on the action of the other. Therefore, defining an action as situated, means to conceive of it as a consequence upon the interactions between the actors involved in the setting.

2.2   *Doing, saying and knowing in the workplace*

Interactions with others, the physical environment and the objects present, are all relevant to the study of work as situated activity. In these interactions, language and communication play a central role as tools of negotiation and action. In fact, through language, actors interpret-construct the situation they are facing (in verbal interactions between actors) and make sense of it. Indeed, as highlighted by the approach called Communicative Constitution of Organization (CCO)[3], communication practices are something different from message transmission and communication, and they have to be interpreted as processes of meaning co-production and negotiation (Bovin et. al 2017; Vasquez and Cooren 2013). Gherardi (2019) refers to the work of Schoeneborn and colleagues (Schoeneborn et al. 2019), in highlighting that the meaning neither resides in the messages actors exchange, nor in their cognition, but rather in the practices heterogeneous participants (humans and nonhumans) engage in. Similarly, to CCO, workplace studies also focus on discursive practices, conceptualizing the study of work settings as the analysis of patterns of language and interaction. Conversational analysis is often used by these studies of work as a "rigorous perspective for the study of talk in interaction" (Engestrom and Middleton, 1996). Talk-in-interaction is analyzed as "the central medium through which the daily working activities of many professionals and organizational representatives are conducted" (Drew & Heritage, 1992). These studies also participated in the definition of the stream of language studies at work that emerged from distinctive but convergent lines of investigation in sociology, anthropology, and linguistics, (Llewellyn & Heritage, 2010). During the 1990s, these studies increasingly focused on the uses of language in specific institutional contexts and for particular purposes (Gumperz, 1989; Drew & Heritage, 1995; Mondada, 2002; Llewellyn, 2008; Boutet & Maingueneau, 2005; Llewellyn & Heritage, 2010).

Communicative competences are thus considered essential components of specific professional expertise. In medicine, an essential part of professional competence lies in the communicative capacity of the doctor in interactions with the patient (Cicourel, 1987). Indeed, although medicine uses sophisticated instruments for detecting bio-physiological characteristics, it is during the interaction with the patient that the doctor interprets the situation, decides

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[2] As we will better see in the following session, the context of action is constructed professionally through what has been called *professional vision* (Goodwin 1994; 1997).

[3] The CCO approach focuses on how organization happens in communication. In this view organizations are communicatively constituted and "it means that one should examine what happens in and through communication to constitute, (re-)produce, or alter organizational forms and practices" (Cooren at al. 2011 p.1151). CCO invites scholars to "start from communication in order to explain organization and organizing not the other way around" (Cooren 2012, p.4). The CCO approach claims that communication ''is the means by which organizations are established, composed, designed, and sustained'' (Cooren et al., 2011, p. 1150). It should be noted that CCO's conceptualization of sociomateriality is also grounded on the work of Bruno Latour (1986; 2005) and other *Actor-Network Theory* scholars, while their conceptualization of 'practice' is explicitly connected with practice-based 'bandwagon'(Corradi, Gherardi & Vezelloni, 2008). Vasquez and Cooren (2013) for instance maintain: "Our definition of practice stems from ethnomethodology, which is concerned with what the actors do in a specific situation. In that sense, we follow the practice turn, which is receiving a great deal of attention in organizational studies (Corradi, Gherardi, & Verzelloni, 2008)" (pp. 43).

and explains the actions to be taken. The very formulation of the diagnosis in medicine is a collaborative activity performed through discursive practices between the actors involved.

Highlighting the importance of language does not necessarily diminish the importance of other indicators in an environment. Workplace studies pay particular attention to the ways indicators from the work setting are used to coordinate complex collective real-time practices in, for example, coordination centers where experts coordinate the activities of others from a distance. Centers of coordination are characterized from participants' ongoing (re)orientations to problems of space and time, involving the deployment of people and equipment across distances, according to a canonical timetable, or the emergent requirements of rapid response to a time-critical situation (Suchman, 1997, p. 42). These settings, like any other in which expert practitioners interprete real time indicators from the environment, is rich with practical knowledge.

The work of Charles Goodwin provides a useful reference point in describing this practical knowledge. He analyses the process of meaning attribution to an ambiguous situation (1995; 1997), proposing the concept of "professional vision" as a socially organized way of seeing and understanding events. The basic assumption of this concept is that the interpretation of events is not mental and individual processes, rather it is achieved through discursive practices that have been historically constructed within a concrete social context of practice[4]. To demonstrate this, Goodwin (1994; 1995) analyses the work of an archaeological site to show how archaeologists establish, as well as teach, their professional knowledge. It results in a depiction of professional expertise that is rich in practical knowledge and includes practices of coding, highlighting and the production of material representations. For example, territorial coding schemes are a systematic practice that allows archaeologists to transform the complexity of the world into categories and events relevant to the exercise of their profession. Thus, an archaeologist and a farmer see quite different things in the same piece of land (Goodwin 1994). In this sense, the professional vision is a social and cultural activity oriented to cognitive tasks that are carried out within a specific profession. Perception, as well as manipulative skills, must be educated to the practical needs of the specific profession. Said otherwise, practitioners in a given profession learn to "know how to see" as an expert.

The sense of seeing, can thus be conceptualized differently from a fixed cognitive process. Instead, it has to be understood as something that has been learned through situated engagement with processes as the means of developing professional expertise. The anthropologist Cristina Grasseni (2007) refers to this process as skilled visions that are learned through apprenticeship. Conceptualized as social practices, skilled visions, orient perception and structure understanding, Grasseni affirms that skilled vision does not only convey ideas, meaning and beliefs, but also configures them. This resonates with how Goodwin perceives the activities of interpretation and meaning-making, as ones constituted by dynamics involving artefacts, gestures, discursive practices, and modes of selection in the work place (Goodwin, Goodwin, 1996; Goodwin, 1994). For Goodwin, it is the attribution of meaning to something that is immersed in an undifferentiated way in a flow of information that is not relevant until it is subject to interpretation. The act of interpreting therefore, is a practical skill, acquired through an apprenticeship, and embedded in the corpus of professional practices of a given community.

3   The empirical case of the cardiological remote consultation service

Thus far, I have argued that doing, saying and knowing are aspects of a practice that can be studied as a situated activity. I have also noted the significance of professional vision, (Goodwin 1994; 1995; 1996), describing it as a practical knowledge, able to isolate pattern details from the scene, and build an interpretative framework for the current situation through language. The following, analyzes an empirical case as a paradigmatic example of this interpretative framework and shows how these concepts explain expert work in a technologically mediated environment. Using the case of a telecardiological consultation, the article shows how work can be interpreted as a material-discursive skilled performance, where the line of therapeutic intervention discursively emerges from situated interactions. These material-discursive performances involve several actors: the actors' who use the service (general practitioners, GPs) and their patients; cardiologists who are experts in working remotely; material artefacts (electrocardiograms, the trace recording machines); the information and communication infrastructures; specific software used to read remotely recorded ECG traces and a dedicated organization able to connect a cardiologist with a GP allowing them to talk in synchronous verbal communications (telephone calls). The case discussed here is a service addressed to GPs that allows a real-time consultancy with a remote cardiologist. It also works as distant reporting of an ECG recorded by the GP.

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[4] According to Gherardi (2019), practice is a "doing" and "knowing how to do" with words that can be analyzed as "discursive practices" normatively sustained by a community of practitioners and learned and performed as part of practitioner competence. This practice-approach allows the exploration of expertise and professional competence as it is deployed in discursive practices, showing both the knowledge embedded in meaningful interactions, as well as the relevance of such expertise for the specific practice (Parolin 2020).

The service is based on:

- A (portable) technological artifact able to record and send ECGs
- A specific software able to visualize the ECG sent by the GP
- A call center that sorts the GPs calls to the in-service cardiologists
- A telephone call from GP with the cardiologist

The telecardiological consultation is a new specialized medical practice that has entered GPs' standard practices to support them in their professional activity. Therefore, the service can be interpreted as an expert consultation dedicated to the GPs that is made possible by the mediation of ITCs. The practice of the telecardiological consultation is therefore something that involves a broad distributed setting, including also the techno-organizational configuration that manages and sustains the service (Parolin 2011). Technically, the service is based on a three-way telephone call between the GPs, the cardiologists, and the call center that manages the sending of the electrocardiogram (ECG) traces. Two aspects seem crucial to the service: an immediate instrumental analysis (the recording of the ECG traces by the GPs) and the real-time access to a specialist cardiological consultation by phone. The GP uses the cardiologists' interpretation of the ECG traces to legitimize her medical course of action, on the basis that ECGs provide technical objectivity by displaying the patient's bio-physiological functioning. In the presentation of the service, the ECG trace was invoked as an element of accountability to the patient situation, specifically as a tool able to display an "objective state" of the patient through a direct connection (thus not mediated by the human interpretation) with reality[5]. At the same time, the GPs consultation with a remote cardiologist allows using his/her specialist cardiological knowledge as an element of reassurance for themselves and his/her patients[6].

This cardiological consultancy service has been offered by a private health care center active in Italy since 1998[7]. The 24-hour service is provided by cardiologists who examine the electrocardiograms (ECGs) sent electronically by the GP's. At the time of the research around 800 used the service. The data consists of collected telephone records over the course of a month, including a total of 1052 conversations between cardiologists and doctors. For the present purposes however, I focus on a small selection of conversations that illustrate the discursive practices as situated alignments of a heterogeneous network of knowledge (*see also* Bruni, Gherardi and Parolin 2007).

The consultations led to an outcome that had a direct influence on the actions taken by the GP. These outcomes can be divided into four different categories (Parolin, 2006):

- 51.6 % of the conversations concluded with no clinical action being taken. Belonging to this category were both assessments of patients who presented with no cardiological problems, and conversations that led to a slight adjustment (if further tests did not accompany this) of the existing therapy
- 30.3 % concluded with a prescription for further medical tests
- 9.6 % of consultancies concluded with the patient being dispatched to the Emergency Room
- 8.5 % of telephone calls concluded without the consultancy because the trace could not be assessed or was deemed not relevant.

From an overview of the entire data set (Parolin 2006; 2011), it is possible to identify different uses of the teleradiological consultancy service. While the rhetoric of the service focuses on urgent situations of severe cardiological crisis, the GPs also use the service for different purposes. Indeed, the conversations analyzed (1.052 telephone calls) can be almost equally distributed into 'routine' (certificates of good health or routine checks for monitoring chronic patients), and 'non-routine' (patients who had manifested or reported symptoms that suggested serious cardiological problems, or exceptional symptoms in chronic patients under pharmacological treatment).

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[5] As noted *inter alia* by Marc Berg (1997), medicine increasingly uses diagnostic technologies to delegate elements of the diagnosis process. Similarly, there is a tendency to delegate aspects of medical knowledge to standard protocols and expert system to support decision making. This shift from the human to the technological in medical knowledge is the result of a modernist view of medicine and its attempt to rationalize the medical knowledge that emerged with the diffusion of medical professions (Berg 1997).

[6] Although the service performs a function of reassuring and legitimizing the choices of GPs, it is useful to note that the attribution of responsibility is not called into question by the service. The responsibility for the choices regarding the patient's trajectory within the health care system is a prerogative of GPs, even in the case of those choices based on service consulting.

[7] This work comes from my PhD dissertation (Parolin 2006), at the University of Trento, as part of a collective research project (*see* also Bruni, Gherardi and Parolin 2007; Bruni, Fasol and Nicolini 2005; Bruni and Parolin 2009; Gheradi 2010; Gherardi and Strati 2004; Parolin 2011) carried out by RUCOLA research group.

Some of the telephone calls are very short, while others required more time to arrive to an outcome. Several conversations that were very short were with regard to routine checks (e.g. the need for certificates of good health or recurring checks for chronic patients).

Excerpt 1

> [Greetings]
> GP: well, then listen, I don't know if the ECG has arrived well because he is a seven-year-old boy
> C: yes, everything is fine
> GP: nothing .. it's just to .. must .. must enroll in football school
> C: everything is fine, a physiological sinus arrhythmia, everything is fine
> GP: fine
> C: we send it to you
> GP: yes, thank you
> [Salutations]

However, a conversation can also be short in cases connected to non-routine and urgent situations. The following excerpt shows one of these cases.

Excerpt 2

> [Greetings]
> GP: listen to me, I have this 76-year-old patient who ... eh ... the only data in the history are ... he is a patient who occasionally suffers from chronic bronchitis with winter flare-ups and there is a mental frailty behind ... so ... a oligophrenia and... nothing, this morning he had an episode of illness... lipotimico - because he remained conscious - while he was in the bathroom... mah, he was alone, then he says he recovered ... but he had a sweat and all, now the family called me because in the afternoon he says he has a pain in the stomach in the epigastric region ... it is a protracted pain ... he has no never suffered from these disorders ... and being in doubt I made this ECG trace.
> C: then, listen, in the ECG the rhythm is sinus... with a heart rate of 54 beats per minute, so it is bradycardic, but it has an incomplete right branch block, a right focal block, but it has negative T's in V4V5V6 with ST it is slightly undersized... The meaning, honestly, I can't tell you ... I can't tell you if this is an old thing or the mirror of what he is having now... but I think he should be evaluated at the emergency room...
> GP: yes, yes, yes
> C: yes? Ok.
> [Salutations]

In this case, the ECG revealed anomalies, which in the presence of symptoms considered typical (lipotimìa), lead rapidly to the decision to send the patient to the emergency room.

In both cases, one should note how the conversation begins with the GP presenting the "case" which offers a brief overview of the patient's anamnesis. The mentioned structure of the telephone call, opened by a description of the reasons why the doctor is using the service, is typical. Indeed, while explaining the reason for the call, the GP usually provides also a preliminary description of his/her patient. In this way, the GP offers a frame where the ECG can be interpreted. In excerpt 2, the GP recounted the patient's situation, defining the symptoms as abnormal "he never suffered from these disorders". The discussion of this specific occurrence, in the context of his patient's usual symptoms, directs the GP's attention to something potentially critical. However, to clarify the situation, the GP asks for the intervention of the ECG trace as means of "accountability" for his client, that is to say, a way that represents the state of the patient's health in an easily digestible format.

The ECG is the artefact invoked to clarify an ambiguous situation, one which clarifies if the patient's complaints are, or are not, symptoms of cardiological problems. This instrument, therefore, plays an essential role within the discursive performance and allows, through the mediation of the cardiologist, to bring out the subsequent therapeutic decision. In the cases of symptoms considered typical, the function of the service is consequently twofold. On the one hand, in taking an ECG the GP seeks a readable account of the state of the patient, which can detect (or exclude) severe cardiological problems. On the other, the interaction with the cardiologist is used to make sense of events and formulate a plausible hypothesis about the possible cause of these symptoms (including symptoms other than cardiological ones).

In the case illustrated by Excerpt 2, the cardiologist reads the ECG and is able to code, highlight and determine the patient's problem. The cardiologist, through professional competences that arise from the set of practices of his/her

professional community, appoints and circumscribes the problem using the technical-scientific language of his/her community.

Looking at the ECG track, the cardiologist first highlights specific features of the ECG trace that refers to the patient "in the ECG the sinus rhythm ... with a heart rate of 54 beats per minute". The interpretation of this first characteristic of the ECG allows the cardiologist to immediately conclude that the patient is bradycardic "therefore he is bradycardic". Subsequent readings of the ECG, allows the cardiologist to highlight and recognize other anomalies "but he has an incomplete right bundle branch block, a right focal block, but he has negative Ts in V4V5V6 with ST that is slightly undercut". Once these anomalies were highlighted and named, the cardiologist - looking for a therapeutic course of action - translated the characteristics of the ECG into hypotheses concerning the patient's state of health. Even if the cardiologist pointed out how a direct correspondence between ECG trace and the health state of the patient could be problematic, the interpretation of these features of the ECG in framework offered by the description led to the action. "The meaning [of the ECG anomalies] honestly, I cannot tell you .. I cannot tell you if this is an old thing or a mirror of what he has now". These considerations led the cardiologist to suggest the safe course of action to the GP: "but I think it should be evaluated in the emergency room" [...].

This case shows that the discursive performance between the GP *and* the cardiologist is what constructed the role of the ECG in interpreting of the patient's state of health. Practicing telecardiology, therefore, is not a one-way interpretative action, where the cardiologist reads and interprets the ECG trace, but rather a co-constructed interpretation of the patient's condition, mediated by the professional knowledge of the two doctors, the technological infrastructure, and the ECG. I argue, that the telecardiological service is a sociomaterial practice, involving heterogeneous materials, knowledge and discourses that once aligned lead to an output. When the conversations are short, aligning the description of the situation and the reading of the ECG is obtained easily. Excerpt 1 is a case in point. It shows the certification purpose, and the health status of the young patient, are easily aligned to the reading of the ECG trace. Similarly, in the Excerpt 2 the description of symptoms was considered typical and were easily aligned to an anomalous ECG.

The following excerpt shows an example where the interpretation of the situation required greater deliberation between the two doctors, and highlights how the therapeutic line of action emerges as a result of the situated discursive performance by the two practitioners.

Excerpt 3

[Greetings]
GP: Listen, I have an emergency because I don't hear anything with the patient ... this lady is from 1924. At some point… the nurse only reported her to me today… it's been a while since she has these important crises of dyspnea, with forced orthopnea, she has no pain, but she feels the sensation of sudden death, she told me now. I did this electrocardiogram in a bit of a desperate condition... so I don't know how it came... if you can give me ideas because I don't have any
C: the track came out very well
GP: excuse me?
C: I say the track came out very well
GP. Ah, well, I'm happy to hear it
C: the rhythm is sinus, 84 beats per minute, ... I tell you immediately... the atrioventricular conduction is at the upper limits of the norm, but I tell you that there are no major alterations of any kind…
GP: there are none…
C: it has a left axial deviation, an R that grows a little in the anterior, but I think it is from the septal type but ischemic alterations, so there are none
GP: there are none
C: I would say no
GP: also because the pressure is good I now it…. see if I did something wrong, I made a 4 mg benenol fial, in the vein and a 100mg phlebium
C: yes, how much pressure did she have?
GP: 120, she was coming down, though ...
C: you didn't do badly for sure ... I would take a look at a Doppler of optic logs
GP: ah here that there is not something ...
C: if it is not aortic auscultation... but the ECG is not an aortic trace I would take a look at an over-optic Doppler
GP: I don't feel anything, I was scared she was fibrillating, I couldn't hear anything at all
C: but it is probably comatose emphysema, it has some complex little ones, but ... it doesn't have an ECG track .. [not understandable]
GP: so I can feel comfortable from that point of view

C: from the cardiovascular point of view I think so
GP: I don't touch anything else... I don't touch anything
C: make a doppler, if you want, take a look at a Tac
GP: eh, they are patients who are difficult to...
C: eh, yes
[Salutations]

This phone call is slightly different as the doctor is not a GP, but a practitioner working in a nursing home. When the doctor calls the service, he is convinced the patient is presenting highly problematic symptoms and is at great risk. Indeed, using his stethoscope, he cannot hear the patient's heartbeat and is unable to interpret this anomaly in any medical framework "if you can give me ideas because I do not have any". Other symptoms referred by the GP in his preliminary depiction of the situation refer to respiratory problems (dyspnoea and orthopnoea) in the absence of pain. Even if the GP perceives the situation to be critical, the symptoms he describes are not considered typical of a severe cardiological condition. Reading the ECG in this framework, the cardiologist highlights how the trace does not show any relevant alterations that can be referred to as a cardiological crisis. Based on its features, the cardiologist interprets the ECG trace patient as not problematic "there are no major alterations of any kind". The cardiologist, thus, reassures the doctor about the severity of the patient's health condition. After these reassuring turns by the cardiologist, the doctor-user aligned himself to the cardiologist's interpretation of the situation, despite the fact that it contrasted with his previous perception. Once the interpretation of the ECG does not shows any ischemic alteration, the doctor embraced the non-problematic diagnosis proposed by the cardiologist, who highlighted how the patient's blood pressure was also good.

Thanks to this interpretative alignment, the doctor and the cardiologist - without any further explicit agreement – excluded the option of sending the patient to the emergency room, and dedicated the remainder of the call to investigating the anomalies shown by the patient. In the absence of the cardiologist sending the patient to the emergency room, the conversation immediately moves to the consideration of therapies, and further investigations to explain the anomalies identified by the doctor. The GP then uses the consultancy to elicit specialist feedback on the therapeutic intervention she performed, and illustrates that even if the patient's situation is interpreted as not requiring an urgent intervention, the cardiologist can advise further cardiological-related investigations on the patient "I would look at a doppler of the supra-optical trunks". Indeed, even if the cardiologist hypothesizes that a respiratory problem is causing the patient's anomaly, namely the absence of a heartbeat, she highlights how challenging it is to completely exclude cardiological problems without comparing the actual situation shown by the ECG with a previous one.

That the ECG itself does not always prove the patient's situation well is shown by the next excerpt.

Excerpt 4

[Greetings]
GP: I've this ECG done on a patient already affected with chronic ischemic cardiopathy, because he felt ill while he was eating, he felt faint and a weight on his stomach.
C: the trace doesn't seem… how is he now?
GP: He's lying down now… he feels weak… he hasn't got dyspnea, absolutely not… he still feels this weight… I think its indigestion, I mean, he needs to vomit… but you know… I preferred to do the ECG…
C: I'd say… there aren't any evident alterations… of course, then you have to look at the clinical (assessment)… because these things, sometimes this thigs are a bit tricky… for the moment I'd keep an eye on him… there's a left axial deviation… there's … some ventricular extrasystole… is he taking Cardio aspirin?
GP: No, in fact I wanted to give it to him
C: But he has a history of ischemic cardiopathy, but he hasn't had acute episodes?
GP: No, no. Perhaps… five years ago, there was something… when the chronic ischemia diagnosis was made…
C: I'd wait a bit longer… how old is he?
GP: 85
C: The risk is clearly there, if the things doesn't sort itself out, I'd have him looked at, just to be on the safe side… but at the moment the trace doesn't show anything…
GP: … out of the ordinary…
C: although traces can sometimes be negative…
GP:... right, in fact… that's true, you can't always relay on the trace…
C: no, no there's a good percentage of heart attacks with normal traces… except of this… well… I mean… at 80 years old, of course, some problem always comes out!
GP: Yes, I'll give him an antacid and then we'll see

[Salutations]

4   Discussion

The cases show that telecardiological consultation revolves around the activity of the reading and interpreting the electrocardiogram (ECG), which becomes the privileged object in this medical practice. However, it was also clear, that the centrality of this diagnostic tool was negotiated within the broader context of the practice. For example, looking at the clinical practices shows how the reporting of clinical examinations is always related to the contextual elements carried in the patient's body, their symptoms and clinical history.

Therefore, the ECG can certainly be considered as one element of the patient's accountability, but not the decisive element in the problem-solving logic at work. This is not surprising. Indeed, despite the tendency toward instrumentalized medicine (Berg 1997), the substitution of human decisions with one based on the expert systems seems quite problematic. Hartland's use of intelligent systems to interpret electrocardiograms provides a useful means to explain my point. Hartland (1993), focused on the knowledge and skills in medical settings to investigate how far expert systems can 'contain' the knowledge used by doctors to interpret clinical data. He highlighted several problems that the adoption of an intelligent machine to classify ECGs may cause. The machine in question had the function of classifying ECGs into 'normal' and 'abnormal'. Hartland points out that in medicine, there is no clear demarcation line between 'normal' and 'abnormal'. On the contrary, the category 'normal' is the outcome of negotiation among numerous factors which influence the result of the ECG: age, sex, race, and most importantly the patient's clinical history. As a consequence, it is not possible to establish *a priori* what is a normal and an abnormal ECG. According to Hartland, a machine cannot autonomously decide whether an ECG is normal or otherwise, because knowing how to classify an ECG requires knowledge that can only be acquired with the practice and apprenticeship of profession medical training. Indeed, from this analysis, the ECG was clearly only one of the elements at stake in a discursive construction of the diagnosis, and the consequent course of therapeutic action. The meaning of an electrocardiograph is not something that can be discerned *a priori,* according some computational matrix, it's meaning is embedded in a situated dimension of discursive interaction between the two doctors. During the discursive interaction, the two doctors, each through their professional vision (Goodwin 1994), read and consequently activated a series of elements that contributed equally to the interpretation of the situation. Symptoms, events, medical history, risk factors, as well as specific features of the ECG, are all combined elements that are necessary to find alignment.

This is more interestingly fleshed out by asking what happens when the ECG does not align with the doctor's description of the patient? In these cases, characterized by a longer conversation, the two doctors interactively mobilize other elements that can sustain one of the two elements that do not align: a description of the patient or, in turn, the electrocardiogram. Excerpt 3 showed how an ECG read as not problematic, changed the meaning of the symptoms perceived as highly dangerous, into an anomaly concerning respiratory problems. In this case, the ECG seemed to "prove" the state of the patient. However, it is only with the mobilization of other elements (blood pressure and previous history) that the ECG acquired the strength to define the patient's situation.

In the Excerpt 4, the probity of the ECG as a good account of the patient's health was highly contested. As in the previous example, the symptoms and the reading of the ECG here, did not obviously align. Nevertheless, as the kind of symptoms were entirely consistent with the ones occurring in severe cardiological episodes, the value of the ECG is resized. Mobilizing the patient's history and age, highlighted how an ECG was discursively undermined by the two doctors, whose expertise overruled the ECG in the clinical practice (an ECG can also be negative even during a heart attack).

In both cases, the two doctors' discursively performed reliable interpretations about the patient's situation. They embarked on lengthy discussions that mobilized different bio-physiological, chemical, material, social and psychological, aspects of the patient's state of health, in order to develop a coherent interpretation of the situation of the patient. The discursive mobilization of other elements allows for the resizing of both the role of ECG and clinical observation within the medical practice. The practice is thus a material discursive practice mediated by technology (ECG, ITCs, specific software) and organizational devices (the call centers) that allow a GP and a cardiologist to discuss a patient's situation. They mobilize all the features of the situation to find the current alignment to activate a specific course of action (emergency room, further investigations, medical drug treatments, no further actions).

5   Conclusion

This article aims to show the intricacies of new professional practices currently made possible by interactions that occur around information and communication technology. This article showed the role of material artifacts (the ECG traces, the recording machine and the infrastructure) and communication (synchronous communication in the form of a phone

call) in examples of cardiological remote consultancy. Using a practice-based approach, I maintain that besides the specific cardiological knowledge to perform expert interactions within the system, cardiologists have to be able to work interactively with GPs. They have to be able to discursively align heterogeneous elements to perform a collective interpretative diagnosis for the patient. In doing so, some elements are highlighted as more salient than others as they seek to unpick the significance of the ECG and the clinical observation.

Communication begins with GPs clarifying their use of the service, before proceeding to the reading of the ECG trace. In doing so the GP furnishes a frame of the situation in which both the symptoms and the ECG trace is interpreted. When the situation is not immediately clear, that is to say the description of the patient and the ECG traces do not match, the two doctors mobilize variant bio-physiological, chemical, material, social and psychological aspects of the patient in order to rule out one of the two privileged objects participating to the practice (the clinical observation of the patient and the ECG). In this sense, acting as an expert in an ICT mediated cardiological consultancy, demands greater sensitivity to the performance of material-discursive practices. It also entails the ability to activate meaningful conversation where the patient's state and the ECG can be included in dialogue that sustains an informed (that is to say, expert) interpretation of the situation. This expert knowledge is a material discursive practical knowledge (Parolin 2006; 2011), that the cardiologist has learned in situated interactions during the participation of the remote cardiological practice. Similar to Grasseni's skilled vision, and Goodwin's professional vision, the cardiologists practical skills in interaction, namely the capacity to mobilize heterogeneous elements in the search for alignment, are acquired through apprenticeship and possessed in the suite of professional practices of a given community.

Referring back to the initial question concerning the role of ICTs, the evidence suggests a need to reevaluate the situated use of technologies within work practices. Specifically, the interaction between technology and material artifacts, as well as discursive practices, need to be understood as an integral part of professional practices. The technological infrastructures and the material artifacts participate in ways that contribute to the manner in which professional knowledge unfolds. In this case, it is clear that the teleconsultation is not simply a function of remote reporting, but one of real discursive consultation between the two doctors, where they draw upon technological and material artifacts to discursively co-construct a reliable and case specific interpretation of a particular situation.

Acknowledgements

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