RESPONDING TO PROFESSIONAL KNOWLEDGE DISRUPTIONS OF UNMITIGABLE UNCERTAINTY: THE ROLE OF EMOTIONS, PRACTICES, AND MORAL DUTY AMONG COVID-19 PHYSICIANS

Amelia Compagni

Bocconi University

Milan, Italy

amelia.compagni@unibocconi.it

Giulia Cappellaro

Bocconi University

Milan, Italy

giulia.cappellaro@unibocconi.it

Amit Nigam

City University of London

London, UK

amit.nigam.1@city.ac.uk

forthcoming in Academy of Management Journal

Acknowledgments: We are very grateful to the Associate Editor Heather Vough and the three anonymous referees for encouraging us to improve our reasoning. We thank warmly all the physicians and the management of C-Hospital for dedicating time to the study and sharing their experience in difficult times. We thank Joelle Evans, Grace Augustine, Stefan Timmermans, Robert Gibbons, Woody Powell for comments on this and earlier versions of the paper and all session attendants during presentations at the 37th EGOS Colloquium, 2022 PROS Conference, 2022 AOM Annual Meeting, Bayes Business School, Stanford CASBS Institute on Organizations and their Effectiveness; Bocconi University, Aalto University and Hertie School.

ABSTRACT

Drawing on an in-depth study of physicians facing the Covid-19 pandemic in Italy in 2020, we advance theory on how professionals in their workplace respond to knowledge disruptions associated with complex societal challenges that undermine the adequacy of their knowledge base to solve professional problems. We show that, in the context of the uncertainty generated by the knowledge disruption and unable to mitigate it through typical knowledge-based strategies, professionals experience a trail of negative epistemic emotions linked to the immitigability of this uncertainty. Despite these negative epistemic emotions and motivated by a heightened sense of moral duty, professionals engage in service-oriented practices of collegial and humanistic work that depart from the knowledge-centric practices of their usual work. We detail how the repeated development of positive moral emotions when performing of such practices leads professionals to ultimately consolidate and embed service-oriented practices in their professional work. Our study contributes to the literature on professions and organizations by theorizing the distinctive category of knowledge disruptions of unmitigable uncertainty and by uncovering the micro-level dynamics and mechanisms that sustain professionals' responses.

Keywords: Knowledge disruptions, uncertainty, professionals, emotions, societal challenges

Knowledge is critical in guiding how professionals do their work and respond to diverse events. It forms the basis for the inferential processes that allow professionals, as experts, to attach solutions to problems, and is the basis for professionals' claims to jurisdiction over tasks, status, and authority (Abbott, 1988; Freidson, 2001; Larson, 1977). Knowledge is critical to professional work because it allows professionals to act with a degree of certainty and rationality upon complex and uncertain problems. This centrality of knowledge roots professionals in the cognitive–rational aspect of professionalism (Becker, Geer, Hughes, & Strauss, 1961; Heimer, 2001) and has important effects on individual professionals, shaping the way they relate to each other and to beneficiaries and clients in their daily practice (Anteby, Chan, & DiBenigno, 2016; Freidson, 1986; Light, 1979). Because of the importance of knowledge in allowing professionals to act with certainty and rationality on professional problems, knowledge disruptions—events or longer-term societal shifts that challenge the adequacy of professional knowledge for accomplishing professional work—are likely to be profoundly felt.

Prior theory has focused on knowledge disruptions that are accompanied by the emergence of an alternative body of knowledge—embedded either in new technologies, other professional groups or sub-groups within the same profession—that makes the adequacy of a focal profession's body of knowledge uncertain and threatens its jurisdictional authority to solve certain types of problems. This literature identifies two mechanisms by which professionals belonging to the focal profession respond to these knowledge disruptions. Professionals can restore, at least partially, their knowledge's adequacy - and mitigate uncertainty created by the knowledge disruption - by expanding their knowledge base to selectively incorporate elements from the alternative body of knowledge (Barley, 1986; Evans, 2021; Nelson & Irwin, 2014; Waring & Currie, 2009; Wears & Sutcliffe, 2019). They can also engage in jurisdictional politics by delegitimizing the alternative body of knowledge and correspondingly defend their own knowledge base (Anteby, 2010; Currie, Lockett, Finn, Martin, & Waring, 2012).

There may, however, be knowledge disruptions that render uncertain the adequacy of knowledge of a profession, or even across the system of professions, without the emergence of an alternative body of knowledge. Without explicitly theorizing them as knowledge disruptions, an emerging stream of literature proposes that societal challenges—represented by major public health threats, economic and financial downturns or natural and social long-term shifts (Brammer, Branicki, Linnenluecke, & Smith, 2019; Ferraro, Etzion, & Gehman, 2015; Howard-Grenville, 2021; Lefsrud & Meyer, 2012)—can result in such kind of knowledge disruptions. This stream of literature has identified some features of societal challenges, including their radical and hard-to-mitigate uncertainty, complexity, and non-linear evolution (Gehman, Etzion, & Ferraro, 2022; Rittel & Webber, 1973), that make them different from other knowledge disruptions. These features render specialized professional knowledge inadequate to the task of addressing, let alone

solving, the problems generated by societal challenges (Kates & Dasgupta, 2007; Kunisch, Blagoev, & Bartunek, 2021). For instance, climate crises, e.g. flooding or drought that have been linked to climate change, are extremely challenging and hard to solve problems for a variety of experts including climatologists, engineers and urban planners, economists, agriculture and forestry experts (Lidskog & Löfmarck, 2015; Woodruff, 2016). For this type of knowledge disruption, which we theorize as knowledge disruptions of unmitigable uncertainty, professionals tend to lack enough knowledge to understand the problem in its various manifestations and complex causes. In addition, these problems tend to escape most of the ways of problem solving that professionals traditionally draw on, including ways of drawing on abstract knowledge to predict the evolution of the problem or the outcomes of certain solutions (Kates & Dasgupta, 2007; Woodruff, 2016). Because knowledge disruptions of unmitigable uncertainty do not arise in conjunction with the emergence of an alternative body of knowledge and, as such, are unlikely to be perceived by professionals as jurisdictional threat, current theorization focused on knowledge expansion and jurisdictional politics may not adequately characterize professional responses.

Understanding how professionals respond to this category of knowledge disruptions in the workplace is critical for two reasons. First, because of their status as experts, professionals are expected to play an important role in attempting to meet these challenges. How professionals continue to perform their work, and make decisions in the context of such knowledge disruptions, is relevant to understanding what motivates and guides professionals' actions in situations in which their knowledge base is failing them, what avenues are considered professionally viable and, potentially, what levers can be built upon in order to support professionals in elaborating some response to these knowledge disruptions. Second, professionals' responses in the workplace are going to ultimately make a difference to the overall response that entire professional groups can

formulate to address this type of knowledge disruption, which include many of the most significant challenges facing contemporary organizations and society. While coordinated action (George, Howard-Grenville, Joshi, & Tihanyi, 2016) has been suggested as a potentially effective solution, how this might happen is not obvious. This makes empirical investigation and theory development on how professionals are impacted by and respond to such knowledge disruptions important.

We develop an inductive analysis of Italian physicians' responses to the first outbreak of the Covid-19 pandemic in the workplace setting—an academic medical center in the Lombardy region. We find that the Covid-19 pandemic, which rendered physicians' specialized knowledge for diagnosing and treating patients inadequate, was accompanied by negative epistemic emotions—emotions that relate to knowledge and processes of knowing, such as problem solving (Morton, 2010). These negative epistemic emotions persisted and evolved through multiple unsuccessful efforts to cognitively mitigate the uncertainty of knowledge generated by Covid-19. Negative epistemic emotions were accompanied by the surfacing of the professional sense of moral duty (of care) that motivated physicians to initiate and then prioritize a set of service-oriented practices of collegial and humanistic work, which allowed them to compensate for ineffective knowledge-based practices. Service-oriented practices generated positive moral emotions—by which people categorize practices as either good or bad (Haidt, 2003a). The service-oriented practices came to be ultimately consolidated and embedded in professional work.

Our study breaks new ground in two ways. First, we conceptualize the distinctive category of knowledge disruptions of unmitigable uncertainty and theorize the two features that render unmitigable the uncertainty they generate, based on how such uncertainty impairs all the steps of the inferential process at the basis of professional work and renders knowledge-based strategies aimed at repairing the disruption ineffective. In providing empirical and theoretical grounding to

this kind of knowledge disruptions, we extend prior theory whose assumptions are problematic in these instances. In addition, for the first time, we relate knowledge disruptions to emotional dynamics of professionals and introduce the category of epistemic emotions and their salience in the context of failure of professional work. Second, with this study we uncover the micro-level dynamics by which professionals can respond to knowledge disruptions of unmitigable uncertainty in their workplaces. Unlike prior literature that has emphasized cognitive practices of knowledge expansion and strategies of jurisdictional defense, we theorize that practices of collegial and humanistic work, far from traditional knowledge-centric practices, may allow professionals to generate an alternative but nevertheless viable and constructive response. We posit that these practices are inspired by the need to abide to the professional moral duty to serve, rather than an understanding of professionalism rooted in knowledge and rationality.

THEORETICAL FRAMEWORK

Disruptions to Professional Knowledge, Uncertainty, and Professionals' Responses

Scholars in the sociology of professions (Abbott, 1988; Freidson, 1970, 2001; Larson, 1977) and in organization and management theory (Barley, 1986; Goodrick & Reay, 2011; Nelson & Irwin, 2014) have long emphasized the centrality of knowledge to professional work. Knowledge is the basis for professional social structures, division of labor through specialization, and for allocating status and prestige in professional hierarchies (Bucher & Strauss, 1961; Larson, 1977; Lockett, Currie, Finn, Martin, & Waring, 2014). For individual professionals, knowledge is core to each step characterizing their daily practice and the inferential processes that allow professionals to match solutions with problems (Abbott, 1988). Knowledge is fundamental to diagnose and define the problem professionals face, its nature and defining features; it is then fundamental for considering, among a plethora of possible solutions to that problem, the solution that is predicted to obtain the best outcomes; finally, knowledge is essential in applying that solution and assessing

to what extent it has solved the problem at hand (Abbott, 1988). By using their knowledge effectively, professionals are expected to solve those issues that lay people, precisely because of their lack of specialized knowledge, are incapable of addressing (Abbott, 1988; Freidson, 1986).

The importance of professional knowledge comes with a concomitant emphasis on the rational–cognitive aspects of professionalism (Freidson, 2001; Light, 1979) and on the ability to mitigate uncertainty in professional work (Fox, 1957; 1959). Acquisition and mastery of a specialized body of knowledge are traditionally the processes through which individuals first enter a profession (Anteby et al., 2016; Pratt, Rockmann, & Kaufmann, 2006). During these processes, individuals are trained and socialized into preventing, controlling, and mitigating any uncertainty linked to the application of their knowledge (Bosk, 2003; Light, 1979), or that may call into question its adequacy as a basis for solving problems (Fox, 1957, 1959; Gerrity, Earp, De Vellis, & Light, 1992; Timmermans & Angell, 2001). For instance, as Light (1980) suggested, physicians train "for certainty" and learn to see diseases as tractable problems, treatments as scientific facts, and themselves as "omnipotent" in providing a solution to problems. Complementing this training is socialization into values that highlight the impersonal. This includes values of rationality (Becker et al., 1961; Brante, 1988, 2011), objectivity (Parsons, 1954), and affective neutrality with respect to clients (Freidson, 1986; Heimer, 2001). Objectivity and impersonality, in turn, support the asymmetry of knowledge between professionals and clients that constitutes the basis for professional status (Light, 1979, 1980).

Because professionals are trained and socialized into the certainty of their knowledge, any event or longer-term societal shift that seriously challenges the adequacy of a profession's knowledge base is likely to be perceived as a disruption to both their knowledge and their work. Prior research has examined different sources of knowledge disruption and theorized mechanisms

of professional response. Significant work examines responses to knowledge disruptions whose origins are exogenous to a profession and stem from technological change (Barley, 1986; Compagni, Mele, & Ravasi, 2015; Nelson & Irwin, 2014), new socio-cultural movements (Cappellaro, Tracey & Greenwood, 2020; Evans, 2021; Lifshitz-Assaf, 2018; Wears & Sutcliffe, 2019), or government reforms (Currie, Finn & Martin, 2009, 2010). Knowledge disruptions can also derive from the emergence of a new professional group with a different knowledge base that may be able to solve similar professional problems (Anteby, 2010; Currie et al. 2012; Martin, Currie, & Finn, 2009; Waring & Currie, 2009). Within a single profession, knowledge disruptions can originate in the emergence of new ideas about how tasks should be performed (Goodrick & Reay, 2011; Nigam & Dokko, 2019), or from debates or intellectual movements internal to the profession (Bechky, 2020; Howard-Grenville, Nelson, Earle, Haack, & Young, 2017).

Common across this rich literature examining the effects of and responses to diverse knowledge disruptions are two core assumptions. The first assumption is that knowledge disruptions are created by the emergence of alternative and competing bodies of knowledge. This new, competing knowledge can make professionals uncertain about the capacity of their specialized knowledge to address professional problems sufficiently and appropriately in the context of a changing world (Bechky, 2020; Evans, 2021; Howard-Grenville et al., 2017; Nelson & Irwin, 2014). For example, knowledge disruptions that originate in technological change can introduce new forms of knowledge that are embedded in the technology itself. Nelson and Irwin (2014) show how the advent of the Internet challenged librarians about the adequacy of their specialized knowledge to master the task of searching, suggesting that the searching of archival sources could be performed more effectively by a computerized search engine. Implicitly, this could make librarians' knowledge less relevant to their clients, and support the primacy of an

alternative body of knowledge (e.g., in information systems and computer science), which other professional groups could draw on to formulate new, easily accessible search tools. A second, related assumption is that knowledge disruptions, and the uncertainty that they raise about the adequacy of a profession's knowledge, are perceived by professionals as threatening to their jurisdictional control, status, and prestige (Anteby, 2010; Currie et al., 2012). By opening new task areas (Anteby, 2010; Barley, 1986) or suggesting alternative professional groups as more knowledgeable, knowledge disruptions make professionals' control over a set of tasks uncertain (Evans & Silbey, 2022; Waring & Currie, 2009). For example, the emergence of knowledge management concepts and techniques, and their application to clinical risk by newly created hospital risk managers, was perceived by physicians as destabilizing of the primacy of their knowledge of medical processes and a threat to their professional autonomy with respect to managers (Waring & Currie, 2009).

Consistent with these two assumptions, extant research, looking at knowledge disruptions of diverse origins, has converged on two primary sets of responses enacted by professionals in the workplace. Because disruption to knowledge and jurisdictional threat are closely connected, most professional responses aim at both ensuring the adequacy of professional knowledge as well as re-establishing its primacy vis-à-vis the competing body of knowledge. First, one of professionals' responses is to expand their own knowledge base in ways that incorporate at least part of the competing knowledge. Knowledge expansion can include processes of selective learning (Barley, 1986; Evans, 2021; Waring & Currie, 2009) and the creation of new tasks able to internalize part of the new body of knowledge (Nelson & Irwin, 2014; Howard-Grenville et al., 2017; Wears & Sutcliffe, 2019). For example, when stem cell scientists felt their specialized knowledge base was inadequate to respond to the challenges raised by bioethicists and moral philosophers, they started

selectively incorporating into new tasks knowledge, concepts, and reasonings from this professional group in a process of "cognitive expansion" (Abbott, 1988) that allowed them to overcome the inadequacy of their technical knowledge base (Evans, 2021). Second, an additional response involves actions to maintain jurisdictional control. For instance, challenged professionals may engage verbally in legitimizing their own specialized knowledge while delegitimizing the new, competing knowledge base (Anteby, 2010; Currie et al., 2012; Lifshitz-Assaf, 2018). Professionals may also negotiate (Svensson, 1996) the control of the application of the new body of knowledge by members of other occupational groups to ultimately reduce any uncertainty around the primacy of their own core knowledge claims (Martin et al., 2009). Exemplary in this sense is the study of mainstreaming genetics knowledge into the UK National Health Service (Martin et al., 2009). While powerful professionals specialized in genetics consented to delegating routine tasks to other professionals, they attempted to retain control of their specialized knowledge by providing education to and auditing those to whom they had delegated these tasks.

In delineating these responses, prior theory has developed in keeping with an important boundary condition regarding the nature of the uncertainty generated by these knowledge disruptions. Across studies, it is suggested that this uncertainty can be mitigated by reconfiguring knowledge within a profession. Stem cell scientists were able to reconfigure their own professional knowledge by importing an alternative body of knowledge from ethics and philosophy, and succeeded in mitigating the uncertainty they felt about the adequacy of their knowledge base (Evans, 2021). When knowledge disruptions lead to jurisdictional threat, professionals can reduce the uncertainty around the primacy of their own knowledge vis-à-vis other professional groups or potentially substituting technologies (Nelson & Irwin, 2014) by incorporating competing knowledge into their own knowledge base and by defending this expanded knowledge base in

ways that re-establish its primacy. Prior theory, then, is less equipped for explaining how professionals can produce a viable or effective response to a knowledge disruption in which the adequacy of professional knowledge as basis for problem solving is challenged but there is no obvious alternative body of knowledge to draw on, adapt, or discursively defend from, in ways that mitigate the uncertainty generated by the knowledge disruption.

Knowledge Disruptions of Hard-to-Mitigate Uncertainty and Professionals' Responses

Understanding when and how knowledge disruptions can generate uncertainty that may be difficult to mitigate is an important first step to studying how professionals respond. To our knowledge, there is no specific body of theory conceptualizing or distinguishing the uncertainty generated by different types of knowledge disruptions. However, research does suggest two conditions. First, prior work hints that this type of knowledge disruption would likely be an outcome of societal challenges—that is, complex problems of social or natural origins, for which professionals and experts have no immediate or evident solution (Grint, 2022; Rittel & Webber, 1973). These societal challenges include acute events such as major public health threats, like pandemics (Epstein, 1996; Howard-Grenville, 2021), or economic and financial downturns, as in the case of the 2008 financial crisis (Brammer et al., 2019; Colander et al., 2009; Fligstein, Brundage, & Schultz, 2017), as well as more enduring challenges, such as those connected to climate change, mass migrations, or poverty (Ferraro et al., 2015; George et al., 2016; Kates & Dasgupta, 2007; Lefsrud & Meyer, 2012). Most of these societal challenges have been shown to be either difficult to predict in their emergence (Fligstein et al., 2017) or display non-linear dynamics in their evolution (Gehman et al., 2022), features that have resulted in an evident inadequacy of specialized professional knowledge to offer or formulate definitive solutions (Kates & Dasgupta, 2007; Grint, 2022). Second, at least some research on societal challenges suggests that they may be characterized by an absence of relevant knowledge to tackle the problem across the system of

professions (Pradilla, da Silva, & Reinecke, 2022; Rittel & Webber, 1973). Unlike knowledge disruptions discussed in prior research, where the disruption originates in new knowledge embedded in technology or created by an alternative professional group, new or newly salient societal challenges are not necessarily initially accompanied by the emergence of alternative bodies of knowledge. As a result, there may be cases of societal challenges where no professional group knows better than any other how to diagnose the problem or offer a solution (Epstein, 1996; Ferraro et al., 2015).

Together, these two insights highlight the fact that knowledge disruptions that emerge from societal challenges are likely to be associated with a radical uncertainty of knowledge (Gehman et al., 2022; Rittel & Webber, 1973). When faced with such knowledge disruptions, professionals may come to see their specialized body of knowledge and its interpretative frameworks as inadequate for capturing a societal challenge's emergent features (Pradilla et al., 2022) and non-linear dynamics (Gehman et al., 2022; George et al., 2016; Howard-Grenville, 2021). This can potentially reduce professionals' capacity to reach a univocal diagnosis of the problem and predict how it will evolve (Fligstein et al., 2017). It may also make the identification and application of science-based solutions challenging (Bayer & Oppenheimer, 2006; Gehman et al., 2022; Kates & Dasgupta, 2007; Pradilla et al., 2022). As shown by Lefsrud and Meyer (2012), for instance, professionals and experts faced with the issue of climate change can develop very different ideas about the severity of the problem and elaborate diverse frames around its causes and possible solutions, all of equal plausibility. Similarly, Epstein (1996) illustrates how, during the AIDS epidemic, in the absence of certain knowledge about the disease, a variety of actors, including non-professionals, could voice their different understandings of the problem and its causes. The absence of alternative bodies of knowledge to draw on and adapt, and the possibility that no other

professional group has adequate knowledge to solve the problem, make these knowledge disruptions less likely to be perceived by professionals as threats to jurisdictional control. Rather than destabilizing and undermining the primacy of professionals' specialized knowledge, they can lead professionals to experience a profound sense of uncertainty about the overall adequacy of their professional knowledge to serve as a basis for solving problems (Ferraro et al., 2015; Gehman et al., 2022). Efforts to engage in knowledge expansion through selective learning from other professions may prove unsatisfactory in mitigating such uncertainty (Grint, 2022).

Despite these insights, we know little of how professionals are impacted in their workplace by knowledge disruptions that deeply challenge the adequacy of their knowledge but are not accompanied by the emergence of an alternative body of knowledge. Professional responses to these knowledge disruptions in their day-to-day work are likely to be a critical determinant of whether there is any effective societal response. Amid the uncertainty of knowledge they experience, professionals will have to continue to conduct their work, take decisions, and plan their actions (Lidskog & Löfmarck, 2015; Milly, Wetherald, Dunne, & Delworth, 2002; Woodruff, 2016). For example, to make cities more resilient to climate change, urban planners will need to engage in work to protect planned infrastructure from increasingly frequent flooding in a context where knowledge for predicting the frequency and extent of flooding is absent among planners, engineers, and hydrologists (Milly et al., 2002; Woodruff, 2016). To speak to this important theoretical puzzle and empirical issue, in this study, we ask the following research questions: When the knowledge base of an entire profession is made uncertain, how do professionals respond, in their workplace setting, to such knowledge disruption? When specialized knowledge fails, what else can professionals rely upon to face such uncertainty?

METHODS

The Covid-19 Pandemic as Research Setting

The Covid-19 pandemic represents an exemplary case of a knowledge disruption able to make deeply uncertain the adequacy of professional knowledge as basis for problem solving (Currie, Gulati, Sohal, Spyridonidis, & Busari, 2022). While several healthcare occupations, for example, nurses and care assistants, contributed to the care of patients, Covid-19 first and foremost greatly destabilized physicians, the professional group primarily responsible for drawing on a body of specialized knowledge to find an optimal course of treatment and, ultimately, a cure for patients[1]. Despite the fact that the virus responsible for the Covid-19 disease, that is, Sars-CoV-2, was isolated and sequenced in early 2020, the uncertainty of knowledge around Covid-19 persists. The medical, scientific, and scholarly communities, including those of organization and management studies, have repeatedly described the Covid-19 pandemic as an unforeseeable event (Koffman, Gross, Etkind, & Selman, 2020), complex for both its causes and its manifestations across economic, environmental, and social domains (Begun & Jiang, 2020; Howard-Grenville, 2021), hard to predict in its non-linear evolution (Kunisch et al., 2021), and, as such, intrinsically difficult to solve (Kawa et al., 2021; Koffman, et al., 2020). Today, even after its most acute manifestations as a global health emergency are considered ended, Covid-19 not only remains a significant public health problem, but is permeated by persistent uncertainty of knowledge about the dynamics of both its diffusion and potential resurgence (McVernon, 2023) and, most importantly, about the effectiveness of medical treatments (London & Seymour, 2023).

The uncertainty generated by the Covid-19 pandemic was particularly salient for physicians working in the first countries in the world that faced the outbreak in January, 2020, when data and information were extremely scarce and the clinical features of the disease were truly unknown (Koffman et al., 2020). This was the case for physicians in Italy, the first Western country to

[1] Testament to the disruption to medical knowledge engendered by the pandemic are the almost seven million documented deaths from Covid-19 worldwide (https://covid19.who.int/)

experience Covid-19. On February 21, 2020, the first Italian case of Covid-19 was detected in the Lombardy region, which became the hardest hit region in the world. We adopted an embedded case study design, studying all the physicians serving Covid-19 patients at C-Hospital (pseudonym), one of the largest hospitals in the city of Milan, Lombardy region, and among the first to treat Covid-19 patients. C-Hospital is a research-intensive, academic medical center of 600 beds, which became a Covid-19 dedicated facility and admitted patients from the entire region. Physicians at C-Hospital were forerunners in experiencing and responding to the knowledge disruption of the Covid-19 pandemic in the context of their workplace.

Data Collection

We triangulated different sources of primary and secondary data which allowed us to reconstruct the complex social setting (Lofland, Snow, Anderson, & Lofland, 2006) in which physicians worked during the first outbreak of the pandemic. Table 1 summarizes the data sources and Appendix I displays the main demographics of our interviewees.

--- Insert Table 1 about here ---

During the first Covid-19 outbreak (February–June, 2020), when access to Italian hospitals was denied for public safety reasons, we started collecting publicly available data on C-Hospital's response – e.g., press releases, interviews, scientific communications - and policy actions taken by the Lombardy region and the Italian government. In July, 2020, as soon as research activities were allowed again, we obtained full ethical approval from the Ethics Review Board (ERB) of Bocconi University, approval that was extended to C-Hospital, to start the primary data collection. In approving the interview protocol, both the ERB and the gatekeepers at C-Hospital asked us to adopt precautionary measures to deal with the emotional distress of physicians and to limit potential repercussions of our data collection efforts on professionals and their activities. Therefore, we adopted typical interviewing techniques for sensitive topics, such as pacing

questions based on the respondent's needs, taking breaks, and postponing painful discussions (Corbin & Morse, 2003). In addition, we tried to strike a balance between remaining factual in our questions and allowing interviewees to express emotions and recount particularly salient episodes or personal experiences (Corbin & Morse, 2003). Physicians appeared very engaged in the interviews, repeatedly expressing to us a sense of vividness of what they were recounting, and eager to reflect on their experience by expressing gratitude for the opportunity to be interviewed.

Semi-structured interviews. Our primary data source consisted of 81 semi-structured interviews. With the support of the human resource (HR) department, we identified all the physicians involved in the response to the Covid-19 pandemic. In the end, we recruited and interviewed 74 physicians, which represents nearly 80% of the total number of physicians active during the first Covid-19 outbreak. Physicians had performed different activities during the outbreak, including providing direct care for Covid-19 patients in wards, emergency departments (EDs), or intensive care units (ICUs), coordinating the work of colleagues (including training), managing the communication between Covid-19 patients and their relatives, or controlling and managing the entry/exit flows at hospital checkpoints. Physicians belonged to different medical specialties (see Appendix I), broadly categorized as internal medicine specialties (45%), surgical specialties (35%), and emergency and intensive care (20%). All interviews lasted between 50 and 120 minutes, were audio-recorded—with the exception of one, for which we took extensive notes—and transcribed, yielding approximately 1,100 pages of transcript. The interview protocol aimed at gathering the physicians' perceptions of the outbreak, the detailed accounts of how they faced it over time in their daily work, and the reflections spurred by the experience. Interviews with physicians were complemented by a set of semi-structured interviews with C-Hospital managers (7 interviews; 98 pages), including the General Director, the Medical Director and his

staff, the Head of the HR department and his staff, the Chief Operations Officer, and the Head of the Information Technology department. These interviews allowed us not only to reconstruct the main changes that C-hospital underwent, but also to appreciate the role played in the hospital by physicians in responding to the outbreak. All interviews were conducted by the first two authors, who are native Italian speakers. To preserve the original meaning of informants' words, in the first round of open coding, informant-centered codes were in Italian and translated into English for subsequent coding. At the end of the coding process, relevant quotes were translated into English.

Internal communication and organizational archival materials. We triangulated interviews with internal communication and organizational archival materials. This material included all the self-recorded videos produced by physicians to inform, encourage, or teach colleagues how to face the outbreak or specific aspects of the disease, slide presentations describing the ongoing hospital organizational transformation, and daily emails sent by the Medical Director to physicians to update them on the evolving situation and reflect on what was happening. We complemented these materials with public interviews and podcasts released by physicians, and hospital press releases.

Physicians' scientific production and engagement with the professional community. To study how physicians' actions were embedded in the broader medical professional community, we traced the scientific materials (273 articles) on Covid-19 produced over time by C-Hospital's physicians as well as their video presentations at medical conferences (15 videos). Scientific articles were retrieved through PubMed and included studies, for example, on Covid-19 treatment options, staff stress and burnout surveys, commentaries, and descriptions of patient care pathways.

Data Analysis

We moved iteratively between the data, emerging theory, and relevant literature following an approach of gradual abstraction (Miles & Huberman, 1994) that involved four steps.

Analysis of Covid-19 as professional knowledge disruption and temporal bracketing based on impact of uncertainty on physicians' inference. We first reconstructed a chronology of the outbreak and constructed visual maps of the hospital reorganization, attaching to those meaningful pieces of data, such as the number of Covid-19 patients admitted, and the number of Covid-19 wards and ICU beds. We then read our interview transcripts and archival data, focusing on how physicians talked about the Covid-19 pandemic in relation to previous professional challenging situations, and the actions performed in response to the Covid-19 outbreak. We were struck by how physicians consistently framed the Covid-19 pandemic as a deep and unprecedented challenge to the adequacy of their specialized professional knowledge, using such phrases as: "completely lacking knowledge of the disease", or "not knowing how to proceed." Importantly, physicians would refer to the Covid-19 pandemic as generating *uncertainty*. Iterating back and forth from the literature on professions, knowledge, and uncertainty, we conceptualized Covid-19 as an instance of knowledge disruption and interrogated the data with probing questions such as: What was the uncertainty about? How did it impact the work of physicians? By performing open and axial coding techniques (Miles & Huberman, 1994), we uncovered how physicians perceived uncertainty in each of the steps of the inferential process they normally applied to make clinical decisions (Abbott, 1988). In particular, we identified first-order codes pertaining to: a) the first step (i.e., diagnosis), in which normally physicians ask themselves: what is the clinical problem at hand?; b) the second step (i.e., prognosis) in which they consider the possible treatments or solutions to the clinical problem and forecast their outcomes, and b) the third step when they apply a specific treatment to the problem and observe its impact. Examples of first-order codes are: "lack of professional knowledge about the Covid-19 disease" (step 1), "unpredictable evolution of the disease" (step 2) or "uncertain effectiveness of known treatments for Covid-19" (step 3). By

temporally organizing the first-order codes related to uncertainty, we bracketed (Langley, 1999) our story in three phases. While inferences involving diagnosis, prognosis and treatment were ongoing as part of the work of treating patients throughout the first outbreak of Covid-19, we distinguished the three phases based on the step of physicians' inference most impacted by uncertainty in each time period: uncertainty about defining the imminent knowledge disruption (i.e., diagnosing the Covid-19 disease; Phase I), uncertainty about identifying solutions and forecasting their respective outcomes (i.e., the evolution of the Covid-19 disease and potential treatments; Phase II), and uncertainty about finding solution to the knowledge disruption (i.e., the capacity of a certain treatment to constitute an effective cure for Covid-19; Phase III). The phases corresponded to the temporal periods marking the experience of C-Hospital's physicians with the Covid-19 pandemic, that is, the first 10 days, when no Covid-19 patient had yet been detected and the clinical problem was yet to manifest itself (Phase I), the second period of full experience with caring for Covid-19 patients and experiencing the progression of the disease (Phase II), and the period when Covid-19 units were progressively closed and physicians returned to their specialty activities without having a definitive and effective medical solution for Covid-19 (Phase III).

Systematic coding of professionals' emotional dynamics linked to the Covid-19 knowledge disruption. While reading the interviews, we noticed how physicians described in emotional terms the uncertainty of professional knowledge generated by the pandemic and their experience with responding to it. In line with other studies (e.g., Schabram & Maitlis, 2017; Toubiana & Zietsma, 2017) we thus systematically coded for emotions in our data. First, we searched the texts for keywords and expressions that were highly emotive, and we provisionally identified the most common emotions across all our informants, which included confusion, anxiety, fear, admiration, pride, frustration, dejection, hopelessness, sense of relief, and calm. For each of these provisional

emotions, we began with multiple labels that we succeeded in reducing to one only after the overall step of the coding of emotions. We cross-checked the keywords identified with those provided by the LIWC dictionary[2] (Italian version, Agosti & Rellini, 2007). We then complemented keywords with longer expressions that conveyed, through tone and choice of words, the same emotional content. For instance, in the case of the emotion that we ultimately labeled as elevation, we considered as signs of this emotion keywords such as "admired" or "proud" and expressions like "despite all, we did a fantastic job in the Covid-19 wards!"

We recognize that a potential concern with extrapolating emotions from text lays in the lack of nuances in the emotions identified (Kouamé & Liu, 2021). For instance, fear can be a basic emotion felt by anybody who feels threatened, can be connected to cognitive disruptions (such as not knowing what to expect), or an unknown risk (as in fear of the unknown), or can be linked to moral considerations (as in fear for the other). Hence, we proceeded to relate expressions of an emotion with the context in which it was expressed. For instance, in the case of fear, we asked ourselves: what were physicians afraid of? What was happening around them or were they doing for which they felt fear? This step of contextualization allowed us to conceptually relate our analysis of the emotions to the literature. Some emotions, indeed, referred to how physicians perceived the uncertainty of knowledge linked to the Covid-19 pandemic and to the (failing) cognitive process of applying specialized knowledge to it. We related these findings to the category of *epistemic emotions*, which typically arise when the object of attention is knowledge, including its (un)certainty, or processes of knowing, such as problem solving, when cognitive interruptions or incongruity occur (Morton, 2010; Nerantzaki, Efklides, & Metallidou, 2021; Pekrun &

[2] Linguistic Inquiry and Word Count (LIWC); Boyd, R. L., Ashokkumar, A., Seraj, S., & Pennebaker, J. W. (2022). The development and psychometric properties of LIWC-22. The University of Texas at Austin. https://www.liwc.app

Linnenbrink-Garcia, 2014). Other emotions were connected to what physicians had concretely done in facing the Covid-19 pandemic and to the moral evaluation of their behavior as being good or bad. We therefore categorized these emotions as *moral emotions*, based on the relevant associated literature (Greenbaum, Bonner, Gray, & Mawritz, 2020; Haidt, 2003a).

This analysis allowed us to refine the initial label of emotions, embrace specific definitions and acknowledge their positive or negative valence (Huy, 2002). Negative epistemic emotions[3] were: *confusion*—linked to conflicting or disconnected pieces of information with no clear pattern of relations (Nerantzaki et al., 2021); *fear of the unknown*—caused by the perceived absence of information and uncertainty about future threats or risks (Carleton, 2016); *hopelessness*—a sense of profound frustration linked to failure and inability to resolve a problem (Pekrun & Linnenbrink-Garcia, 2014); and *anguish*—emotional distress linked to awareness of an absolute lack of knowledge (Sans Pinillos & Magnani, 2022). By contrast, positive moral emotions were: *relief*—a sense of reassurance and comfort for having released a situation or someone from distress (Gray & Wegner, 2011); and *elevation*—a sense of pride and/or admiration due to performing or witnessing others' excellence (Algoe & Haidt, 2009; Haidt, 2003b). Based on the initial keywords and phrases, we identified first-order, contextual codes for each emotion, such as "being scared of the inadequacy of knowledge" or "being afraid of making mistakes."

Analysis and categorization of professionals' responses and of the motivating mechanism. By arranging the identified emotions chronologically, we came to conceive of the three phases as being characterized by different mixes of negative epistemic and positive moral emotions. We also commenced drawing a visual map of the phases and connecting the focus of the uncertainty experienced by physicians in relation to the Covid-19 pandemic with the negative epistemic

[3] From now onward we refer to negative and positive emotions to indicate emotions of negative and positive valence

emotions. Given that positive moral emotions were always related by the physicians to what they had done in facing the pandemic, we proceeded to code all the actions that physicians reported performing in the context of their workplace. Through processes of open and axial coding, we identified two sets of practices. One set of practices, that we labeled *knowledge-based strategies*, were associated by physicians to their attempts to mitigate the uncertainty created by the pandemic. They entailed strategies typical of their own professional and knowledge-based work, such as collecting clinical information, studying medical procedures, and condensing information in clinical guidelines and were based on the idea that acquiring new knowledge and standardizing it in recommendations for treatment could reduce the uncertainty in diagnosing, prognosing and treating Covid-19. Yet, physicians explained how in the context of the Covid-19 pandemic these strategies proved unsuccessful in reducing the uncertainty they experienced. Examples of first-order codes related to these failed strategies are "trying unsuccessfully to collect and study any information available about Covid-19," or "failing to cure by applying solutions derived from protocols and guidelines." First- and second-order codes were then progressively aggregated in the construct of "failed attempts to mitigate uncertainty". Physicians talked about performing these practices as their usual way of mitigating uncertainty in clinical practice prior to Covid-19, and associated their failure with the negative epistemic emotions we had identified. In our emerging model of professionals' response to knowledge disruptions, we made sense of these findings by tentatively relating the constructs of failed attempts to mitigate uncertainty (through knowledge-based strategies), uncertainty in the different steps of physicians' inferential process and negative epistemic emotions. In addition, the fact that physicians could not mitigate the uncertainty linked to Covid-19 led us, at this point of the analysis, to label such uncertainty as "unmitigable".

The second set of practices had a relational–affective nature. Drawing on the construct of service orientation from the literature on professions (Goode, 1966; Moore, 1970), we labeled these *service-oriented practices* to indicate those sets of actions physicians performed to the benefit of others, the "others" being the overall hospital community, or patients and their families. Examples of first-order codes are: "taking clinical decisions based on a collective experiential logic" or "removing impersonality and connecting empathically with patients and families." Through a process of progressive abstraction, we came to group first-order codes into second-order practices of "collegial work" and "humanistic work," where the former grouped all physicians' actions based on peer synergistic relations and collective problem solving among themselves, while the latter indicated all those actions of humane and empathetic relations established with patients and relatives. We organized first-order codes of collegial and humanistic along the three phases and distilled dynamics of initiating (Phase I), prioritizing (Phase II), and consolidating (Phase III) service-oriented practices. In reading the interviews, we noticed how physicians would describe performing service-oriented practices as their moral duty and, through terms and phrases such as "have to," "ought to," "not a choice," represented service-oriented practices as a professional imperative. Based on insights from the literature on professions and their value-laden obligations (Abbott, 1983; Freidson, 1994; Wright, Irving, & Thevatas, 2021), we identified different moral duties (to act, to do good and to do well) that, together, we aggregated in the construct of *professional sense of moral duty* (*of care)*, to indicate the normative commitment felt by physicians to certain actions in facing Covid-19. Examples of first-order codes are: "having the moral duty to act," "having to fulfil the profession's mission to help others in need," or "having the duty to collaborate for the sake of the patient." By moving back and forth between our data and theory, we came to tentatively draw conceptual relations between the

motivating role of the professional sense of moral duty, service-oriented practices, and the positive affective reinforcement provided by the moral emotions of relief and elevation. By the end of the step, we compiled our final data structure (Appendix II).

Relationship between constructs and elaboration of models. Finally, we worked both within and across phases to combine and refine the relations among the constructs that had we had assembled in the previous steps. Besides the persistence of uncertainty in its different nuances, we came to conceptualize the combinations of negative epistemic and positive moral emotions as connectors between one phase and the other, on which physicians, through their practices, would subsequently layer additional emotional responses. Based on these considerations, we elaborated two models: the first illustrates the analytical representation of our findings, while the second abstracts relations and constructs to a core model of professionals' responses to a knowledge disruption of unmitigable uncertainty.

FINDINGS

Our analysis, illustrated in Figure 1, shows how physicians in C-Hospital experienced and responded to the knowledge disruption generated by the Covid-19 pandemic. We identify three phases that correspond with physicians' changing perceptions of the uncertainty created by the Covid-19 pandemic with respect to the most impacted step of their inferential process for making clinical decisions, i.e. diagnosing the clinical problem (step 1), evaluating potential treatments and predicting their outcomes (step 2), applying the most effective treatment and assessing its benefits (step 3). In each phase, physicians unsuccessfully attempted to mitigate the uncertainty through traditional knowledge-based strategies and this failure led to a trail of negative epistemic emotions that evolved from confusion through fear (Phase I), to hopelessness (Phase II) and, finally, anguish (Phase III). Within the context of these prevailing negative epistemic emotions, physicians came to feel and act on a moral duty of care, and they first initiated (in Phase I) and then prioritized (in

Phase II) service-oriented practices of collegial and humanistic work. These service-oriented practices were positively reinforced by moral emotions of relief (Phase I) and elevation (Phase II) that partially counteracted the negative epistemic emotions. At the end of this process physicians came to consolidate service-oriented practices in their professional work (Phase III).

--- Insert Figure 1 about here ---

Phase I: Unmitigable Uncertainty about Defining the Imminent Knowledge Disruption

The Covid-19 pandemic started in Northern Italy on February 21, 2020, when the first case of infection by the coronavirus Sars-CoV-2 was detected 60 km away from C-Hospital. Before the first Covid-19 patient was diagnosed at C-hospital itself, physicians lived for ten days (February 21–March 2) with the prospect of facing an unknown disease. Table 2 reports additional quotes in support of the main constructs discussed in this phase.

--- Insert Table 2 about here ---

The uncertainty context: Failed knowledge-based attempts to mitigate uncertainty in diagnosis and the negative epistemic emotions of confusion and fear. This short period was marked by physicians' uncertainty both about exactly what was imminent and about whether their specialized knowledge was adequate to the task of facing the coming pandemic. The perceived uncertainty was rooted in the fact that Covid-19 was an unknown disease, for which physicians lacked knowledge of both its pathological causes and manifestations, something that made fully diagnosing the imminent clinical problem close to impossible, as explained by one interviewee:

> The very beginning before we faced the first patients was extremely uncertain. The word I would use to describe the situation is "unknown" as we were going to face a disease in which none of us was an expert, and the second word is "uncertain" … "unknown" or "uncertain", they are just the same in my mind (Rheumatologist 3, interview)

This uncertainty appeared different from what physicians experienced in their usual professional practice, including times when they faced unexpected drawbacks or emergency situations. For normal crises, physicians had learnt a structured and knowledge-based approach for

coping. This was true, for example, for emergency physicians, whose training had prepared them to face sudden critical events:

> Usually in a crisis one holds on to some form of "algorithm" to be able almost not to think in that situation but just act. Then, instead, we clearly felt from the beginning that it was not possible to have these algorithms as we did not know what we were going to face, what disease really was coming our way in a matter of hours or days … a situation of *total uncertainty* (ED physician 2, interview, emphasis added)

The fact that knowledge about Covid-19 was scarce, and that available information was often contradictory, engendered in physicians the negative epistemic emotion of confusion. They recounted how, before seeing any Covid-19 patients, they "felt just very confused as everybody was saying everything [about Covid-19] and the opposite, while we did not know the 'enemy' that we were going to face" (Eye physician 1, interview). The main source of information was TV and the mass media, as "nothing scientific had been written about Covid-19, and one referred to that interview on TV, one asked around in the corridors but nothing solid … a really great confusion!" (Hepatologist 2, interview). During the first ten days physicians attempted unsuccessfully to mitigate uncertainty by relying on their standard knowledge-based strategies, such as collecting any information available about the disease and studying information about pneumonia and respiratory procedures in medical textbooks. Several physicians, for instance, interrogated their Chinese colleagues about the disease, but in vain, as one physician explained:

> We had frequent contacts with the Chinese [physicians] who of course had the most experience and, in the beginning, we hoped they could give us a sort of "Bible" but soon they made us understand they did not really have anything to pass on to us (ED physician 1, interview)

Pulmonologists created a brief video with information about selected respiratory procedures, such as using a continuous positive airway pressure (CPAP) mask, and sent it to all hospital physicians in an attempt to prepare them for what they may have needed to do in the near future. Despite these attempts, physicians continued to feel unprepared. As one physician recounted:

> Several times at home I watched the video made by our pulmonologists; it was well done but, really, I felt completely unprepared to face whatever was coming (Urologist 1, interview)

The failure to mitigate uncertainty through typical professional knowledge-based strategies amplified for physicians the feeling of inadequacy with respect to diagnosing or defining correctly the imminent problem and turned the initial state of confusion into fear. Knowing that the disease was caused by a virus and that it manifested as a respiratory problem appeared insufficient to perform well even the very first step of the typical medical inferential process. Physicians started voicing their dread of being unable to face the "terrifying unknown" of a new disease (ED physician 1, interview). A physician commented how "uncertainty, fear, and chaos" (Nephrologist 1, interview) became pervasive in the hospital in these early days, while another one exemplified the link between fear and the incapacity to mitigate such uncertainty:

I had never felt so scared by any other disease I had been in contact with […] Even when I was in contact with HIV I was not scared because one knows the disease …Instead, here, it was like we were surrounded by a dark fog and everybody was really scared (Endoscopist 1, interview)

The motivating role of the moral duty to act. Alongside these negative emotional responses, physicians developed the urge to act in ways that could help prepare the hospital and the community to face the unknown. In the first days, "making yourself useful and rolling up your sleeves" (Cardiologist 1, interview) was not a matter of personal choice, but derived from the moral duty to act embedded in the normative principles of their profession. One physician clearly spelled this out for us:

If one is a physician, one decides to become a doctor and swears by the Hippocratic Oath … when the Covid-19 outbreak started, one could not refrain from doing something, actually one should volunteer to contribute. This was our *moral duty* as physicians. And this is exactly what we all did in the first days after the beginning of the outbreak (Hepatic surgeon 4, interview)

Some physicians noted that this strong sense of moral duty to act had not necessarily been felt so deeply in their everyday professional routines prior to Covid-19:

When a specialist is asked to do something outside of their narrow competence, normally a specialist can say no and choose to refrain from acting. Here it was not possible because we were first of all physicians and then specialists (Rheumatologist 2, interview)

In this anticipatory period, the professional sense of moral duty meant that physicians felt compelled to put themselves at the disposal of their community and organization. This involved doing anything, even not medical in nature, which could potentially prepare the hospital to care for Covid-19 patients, as explained by one interviewee:

> We clearly had the perception that there was something to be done and it was necessary to do it; we had to come to work and do whatever was necessary at that point (Surgical oncologist 3, interview)

Physicians' responses: Initiating service-oriented practices and the positively reinforcing moral emotion of relief. The moral duty to act, in the context of an intense emotional experience of fear, led physicians to initiate a series of service-oriented practices outside of their specialized medical knowledge, and for the benefit of "others." These practices entailed a certain degree of collaborative work and the establishment of empathetic relations with colleagues, patients, and their families, and were the harbingers of the collegial and humanistic work fully developed in the next phase. First, to support the hospital and their community in preparing for the coming pandemic, physicians improvised solutions to the pragmatic problems they encountered, often in collaboration with colleagues. These solutions may have drawn, in a general sense, on professional knowledge, but differed from physicians' normal use of professional specialized knowledge in treating patients. For example, in anticipation of the outbreak, physicians actively engaged in supporting each other and the entire hospital community in the reorganization of the hospital's entry point, which is the emergency department (ED). An ED physician recalled how she "spent time with engineers and workers drawing maps and plans of how to restructure patients' flows and logistics in the ED" (ED physician 3, interview) and added how:

> This activity was of course nothing for which my medical specialty was useful, but I felt I had to do it. I was a physician with a stethoscope and a measuring tape … (ED physician 3, interview)

Second, they volunteered to take charge of mundane tasks that could have general benefits for colleagues and patients. For example, though there were no known Covid-19 cases in the hospital, physicians proactively went to the ED and started calling the relatives of patients admitted for other conditions, now that relatives could no longer accompany their family members inside the hospital. The senior physician who started this activity recounted how "this was a new role, something never done before, spurred out of an idea, a perception, a hypothesis born at that moment" (ED physician 4, interview). Once again, another interviewee noted that the service was:

> Nothing medical, actually to most it looked like the work of any receptionist, but we felt there was value in that action and that we were charged as physicians with an important responsibility in that moment (Cardiovascular surgeon 1, interview).

Besides being outside of the realm of their specialized knowledge, these actions entailed a degree of empathetic communication with patients and families, to which physicians seemed little accustomed. With respect to communicating with relatives, the same physician commented:

> Physicians, in general, are not very familiar, maybe for their way of being, with talking to relatives; they normally talk to the patient, but, if I can be sincere, they normally perceive relatives as a nuisance (ED physician 4, interview)

Other physicians volunteered to check the temperature of their professional colleagues at the entrances to the hospital or to take over other simple tasks that might prove useful. As one physician explained, the spirit that animated them was "the duty of doing my own part, [to] make myself useful and participate actively [in order] to respond to the situation" (Gynecologist 1, interview). While performing these tasks they exchanged words of encouragement with colleagues, going beyond mere task execution.

Physicians tended to quite immediately receive positive feedback for performing these service-oriented practices. One of the physicians who had started calling relatives of patients commented:

> In a couple of days, we immediately saw that the situation with relatives chaotically crowding the ED had improved. The feedback for us was excellent and reassuring to the point that we immediately set up a team and organized to call the relatives of all the patients admitted to the hospital twice a day (Cardiovascular surgeon 1, interview)

Understanding that their efforts could have some positive impact led to an emotion of relief among physicians, linked to the sense of having regained some control over themselves and the situation. This followed from a sense of being useful, despite the evident inability of their professional knowledge to provide a clear understanding of the imminent pandemic. As one physician explained, that meant feeling, at least temporarily, "calm and more secure, not in total disarray, but part of something with a logic despite all" (Endoscopist 2, interview).

Summary. Amid the unmitigable uncertainty involved in anticipating the pandemic and the intense experience of fear of the unknown, physicians, motivated by the moral duty to act, initiated service-oriented practices that would allow them to regain some control and do something useful, even if these practices did not draw on the core knowledge of their profession and their specialties. These practices, and the positive feedback they received from them, helped them develop a positive sense of relief and reassurance.

Phase II: Unmitigable Uncertainty in Identifying Solutions and Forecasting Outcomes

The first Covid-19 patient was detected in C-Hospital on March 2, 2020. From that date, C-Hospital was fully transformed into a Covid-19 hospital and admitted, in the newly dedicated Covid-19 wards and ICUs, up to 250 Covid-19 patients from the entire Lombardy region. Other clinical activities at the hospital were stopped or curtailed. Physicians from different specialties entered the Covid-19 wards with the mix of emotions developed in the previous period. Though they experienced relief for having done everything possible to equip the hospital to function as well as it could when Covid-19 patients were to be admitted, this relief only partially counteracted their fears about the inadequacy of their knowledge base for treating Covid-19 patients. Nevertheless, this relief prevented physicians from breaking down when they came into contact

with Covid-19 patients for the first time and allowed them "to face the situation with determination" (Nephrologist 2, interview). Table 3 reports additional quotes.

--- Insert Table 3 about here ---

The uncertainty context: Failed knowledge-based attempts to mitigate uncertainty in prognosis and the negative epistemic emotion of hopelessness. As physicians started caring for Covid-19 patients, they came to fully experience the knowledge disruption represented by this unknown disease and the uncertainty it generated. In addition to physicians' inability to clearly define the disease, evident in the first period, they struggled, when assessing patients' symptoms, to predict how the disease would evolve. Patients who at one moment seemed stable could experience a sudden deterioration in their health. One physician recounted how the unpredictable manifestation of symptoms limited physicians' prognostic capacity:

> How is it possible [we asked ourselves]? This patient arrived from the ED walking on his legs. He had a promising path, and then all of a sudden, he was brought to the ICU. And this happened not once but with one, two, three patients … (Cardiologist 1, interview)

Second, the failure of diagnosis and prognosis made inference—drawing on professional knowledge to link diagnosis and prognosis with options for treatment—highly uncertain. The unpredictable progression of the disease, combined with the lack of science for guiding treatment, prevented physicians from reliably forecasting the outcomes of solutions at their disposal. Hence, their treatment decisions remained pervaded with uncertainty, as one physician expressed to us:

> Every day I asked myself "did I do right, did I do wrong?" "Am I managing the problem in the right way by doing certain things and not others?" (Urologist 1, interview)

This uncertainty was contrasted with physicians' experience of their normal professional work. One physician explained that the connection between treatments and outcomes, given a diagnosis and prognosis, is normally predictable:

> In a situation of respiratory failure or pneumonia we know that giving cortisone is beneficial. Here we did not know if we were going to do good or bad for the patient (Pulmonologist 2, interview)

Physicians working in the Covid-19 units tried unsuccessfully to mitigate this uncertainty by relying on traditional knowledge-based strategies. For example, they immediately adopted provisional clinical protocols and guidelines drafted by Italian professional associations. Yet many physicians recounted how such guidelines, by binding them in a standardized way, were inadequate to face the uncertainty surrounding Covid-19 treatments. One physician explained:

> Guidelines changed almost every day but nevertheless they were always behind with respect to reality. We clearly felt that instead of reassuring us they made us rigid, focusing on one solution that the day after we were told was not good, instead of leaving us to our intuition and to try out diverse solutions (Endocrinologist 1, interview)

Confronted with their prolonged incapacity to provide effective solutions for Covid-19 patients, which could be indicated by the large number of lives lost, and the failure of traditional knowledge-based strategies to reduce the uncertainty of their inferential process, the fear that physicians felt in anticipation of facing Covid-19 transformed itself into the negative epistemic emotion of hopelessness. This hopelessness was a feeling of despair closely linked to the "feeling of powerlessness, impotence, and extreme frustration" (Urologist 1, interview) of their repeated inability to conduct effectively the prognostic step of the clinical inferential process and predict which treatment could change the course of the disease. "Powerlessness" and "disheartening" were the most frequent words used to describe the emotional impact of the inadequacy of cognitive reasoning, as exemplified by this physician:

> Working for so many hours without really making a difference was very frustrating; and then the feeling of not being able to help, of not doing your job as a physician … day in and day out I was not solving anything. It was disheartening, depressing (Orthopedic surgeon 1, interview)

In a context of uncertainty and emotional hopelessness deriving from the failure of their professional knowledge-based approach, physicians' ongoing sense of moral duty motivated a set of professional practices that differed from their standard clinical practices prior to Covid-19.

The motivating role of the moral duty to do good. Despite the sense of hopelessness, physicians were relentless in their commitment to facing the Covid-19 pandemic in ways that were proactive and positive. A strong sense of moral duty of care surfaced to sustain their actions. While in the anticipatory phase this moral duty motivated any action to do something useful, in this period it came to focus on actions that would help patients. Physicians expressed the idea that this "innate, ingrained principle" became the driver for their actions, noting, "that was what kept us there" (Gastroenterologist 1, interview). They made clear how this moral duty to do good was ingrained in the overall mission of the medical profession, that is, that of helping others in need and of safeguarding a patient's health as the utmost priority. As explained by an interviewee:

Our real mission as physicians emerged during those months [in the Covid-19 wards]. Extending ourselves for the good of the patients, of others, of the entire community, is indeed the utmost value of being a physician (Hepatic surgeon 4, interview)

Yet, physicians recounted that this moral duty to do good or anything possible for the patient had sometimes been forgotten in their professional work pre-Covid-19. They explained how:

In the daily practice, our main purpose as professionals, that is that of safeguarding at all costs the health of our patients, can get lost, *our "polar star" gets lost*. With Covid-19 we found it again (ICU physician 5, interview, emphasis added)

Informants explained how the primacy placed on specialized knowledge in modern medicine meant that it became acceptable, or even a mark of an excellent professional, to focus on their sub-specialty expertise, at the expense of addressing a patient's care needs holistically, as one interviewee commented:

As physicians, we are directed to be excellent in a very narrow field of expertise, to be hyper-specialists. The market asks this, patients ask this […]. This means we distance ourselves in our daily work from practicing medicine with a capital M, at 360 degrees. *We stick to our comfort zone and we do what we have total control and certainty of, on the basis of our knowledge* (Hepatic surgeon 3, interview, emphasis added)

This reliance on the certainty of specialized knowledge, according to our interviewees, led them to emphasize their self-sufficiency within the limits of their specialist domain. As a result,

physicians could underestimate in their professional practice the value of collaboration with colleagues across different specialties in ways that could provide better care. In addition, it decreased the value of putting the relationship with patients at the center of the professional work, relying more, instead, on technology-based interactions that further reinforced their specialized knowledge. One of them explained:

> Our daily work tends to depersonalize, to remove the contact between physicians and patients. In the way the work of physicians is nowadays conceived, this part is normally missing, the real contact with patients […] but that part, in reality, is essential for a physician (Cardiovascular surgeon 2, interview)

Physicians' responses: Prioritizing service-oriented practices and the positively reinforcing moral emotion of elevation. Amid the hopelessness felt by physicians due to the repeated failure of their professional knowledge to provide solutions, the moral duty to do good motivated them to prioritize service-oriented practices of collegial and humanistic work that they had started exploring in the previous phase. Collegial work was based on two sets of physicians' actions. First, they created a climate of peer synergistic relations, entering the Covid-19 wards with "extreme humility," de-emphasizing their role in the medical hierarchy, and admitting to each other "not to know anything" (Gastroenterologist 4, interview). A top orthopedic surgeon recounted addressing a young physician in this way:

> "You probably know much better than me what to do; you are fresh from your studies. Tell me what I need to do." And I said that I could not really do anything and knew nothing useful, but that I was willing to do anything she deemed necessary for the [Covid-19] patients (Orthopedic surgeon 1, interview)

Physicians changed their normal way of talking to colleagues, by refraining from using that "ordering tone that we are used to using once we are up in the chain of command" (Hepatic surgeon 1, interview). As they felt that "top roles did not coincide anymore with knowing more," they judged that respecting hierarchies would not have been "functional to the purpose physicians had, that of saving patients' lives" (Pulmonologist 2, interview). Peer synergistic relations were also

fostered by the systematic performance of gestures of solidarity among colleagues. Physicians, for instance, volunteered to do the most burdensome work, such as night shifts, prolonged their presence in the wards, or anticipated activities that could relieve colleagues of additional work.

Second, in such a climate of equal sharing of tasks and authority, due to the dismantling of traditional knowledge-based hierarchical structures, physicians took clinical decisions based on a collective experiential logic. They shifted from relying on the scientific, technical knowledge, which was traditionally developed and codified within specialties, to an emphasis on the service-oriented grounding of their professional work. They put "to the side specific professional interests" (Nephrologist 1, interview), and united around the common purpose of working for the sake of the patient. As noted by an informant, "There was not 'my' patient or 'your' patient; there were 'our' patients" (Clinical immunologist 2, interview). One physician recounted how this was a "new way of working in which you would not do everything by yourself, but work in a real team" (Gastroenterologist 1, interview).

Confronted with a medical community unable to provide reliable guidelines and protocols, physicians started "freely exchanging ideas and advice," "taking decisions together" on how to deal with single cases as a united team in the effort to "experiment with any possible treatment or solution to Covid-19" (Nephrologist 1, interview) they could think of. In a situation of great uncertainty and incapacity to provide solutions, working collegially allowed them to compensate, at least partially, for each other's knowledge failures and develop a sort of collective problem-solving capacity:

> That spirit of collaboration created by working together in the wards meant that a sort of collective intelligence would immediately mobilize to resolve a problem, without even asking. If you raised a problem, three seconds later someone would come to help (Clinical immunologist 2, interview)

Proceeding collegially by cross-specialty experimentation as a united team allowed physicians to achieve some local progress in their understanding of the disease. This emerging evidence was far from "the gold standard" of being "written in medical books" and remained experiential in nature. Embracing this collegial way of relating to each other represented the maximum expression of physicians' effort to do their best for Covid-19 patients, as one of them explained:

> In that moment each of us provided his or her own small contribution but what was important was that we were all one interconnected community, like a beehive... It did not mean that [Covid-19] patients would not die but that at least *we had done together the maximum possible for each of them every day* (Heart surgeon 1, interview, emphasis added)

In addition to collegial work, physicians prioritized humanistic practices that put the human relation in patient care at its center. In their interactions with Covid-19 patients, physicians endeavored to "attend to the most important needs of these patients and their families" (ED physician 5, interview), including needs that were beyond the clinical sphere. The duty of care, given the lack of treatment options, encouraged physicians to remove the typical emotional distance, to "see the patient as a person" in the context of family ties, and "think about the patient's feelings" (Endocrinologist 2, interview). For example, a physician recounted how, even if not allowed, a lady was taken to see her deceased husband in the hospital mortuary, recalling that this "small gesture of humanity made her feel somehow better despite all and will stay with her for the rest of her life!" (Gastroenterologist 4, interview). Doing the best for patients involved overcoming the impersonality characterizing the relationship between physician and patient. A physician recounted taking time with patients to account for the "emotional and psychological aspects" of being affected by such an unknown and isolating condition:

> In the Covid-19 ward, I dedicated more time to patients [than I normally do]. I dedicated more time not because it took more time to prepare—for example, wearing the masks and so on—but because *I wanted to dedicate more time to this type of patient*. […] These were patients who felt lonely, who could not meet their relatives, or—in the worst case scenario—who had lost their relatives to Covid-19 (Surgical oncologist 1, interview, emphasis added)

Physicians put at "the center of [their] clinical work the communication with patients and their families" (Rheumatologist 3, interview), and they started transmitting some "closeness with their eyes, with the tone of their voice, or a hand on their shoulder" (Cardiologist 2, interview). They also established the routine of calling Covid-19 patients' relatives twice a day, not just to "provide some info, rather to [be] able to reassure and console them when things were not going well" (Urologist 1, interview).

In performing service-oriented practices of collegial and humanistic work, physicians came to perceive that the practices, despite not resolving the fundamental failure of their professional work, were nevertheless able to provide some benefit. These service-oriented practices even helped them to develop some clinical insights that could better account for the multiple manifestations of Covid-19 beyond pneumonia and for some variation in disease progression across patients. A physician described how her team rejoiced for any small advancement derived from collegial work:

> We learned in the field, day after day, to understand and anticipate how patients will behave. These were small advancements that allowed us to say, "Come on, *we did something, we learned something, we know a little bit more how to manage the whole thing*" (Cardiologist 1, interview)

Patients and their families also signaled gratitude to physicians for the closeness they displayed. Physicians recounted how relatives would thank them for their work and humanity, even when they announced to them the death of their dear ones. Service-oriented practices, and the positive feedback that followed from them, progressively generated a positive moral emotion of elevation, a mix of pride for what physicians were able to do against all odds and of admiration for colleagues and their dedication. This elevation, in turn, positively reinforced the service-oriented practices. Physicians described feeling "good," "motivated," "happy," and "vital" while working in the Covid-19 wards and "having fun somehow" or "having a beautiful experience" with their colleagues. The positive emotion of elevation corresponded to physicians' moral assessment of

their prioritization of service-oriented practices as fundamentally good. Seeing that "our way of relating to patients made a big difference for them made us want to continue working and to do it that way" (Urologist 1, interview). Similarly, a collegial way of working was interpreted as a "sign of the dedication and the generosity of everybody" (Hepatologist 2, interview) and "what really was making the difference in saving people's lives" (Nephrologist 1, interview).

Summary. Overall, physicians' inability to predict Covid-19 patients' clinical evolution and to forecast the outcomes of their actions represented a fundamental failure of their ability to apply their knowledge to solve professional problems. This failure led them to experience an epistemic emotion of hopelessness. Despite the hopelessness they felt, physicians succeeded in prioritizing a set of service-oriented practices that responded to their professional sense of moral duty to do good for their patients. They came to prioritize a collegial way of working and a humane and empathic way of relating to patients and families. The development of a positive moral emotion of elevation connected to performing these practices provided physicians with the reinforcement to maintain such practices, even after the first wave of the pandemic had passed, when they were potentially less necessary.

Phase III: Unmitigable Uncertainty about Finding Solution to the Knowledge Disruption

During the month of April, 2020, after the outbreak reached its peak of infections, the number of new cases of Covid-19 started decreasing. More than 23,000 people were estimated to have died from Covid-19 in the Lombardy region in the span of the previous two months (Ghislandi, Muttarak, Sauerberg, & Scotti, 2020). At the beginning of May, 2020, C-Hospital began converting Covid-19 wards back to their usual uses and physicians who had served in the Covid-19 units progressively returned to working with their usual patients within their specialty areas. Out of the Covid-19 wards, physicians had mixed feelings. On the one hand, they felt hopeless for

being inadequate in caring for Covid-19 patients, admitting that "we know now what it is about, we have seen that only very few things we did worked, that for the most this is a disease that does its own thing" (Endocrinologist 2, interview). On the other hand, the moral emotion of elevation developed during the previous period tempered this sense of hopelessness. Some physicians acknowledged they had "shed some tears when the ward closed down as I would miss my colleagues" (Cardiologist 2, interview), while others sent thank-you emails, organized goodbye gatherings or printed "ward T-shirts" to mark that "we had indeed been able to do something *great* together" (ED doctor 3, interview). Table 4 reports additional quotes.

--- Insert Table 4 about here ---

The uncertainty context: Failed knowledge-based attempts to mitigate uncertainty of treatment and the negative epistemic emotion of anguish. The immediate aftermath of the first outbreak was permeated with persistent uncertainty about how to effectively treat Covid-19 patients. Physicians reflected that this uncertainty was widespread across the medical profession, with the profession as a whole unable to identify a definitive solution. As one physician explained:

> We might have some treatments that have shown to achieve some results for some patients, but saying that we have something that with certainty leads to cure, and that cures all infected patients, is untrue (Pulmonologist 1, interview)

Another physician commented how attempts to mitigate this uncertainty by means of research and scientific investigation had yet to produce any certainty:

> Despite all the research conducted and published, some things might be clearer but in the end there are *no certainties* on how to cure this disease (ED physician 7, interview, emphasis added)

Awareness of such profound uncertainty about the capacity of physicians' inferential process to connect a definitive solution with the clinical problem represented by Covid-19 and the failure of traditional science-based approaches to produce knowledge on effective treatments transformed the hopelessness linked to the direct experience of failure in the negative epistemic emotion of anguish. Anguish was linked to the awareness of failure of one's professional knowledge. Not only

physicians felt distressed at the idea of having to go back to caring for Covid-19 patients. As one physician explained: "We feel anguished at the idea of going back to face something we are not capable of solving, be it Covid-19 or the next pandemic" (Endocrinologist 1, interview). They were "anxious at the idea that, in the end, in our profession nothing is really certain. It is all a wild card" (ED physician 6, interview). In many cases, uncertainty about being able to provide a definitive solution to Covid-19 was extended by physicians to encompass the entire knowledge-based approach of their own profession, as explained by one physician:

> As physicians we are led to think, to feel that [we are] very certain about [what] we do, about the results we obtain, we know it all …. But we are faced now with the evidence that this is not the case, and not only for Covid-19, but in general …. We now know how fragile our knowledge is and with this how fragile our certainty is (Hepatic surgeon 9, interview)

The motivating role of the moral duty to do well. As they returned to their usual activities, faced with persistent uncertainty about their knowledge and capacity to find solutions, physicians continued to draw on their sense of moral duty to do well in their professional work and conduct their work in ways that were best for their patients. In this phase, the duty became a motivation to not abandon the service-oriented practices of collegial and humanistic work that physicians had developed in the previous period. Physicians persisted with these service-oriented practices because they felt that the practices could contribute to overall patient wellbeing, even though they were not grounded in the specialized and technical knowledge that had previously predominated in guiding their work. In our interviews, physicians reflected on how the experience of caring for Covid-19 patients helped them understand how the collegial way of working represented an essential component of performing well as medical professionals:

> During Covid-19 […] we understood that in our profession one cannot do 100% well on their own … if I do [my job] badly, I am not the only one doing badly, but everything else that should lead to the care of the patient goes badly (Nephrologist 2, interview)

Physicians recounted that these service-oriented practices needed to be maintained for the sake of doing their professional jobs well—that is, doing what was best overall for the patients. They

argued that “exchange [of ideas and advice] among physicians and collegiality are elements that from now on we cannot do without in our work” (Cardiovascular surgeon 1, interview), and that “collaboration is winning also in the eyes of the patient, because if a patient sees that there is team working, they have more trust in us” (ED physician 9, interview). Similarly, physicians reflected on how “the pandemic has been the occasion to bring back the value of human relations, the relation with the patient that is the foundation of our work” (Cardiovascular surgeon 2, interview). Practices infused with “humanity” and “the capacity to relate empathically with patients and families” that had been prioritized in the phase of the Covid-19 units were now understood as being central to physicians’ professionalism, with interviewees describing them as “sacred pillars of the profession” (Pulmonologist 1, interview). Thus, it was imperative to maintain them in current (post-return to normal activities) clinical practice. One physician expressed this point with respect to the close communication with relatives established in the Covid-19 wards:

> We found ourselves having to phone the families of our patients every day and talk to them. This is *something that absolutely has to go ahead*, to continue! (ED physician 5, interview)

Consolidating service-oriented practices in professional work. Motivated by the moral duty to do well, physicians consolidated the service-oriented practices within their everyday professional work. First, they embedded collegial work in the clinical care of their usual patients and tried to move beyond the fragmentation among specialties that had previously characterized their work. They reached more systematically across departments for consultations and joint reviews of patients. A rheumatologist reported how, “before Covid-19, colleagues hardly knew who we were, now they call us on a non-stop basis, in all the hospital wards, and ask for our advice” (Rheumatologist 1, interview). Another physician explained how the synergy created in the Covid-19 wards transferred into daily practice:

There are colleagues I now feel comfortable to call whenever I am in need. The opposite works, too. I have received phone calls from colleagues asking me to see a patient because they now trust and value my competence. We are now very collaborative (Surgical oncologist 2, interview)

Second, physicians incorporated humanistic practices into their regular patient care, approaching regular, non-Covid-19 patients in a more holistic way, and "seeing the patient at 360 degrees for both their psychological as well as medical aspects" (Surgical oncologist 2, interview). Humanistic practices meant dedicating more time to establishing a physician–patient relationship built on personal and empathetic communication. Our interviewees expressed the view that "being relationally capable is as fundamental as being technically capable to provide the best care" (Cardiovascular surgeon 1, interview). Physicians, in fact, explained how investing in the relationship with patients helped them solve medical issues in different and more effective ways. An orthopedic surgeon, for instance, narrated how he felt that, by talking to patients, he could lead them to a better treatment path:

Before I would have come up with a [surgical] solution for any of the problems my patients had. Now my approach has changed and I try to explain to them that maybe some needs are not really a priority. I try to explain that if one does not have pain and is a person of a certain age maybe there is an alternative way to deal with some discomfort (Orthopedic surgeon 3, interview)

Summary. By the end of our observation period, after physicians had returned to their usual activities, the sense of anguish about the ongoing failure of their clinical knowledge persisted. Nevertheless, motivated by their reinvigorated professional moral duty to do their professional work as well as possible and by the perceived value—reinforced by the positive moral emotion of elevation—of service-oriented practices, physicians proceeded to integrate practices of collegial and humanistic work into their daily activities. In doing so, they came to reprioritize service-orientation as an essential component of their professionalism in contrast to the impersonal, knowledge-based, rational professionalism that had prevailed prior to the knowledge disruption.

DISCUSSION

Drawing on the case of Italian physicians responding to the first Covid-19 outbreak, this study asked how professionals respond to a knowledge disruption that challenges the adequacy of an entire profession's knowledge base in the workplace setting. Figure 2 illustrates the core conceptual model of the professional response that we induced from our data. The model proposes that unmitigable uncertainty—which is uncertainty that disrupts inferential processes and cannot be redressed through knowledge-based means or by adapting an alternative body of knowledge—triggers negative epistemic emotions. Epistemic emotions form the overarching context for professionals' responses to the knowledge disruption. In this context, professionals are likely to feel a strong professional sense of moral duty that motivates efforts to engage in service-oriented practices, which generates positive moral emotions. Positive moral emotions reinforce engagement in service-oriented practices and result in a response to the knowledge disruption that consolidates professionals' commitment to incorporating these practices into professional work.

--- Insert Figure 2 about here ---

Our findings contribute to the literature on professions and organizations by enriching and extending a thread of work focused on how professionals respond to events or long-term societal shifts that challenge their knowledge base (Barley, 1986; Currie et al., 2009; Currie et al., 2012; Evans, 2021; Howard-Grenville et al., 2017). First, we enrich the understanding of knowledge disruptions by theorizing the distinctive category of knowledge disruptions of unmitigable uncertainty and positing how this immitigability is interrelated with dynamics of negative epistemic emotions. Second, we extend theory on the micro-level dynamics by which professionals respond to knowledge disruptions and theorize engagement in service-oriented practices of collegial and humanistic work as a viable alternative response. We indicate that the heightened professional sense of moral duty is a mechanism that motivates professionals to engage in such

practices and that the affective reinforcing mechanism of positive moral emotions may make practice consolidation in professional work possible.

Conceptualizing Knowledge Disruptions of Unmitigable Uncertainty

We conceptualize knowledge disruptions of unmitigable uncertainty as a distinctive category. Prior literature has acknowledged that disruptions that render professional knowledge inadequate may generate a degree of uncertainty for professionals (Fox, 1959; Freidson, 2001; Gerrety et al., 2012). However, these studies have implicitly assumed that professionals question the adequacy of their knowledge when confronted with an alternative and often competing body of knowledge (Abbott, 1988; Anteby, 2010; Waring & Currie, 2009). This work has shown that when faced with new knowledge embedded in either new occupational groups or technological innovations (Barley, 1986; Currie et al., 2012; Evans, 2021; Nelson & Irwin, 2014), professionals may become uncertain about whether they have enough or the best knowledge needed to perform their current normal tasks. This can lead professionals to doubt the solidity of their claims to exclusive jurisdictional authority over those tasks (Anteby, 2010; Evans, 2021; Howard-Grenville et al., 2017). Therefore, this literature has assumed that professionals, though faced with uncertainty, can nevertheless continue with their professional work by drawing on, adapting, or defending against the alternative knowledge that generated the knowledge disruption.

In contrast, we conceptualize a category of knowledge disruptions of unmitigable uncertainty that, absent an alternative body of knowledge, impedes professionals from conducting their usual work. We suggest that these knowledge disruptions are likely to emerge from societal challenges generated by either acute natural and social events or long-term shifts that lead to uncertainty about knowledge in an entire profession, or across the system of professions. In these cases, multiple professional groups may lack adequate knowledge to come to a univocal diagnosis of a problem or provide a satisfactory solution (Ferraro et al., 2015; Grint, 2022; Rittel & Webber, 1973). The

Covid-19 pandemic exemplifies this type of societal challenge (Howard-Grenville, 2021; Koffman et al., 2020). While it has not always been a central focus for theory development, scholars have suggested that complex societal challenges are characterized by radical uncertainty because of their complex, non-linear, and emerging nature (Gehman et al., 2022), which may profoundly affect professionals' work. However, because the uncertainty of knowledge has not been the central focus of prior work, the constitutive features of these kinds of knowledge disruptions remain undertheorized. Drawing on our case, we identify two defining characteristics of knowledge disruptions of unmitigable uncertainty.

The first feature is that knowledge disruptions of unmitigable uncertainty undermine the core inferential process that allows professionals draw on their specialized knowledge to link problems to solutions (Abbott, 1988; Freidson, 1986). Although disruptions created by the emergence of competing knowledge systems may call into question whether a professional's knowledge base is the best or most appropriate for solving professional problems, it does not necessarily challenge the core inferential process. In contrast, we show that uncertainty can be unmitigable partially because it progressively impairs all the cognitive steps underlying professional work. Uncertainty undermines the diagnostic step in which the problem or phenomenon at hand is interpreted and defined (e.g., physicians' understanding of the pathology and features of Covid-19). Uncertainty limits the ability of professionals to identify how the problem will evolve and forecast the effects of their actions in solving such problem (e.g., the inability to come up with a prognosis or predict disease progression in Covid-19 patients). Consequently, uncertainty undermines the capacity to identify the most effective solution to a professional problem and apply it successfully (e.g., the identification of a definitive treatment for Covid-19). Ultimately, the uncertainty characterizing this category of knowledge disruptions increases the possibility that professionals will make

erroneous or suboptimal decisions. By disrupting basic inferential processes, knowledge disruptions of unmitigable uncertainty undermine the capacity of the entire profession to find effective solutions. In our case, the extended inability to effectively engage in the inferential processes that are the basis of physicians' work led many to perceive the medical profession's entire corpus of knowledge as fragile. Prior literature has documented examples of uncertainty around diagnosis, prognosis, and matching cases with solutions as types of uncertainty that many, if not most, professionals may encounter during their work (Fox, 1957, 1959; Light, 1979; Timmermans & Angel, 2001). However, we develop a case distinguished by the extensiveness and progressiveness of uncertainty throughout all steps of the professional inferential process.

The inability of professionals to mitigate uncertainty through knowledge-based strategies is the second characteristic that defines knowledge disruptions of unmitigable uncertainty. Prior work implicitly assumed that the use of knowledge-based strategies to temper uncertainty is an essential feature of professionalism (Abbott, 1988; Brante, 1988, 2011; Light, 1979, 1980). This work showed how processes of learning and specialization during professional education allow professionals to consolidate techniques and ways of reasoning for diagnosing problems and developing solutions (Becker et al., 1961; Bosk, 2003; Gerrity et al., 1992; Light, 1979). These same learning and specialization processes limit the scope of the knowledge to be acquired, providing a basis for professionals to abstract from complex problems and categorize them as cases within their knowledge system (Heimer, 2001). Delimitation and abstraction, in turn, help professionals mitigate the uncertainty linked to knowledge (Light, 1979). In contrast, we argue that, for certain knowledge disruptions, uncertainty cannot be addressed through traditional knowledge-based strategies. We theorize that this element of immitigability is not given *ex ante*. Rather, professionals discover the immitigability of uncertainty in the workplace through a series

of failed cognitive attempts to mitigate it. In our case, the professionals repeatedly tried unsuccessfully to address the extensive and progressive uncertainty created by Covid-19 through knowledge-based approaches. These strategies included collecting technical information, studying procedures, using evidence-based protocols and guidelines, and assessing knowledge produced through scientific research designs (Timmermans & Angel, 2001; Timmermans & Kolker, 2004). The extensive and progressive uncertainty throughout the steps of professional inference and the repeated failure to mitigate uncertainty through traditional knowledge-based strategies create a prolonged state in which the inadequacy of professional knowledge hampers professionals' ability to adequately conduct their work. These two features distinguish knowledge disruptions of unmitigable uncertainty as a theoretically distinct category from cases of uncertainty around knowledge that professionals experience more regularly (Fox, 1957, 1959; Light, 1979; Timmermans & Angel, 2001) and from cases of knowledge disruption emerging from new technology or jurisdictional competition (Barley, 1986; Currie et al., 2012; Nelson & Irwin, 2014).

Dynamics of negative epistemic emotions in professionals' experiences of unmitigable uncertainty. Our work breaks new ground by indicating that professionals collectively experience the immitigability of uncertainty generated by this distinctive category of knowledge disruption through shared dynamics of negative epistemic emotions that evolve over the course of the knowledge disruption. Epistemic emotions arise when the object of attention is knowledge, including its (un)certainty or processes of knowing (Morton, 2010; Nerantzaki et al., 2021; Pekrun & Linnenbrink-Garcia, 2014). In our work, we identify emotions of confusion, fear of the unknown, hopelessness, and anguish, which the literature has shown to be connected to specific states of knowledge (Carleton, 2016; Nerantzaki et al., 2021). Neither the psychological nor the organizational and sociological literatures fully account for the emotional dynamics we have

uncovered. On the one hand, the psychological literature on epistemic emotions has traditionally focused on the role of positive epistemic emotions, such as curiosity, surprise, or enjoyment, in processes of learning and knowledge production by non-professionals, such as students (Pekrun & Linnenbrink-Garcia, 2014). On the other hand, with some exceptions (Wright, Meyer, Reay, & Staggs, 2021), the organizational and sociological literature exploring emotions in professional contexts has tended to emphasize the individual psychological dynamic of professionals' experiences of uncertainty or failure of professional knowledge (de Rond & Lok, 2016; Fox, 1957; Gerrity et al., 2012) rather than shared emotional dynamics. For instance, de Rond and Lok (2016) described the incapacity of military physicians to provide the best care to Afghan patients as a source of individual psychological distress. Gerrity et al. (2012) examined physicians facing uncertainty in their work and documented sense of personal inadequacy and perception of stress.

Our work enriches the understanding of epistemic emotions in professional settings by conceptualizing the specific negative emotions perceived by professionals when they collectively fail in the cognitive and inferential steps of their professional work and by theorizing the basis for their dynamics. We show how the uncertainty around each of the cognitive steps of the professional work and the consequent impact on professionals' capacity to draw on professional knowledge to solve problems, is experienced through distinct epistemic emotions of confusion, fear of the unknown, hopelessness, and anguish. We propose that the dynamics of epistemic emotions, both in terms of their sequence and interrelation, depend on the changing cognitive context in which professional work occurs. Confusion and fear of the unknown are linked to the early or preliminary moments of the inferential process when the cognitive effort rests on defining future risks or problems (Carleton, 2016), that have yet to fully manifest themselves. Hopelessness, instead, stems from the direct experience with the failure of professional prognostic capacity and with the

frustration of trying to solve a problem but being unable to do so (Pekrun & Linnenbrink-Garcia, 2014). Finally, anguish emerges only once professionals become aware of the failure of the entire inferential process and feel lost in what they perceive as a collective state of complete ignorance (Sans Pinillos & Magnani, 2022). In our case, physicians, who feared the unknown in anticipation of the knowledge disruption, turned to hopelessness when the uncertainty caused by the knowledge disruption made their work patently ineffective in solving problems. Hopelessness then transformed into anguish when the incapacity of the entire medical profession to provide a definitive solution to the disease sank in. In addition, our findings suggest that the extent of professionals' awareness of the immitigability of uncertainty—i.e. awareness of the limits of typical knowledge-based strategies for addressing a knowledge disruption—might amplify epistemic emotions and facilitate the shift from one emotion to another. For example, failing to mitigate uncertainty around the diagnostic step of professional inference by increasing the information used to define the problem may increase professionals' awareness of the immitigability of uncertainty, and hence help transform an initial confusion into the epistemic emotion of fear of the unknown. Similarly, recognizing the uselessness of adopting a "best solution" approach in solving the problem at hand might help transform the epistemic emotion of fear into hopelessness.

In conclusion, our study construes the dynamics of epistemic emotions as constitutive of knowledge disruptions of unmitigable uncertainty and theorizes how specific epistemic emotions, their sequence and interrelation are shaped both by the uncertainty generated by these knowledge disruptions and the extent to which professionals realize that this uncertainty is unmitigable.

Service-Oriented Practices as Viable Professional Responses to Knowledge Disruptions: Mechanisms of Practice Emergence and Consolidation

The second contribution of our study lies in theorizing the micro-level dynamics by which professionals respond to knowledge disruptions of unmitigable uncertainty through workplace interactions. Specifically, we identify service-oriented practices of collegial and humanistic work that allow professionals to provide a viable response to a knowledge disruption and examine the mechanisms that lead to their emergence and further consolidation in professional work.

First, we advance theory by including service-oriented practices within the repertoire of possible responses that professionals may use when faced with uncertainty of knowledge and other disruptions or challenges to their work. We define service-oriented practices as those practices conducted to the benefit of others (Goode, 1966; Moore, 1970). Service-oriented practices differ from the cognitive–calculative mechanisms of knowledge expansion and jurisdictional politics described by prior studies that have explored how professionals respond to knowledge disruptions. Service-oriented practices also differ from other noncognitive responses, such as disengagement, normalization, and ritualization, reviewed in the literature on professionals' reactions to workplace disruptions that are not necessarily based on knowledge (de Rond & Lok, 2016; Fox, 1959; Maitlis & Ozlcelik, 2004; Schabram & Maitlis, 2017). Schabram and Maitlis (2017), in their study on animal shelter workers, showed how relevant disruptions to the meaning held by these professionals about their work led many of them to disengage from their work due to emotional exhaustion. Alternatively, professionals may attempt to avoid facing the disruption and enact practices of normalization and individual coping that minimize action (de Rond & Lok, 2016; Jiang, 2021; Maitlis & Ozlcelik, 2004). De Rond and Lok (2016), for example, described how military physicians grew sunflowers in the desert in their attempt to cope with the psychological distress linked to the inadequacy of their professional work. Unlike responses of disengagement, normalization, and ritualization, service-oriented practices represent proactive and generative

professional responses to knowledge disruptions. Amidst negative epistemic emotions that may otherwise decrease professionals' motivation to act, these practices allow professionals to assemble a viable response and ultimately improve their usual professional work. Our findings suggest that engaging in service-oriented practices can unite professionals around a common purpose that they perceive as core to their profession, which, in our case, is promoting and safeguarding the health of others. These practices stimulate a renewed sense of agency that knowledge disruption and its unmitigable uncertainty have weakened dramatically. Our work builds on the scant body of evidence that professionals develop other-oriented actions when they cannot effectively apply their knowledge to solving professional problems (Bayer & Oppenheimer, 2006; Craciun, 2018; Fox, 1957). For instance, Fox (1957) explained how physicians unable to find a cure through scientific research developed unusual emotional engagement with their patients. Similarly, physicians caring for AIDS patients in the early years recounted that their "inability to change the course of the disease forced [them] to seek other ways to meet patients' needs" and that "simple acts such as holding patients' hands and listening to their stories were critical" (Bayer & Oppenheimer, 2006: 2274).

Second, in addition to theorizing service-oriented practices as viable responses to knowledge disruptions, our work specifies the mechanism that motivates the emergence of such practices, which is the professional sense of moral duty or normative commitment of professionals to helping others to the best of their capacity, that follows directly from identifying as part of a profession (Abbott, 1983; Freidson, 1994). We show that while knowledge disruptions undermine the certainty of knowledge relied upon by professionals, the professional sense of moral duty works as a "compass," indicating what "would be good to do" and directing professionals toward service-oriented practices. Evidence on the role of professional moral duties in the context of the

uncertainty of professional knowledge is scant. Some work in professional ethics has suggested that absent adequate knowledge, moral considerations should prevail to guide professionals' behavior (Tannert, Elvers, & Jandrig, 2007). Although not specifically focused on knowledge disruptions, an emerging stream of literature in organization theory that analyses the bearing of moral and value-laden obligations on professionals' actions has explained that professional moral duties provide professionals with certain grounding (Wright et al., 2021a) and motivate their actions (Reid & Ramarajan, 2021; Wright, Zammuto, & Liesch, 2017), especially when they feel threatened in their value system. We extend this work by highlighting that this heightened sense of professional moral duty as a guide to action is likely to emerge in the context of knowledge disruption, particularly when the adequacy of the knowledge of an entire profession is rendered uncertain. Although a sense of moral duty has long been acknowledged as a feature of professionalism (Abbott, 1983; Freidson, 1994), we argue that the service-oriented practices that it motivates, specifically those of collegial and humanistic work that we identify in our study, can mark a departure for professionals from their usual practices of how they relate to clients and to one another as colleagues. Prior work has highlighted that knowledge in a profession defines status and power relations in a way that affects how professionals interact with each other in the workplace (Abbott, 1981; Martin et al., 2009; Wiedner, Barrett, & Oborn, 2017). In contrast, our work indicates that the focus on collegial work deemphasizes status and power differences rooted in knowledge specialization and entails, instead, the creation of a more level playing field in which professionals relate to each other as peers, value each other's ideas, and learn and fail together. Similarly, knowledge has been shown to constitute the basis for status differentials between professionals and clients (Light, 1979, 1980) and to support objectivity and affective neutrality in professional–client relationships (Freidson, 1986; Heimer, 2001). However, humanistic work

means that professionals necessarily view clients, in part, as people rather than as cases. This suggests that professionals' ways of interacting with clients depart from the impersonality that prior theory has identified as a central feature of professionalism.

Finally, while moral duty motivates professionals to engage in service-oriented practices in the context of knowledge disruptions of unmitigable uncertainty, positive moral emotions are important in stabilizing these practices. We propose that professionals may develop positive moral emotions from receiving encouraging feedback and approval from their main moral constituencies (Leavitt, Reynolds, Barnes, Schilpzand, & Hannah, 2012). In our case, these constituencies include patients, families, and colleagues. Moral emotions are a source of moral judgment because they connote one's actions as good or bad (Haidt, 2003a). Positive moral emotions, in particular, such as relief and elevation, have been shown to provide encouragement and reinforcement to altruistic and prosocial behaviors (Greenbaum, et al., 2020), leading people to further engage and even expand the practices that made them experience that positive moral emotion in the first place. Our findings suggest that positive moral emotions were indeed fundamental to encouraging physicians in pursuing the sets of service-oriented practices they progressively engaged in. Prior research has focused on the negative moral emotions of shame (Wright et al., 2021a) and concern (Wright et al., 2017) and explained that these emotions may lead professionals to defend and avoid any deviance from their typical professional practices. Complementing this work, we illustrate how positive moral emotions in the context of a knowledge disruption may work to endorse emerging practices that differ from the dominant cognitive-rational professional approach. Because of the positive feedback of moral emotions, collegial and humanistic work ultimately progresses from a contingent response to a knowledge disruption to an essential part of physicians' professionalism.

Broader Implications, Boundary Conditions, and Opportunities for Future Research

While knowledge disruptions that challenge the adequacy of knowledge across an entire profession or system of professions may be rare, they are consequential and hence an important focus for theory development. As this type of knowledge disruption is likely to occur in the context of societal challenges, our work may also add insight to the growing body of research on societal challenges (Ferraro et al., 2015; Gehman et al, 2022). Indeed, we suggest that disruption to professional knowledge might be a distinctive aspect of these societal challenges. Future work could systematically explore the role of professionals in producing responses to societal challenges. Considering cases where disruption to professional knowledge is an important aspect of a societal challenge, our work suggests that professional responses that rely on knowledge-based approaches will more likely be ineffective. We illustrate that knowledge disruptions linked to societal challenges may compound uncertainties in ways that largely defeat the capacity of professionals to mitigate uncertainty through typical knowledge-based strategies. However, the failure of knowledge-based strategies may have a counterintuitive benefit. To the extent that failure of knowledge leads professionals to engage in practices that weaken the boundaries created by differences in knowledge and specialization, coordinated action (George, et al., 2016) needed to effectively address these challenges may be more likely to occur.

There are boundary conditions presented by our specific research setting. One boundary condition stems from the highly professionalized context of our research and, specifically, from three aspects of the medical profession. First, while all professions are deeply connected with a professional knowledge base, this is particularly true of physicians (Freidson, 1970). The academic medical center we studied is one in which the connection between knowledge and a sense of professionalism may be even stronger. The strength of the negative epistemic emotions that we observed may be weaker or may be expressed differently in other cases. Second, as our case has

shown, failure of professional work and inadequacy of specialized knowledge to solve problems in the medical profession can have immediate negative consequences in terms of lives lost to disease. This might not be the case for other professionals for whom failure of professional work has less evident or only long-term negative impacts. Directly observing the consequences of their own failure of knowledge might have amplified the emotional response of physicians and the salience of epistemic emotions. Third, medicine is a profession with a consolidated set of moral duties, some of which are codified in the Hippocratic Oath. Though professional codes of ethics have long been identified as a feature of professions (Abbott, 1983), this consolidated set of moral duties may be more accessible as a basis for action in medicine. Research on less professionalized groups, such as animal shelter workers (Maitlis & Ozcelik, 2004) and journalists (Reid & Ramarajan, 2021), has highlighted a diverse set of individual moral duties. Hence, the responses that we observed, including the epistemic emotions and the emergence of service-oriented practices, may be more likely to occur in professions, such as medicine (Martin et al., 2009), law (Smets, Morris, & Greenwood, 2012), and science-based professions (Evans, 2021; Howard-Grenville et al., 2021), which are characterized by strong and widely shared professional norms and a high reliance on codified specialized knowledge to conduct work. Future research could explore the mix of emotions and responses that may occur in less professionalized settings in which epistemic emotions may be displaced by or interact with other emotions (e.g., general or individual self-conscious emotions) that arise when people generally interpret and respond to triggers or events (Maitlis, Vogus, & Lawrence, 2013). Similarly, it would be interesting to explore the professional response to knowledge disruptions of occupational groups, such as nurses, social workers, or teachers, for whom collegial and humanistic work may be less of a departure from

usual practice. Here, we expect that moral emotions of compassion or empathy may prevail with respect to epistemic emotions linked to the disruption of knowledge.

Finally, given the restrictions imposed on field access, we reconstructed the experiences of professionals through interviews. However, we believe that this limitation may also be a strength of our study, as this type of reflection is unlikely to be shared among peers while the event is occurring. In this sense, interviews gave professionals the opportunity to elaborate with a nonjudgmental audience on the failure of their knowledge base to provide solutions. Our period of observation, limited to the first time in which physicians encountered the knowledge disruption, does not allow us to elaborate on how long lasting their responses might actually be and their long-term repercussion on the profession. Future research should explore, for instance, whether the consolidation of service-oriented practices in professional work persisted over time and if diverting from the dominant model of a knowledge-focused professionalism might have ultimately eroded the professional status of physicians vis a vis other professions.

In conclusion, our study breaks new ground in conceptualizing the category of knowledge disruption of unmitigable uncertainty that complex societal challenges are most likely to bring about and to which professionals and experts alike are expected to provide answers. By uncovering and theorizing the responses of professionals in the workplace to this type of knowledge disruption, both in terms of emotions and practices, our study suggests that, besides knowledge, other elements of professionalism, such as the sense of moral duty or service orientation, might be brought to bear to help professionals navigate the unmitigable uncertainty that characterizes these disruptions.

REFERENCES

Abbott, A., 1981. Status and status strain in the professions. ***American Journal of Sociology***, 86(4), 819-835.

Abbott A. 1983. Professional ethics. ***American Journal of Sociology***, 88 (5), 855-885.

Abbott, A. 1988. ***The system of professions: An essay on the division of expert labor***. Chicago: University of Chicago Press.

Agosti, A., & Rellini, A. 2007. The Italian LIWC dictionary. LIWC.app

Algoe, S. B., & Haidt, J. 2009. Witnessing excellence in action: The 'other-praising' emotions of elevation, gratitude, and admiration. ***The Journal of Positive Psychology***, 4(2), 105–127.

Anteby, M. 2010. Markets, morals, and practices of trade: Jurisdictional disputes in the U.S. commerce in cadavers. ***Administrative Science Quarterly***, 55(4), 606–638.

Anteby, M., Chan, C.K. & DiBenigno, J. 2016. Three lenses on occupations and professions in organizations: Becoming, doing, and relating. ***Academy of Management Annals***, 10(1), 183-244.

Bayer, R. & Oppenheimer, G.M. 2006. Pioneers in AIDS care—reflections on the epidemic's early years. ***New England Journal of Medicine***, 355(22), 2273-2275.

Barley, S.R. 1986. Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments. ***Administrative Science Quarterly***, 31: 78–108.

Bechky, B.A. 2020. Evaluative spillovers from technological change: The effects of "DNA envy" on occupational practices in forensic science. ***Administrative Science Quarterly***, 65(3): 606-643.

Becker, H. S., Geer, B., Hughes, E. C., & Strauss, A. L. 1961. ***Boys in white: Student culture in medical school***. Toronto: University of Chicago Press.

Begun J.W. & Jiang H.J. 2020. Health care management during Covid-19: Insights from complexity science. ***Nejm Catalyst Innovations in Care Delivery,*** DOI: 10.1056/CAT.20.0541

Bosk, C.L., 2003. ***Forgive and remember: Managing medical failure***. Chicago, IL: University of Chicago Press, 2nd Edition.

Brante, T., 1988. Sociological approaches to the professions. ***Acta Sociologica***, 31(2),119-142.

Brante, T. 2011. Professions as science-based occupations. ***Professions and Professionalism***, 1(1), 4-20.

Brammer, S., Branicki, L., Linnenluecke, M., & Smith, T. 2019. Grand challenges in management research: Attributes, achievements, and advancement. ***Australian Journal of Management***, 44(4), 517–533.

Bucher, R., & Strauss, A. 1961. Professions in process. ***American Journal of Sociology***, *66*(4), 325-334.

Cappellaro, G., Tracey, P., & Greenwood, R. 2020. From logic acceptance to logic rejection: The process of destabilization in hybrid organizations. ***Organization Science***, 31(2), 415-438.

Carleton, R. N. 2016. Fear of the unknown: One fear to rule them all? ***Journal of Anxiety Disorders,*** 41, 5-21.

Colander, D., Goldberg, M., Haas, A., Juselius, K., Kirman, A., Lux, T. & Sloth, B. 2009. The financial crisis and the systemic failure of the economics profession. ***Critical Review***, 21(2-3), 249-267.

Compagni, A., Mele, V., & Ravasi, D. 2015. How early implementations influence later adoptions of innovation: Social positioning and skill reproduction in the diffusion of robotic surgery. ***Academy of Management Journal***, 58(1), 242–278.

Corbin, J. & Morse, J.M., 2003. The unstructured interactive interview: Issues of reciprocity and risks when dealing with sensitive topics. ***Qualitative inquiry***, 9(3), 335-354.

Craciun, M., 2018. Emotions and knowledge in expert work: A comparison of two psychotherapies. ***American Journal of Sociology***, 123(4), 959-1003.

Currie, G., Finn, R. & Martin, G., 2009. Professional competition and modernizing the clinical workforce in the NHS. ***Work, Employment and Society***, 23(2), 267-284.

Currie, G., Finn, R., & Martin, G. 2010. Role transition and the interaction of relational and social identity: new nursing roles in the English NHS. ***Organization Studies,*** 31(7), 941-961.

Currie, G., Gulati, K., Sohal, A., Spyridonidis. D., & Busari, J.O. 2022. Distributing systems level leadership to address the COVID-19 pandemic. ***BMJ Leader***, 6(1):39-44.

Currie G, Lockett A, Finn R, Martin G, & Waring J. 2012. Institutional work to maintain professional power: Recreating the model of medical professionalism. ***Organization Studies***, 33(7): 937-962.

De Rond, M. & Lok, J. 2016. Some things can never be unseen: The role of context in psychological injury at war. ***Academy of Management Journal***, 59(6):1965-1993.

Epstein, S. 1996. ***Impure science: AIDS, activism, and the politics of knowledge***. Vol. 7. Univ of California Press.

Evans, J. 2021. How professionals construct moral authority: Expanding boundaries of expert authority in stem cell science. ***Administrative Science Quarterly***, 66, 989–1036.

Evans, J., & Silbey, S. S. 2022. Co-opting regulation: Professional control through discretionary mobilization of legal prescriptions and expert knowledge. ***Organization Science***, 33(5), 2041-2064.

Ferraro, F., Etzion, D., & Gehman, J. 2015. Tackling grand challenges pragmatically: Robust action revisited. ***Organization Studies***, 36: 363-390.

Fligstein, N., Brundage, J.S. & Schultz, M. 2017. Seeing like the Fed: Culture, cognition, and framing in the failure to anticipate the financial crisis of 2008. ***American Sociological Review*** 82(5), 879–909.

Fox, R.C. 1957. Training for uncertainty. In R.K. Merton, G.G. Reader & P. Kendall (Eds.), ***The student-physician***: 207-241. Cambridge: Harvard University Press.

Fox R.C. 1959. ***Experiment perilous: Physicians and patients facing the unknown***. Glencoe.: Free Press.

Freidson, E. 1970. ***Profession of medicine: A study of the sociology of applied knowledge***. New York: Harper & Row.

Freidson, E. 1986. ***Professional powers: A study of the institutionalization of formal knowledge***. Chicago: University of Chicago Press.

Freidson, E. 1994. ***Professionalism reborn: Theory, prophecy and policy***. Cambridge, UK: Polity Press.

Freidson, E. 2001. ***Professionalism, the third logic: On the practice of knowledge***. Chicago, IL: University of Chicago Press.

Gehman, J., Etzion D., & Ferraro, F. 2022. Robust action: Advancing a distinctive approach to grand challenges. In Organizing for Societal Grand Challenges, ***Research in the Sociology of Organizations***, 79, 259-278.

George, G., Howard-Grenville, J., Joshi, A. & Tihanyi, L. 2016. Understanding and tackling societal grand challenges through management research. ***Academy of Management Journal***, 59, 1880–95.

Gerrity, M. S., Earp J.A.L., De Vellis, R. F., & Light, D. W. 1992. Uncertainty and professional work: Perceptions of physicians in clinical practice. ***American Journal of Sociology***, 97(4), 1022–1051.

Ghislandi, S., Muttarak, R., Sauerberg, M., & Scotti, B. 2020. News from the front: Estimation of excess mortality and life expectancy in the major epicenters of the COVID-19 pandemic in Italy. doi: https://doi.org/10.1101/2020.04.29.20084335

Goode, W. 1966. "Professions" and "non-professions." In H. Vollmer & D. Mills (Eds.), ***Professionalization:*** 33-45. Englewood Cliffs: Prentice-Hall.

Goodrick, E. and Reay, T., 2011. Constellations of institutional logics: Changes in the professional work of pharmacists. ***Work and Occupations***, 38(3), 372-416.

Gray, K., & Wegner, D.M. 2011. Dimensions of moral emotions. ***Emotion Review***, 3(3), 258-260.

Greenbaum, R., Bonner, J., Gray, T., & Mawritz, M. 2020. Moral emotions: A review and research agenda for management scholarship. ***Journal of Organizational Behavior***, 41: 95–114.

Grint, K., 2022. Critical essay: Wicked problems in the age of uncertainty. ***Human Relations***, 75(8), 1518-1532.

Haidt, J. 2003a. The moral emotions. In R. J. Davison, K. R. Scherer, & H. H. Goldsmith (Eds.), ***Handbook of affective sciences***: 852–870. Oxford: Oxford University Press.

Haidt, J. 2003b. Elevation and the positive psychology of morality. C. L.M. Keyes & J. Haidt, (Eds). ***Flourishing: Positive psychology and the life well-lived***: 275-289. Washington: American Psychological Association.

Heimer, C. A. 2001. Cases and biographies: An essay on routinization and the nature of comparison. ***Annual Review of Sociology***, 27(1), 47-76.

Howard-Grenville, J., 2021. Grand challenges, Covid-19 and the future of organizational scholarship. ***Journal of Management Studies***, 58(1), 254.

Howard-Grenville, J., Nelson, A.J., Earle, A.G., Haack, J.A. & Young D.M. 2017. "If chemists don't do it, who is going to?" Peer-driven occupational change and the emergence of green chemistry. ***Administrative Science Quarterly,*** 62 (3): 524-560.

Huy, Q. N. 2002. Emotional balancing of organizational continuity and radical change: The contribution of middle managers. ***Administrative Science Quarterly***, 47(1), 31–69.

Jiang, W.Y., 2021. Sustaining meaningful work in a crisis: adopting and conveying a situational purpose. ***Administrative Science Quarterly,*** 66(3), 806-853.

Kates, R. W., & Dasgupta, P. 2007. African poverty: A grand challenge for sustainability science. ***Proceedings of the National Academy of Sciences***, 104(43), 16747-16750.

Kawa, N.C., Arceño, M.A., Goeckner, R., Hunter C.E., Rhue S.J., Scaggs S.A., Biwer, M.E., Downey, S.S., Field, J.S., Gremillion, K. & McCorristo J. 2021. Training wicked scientists for a world of wicked problems. ***Palgrave Communications***, 8(1), 1-4.

Koffman, J., Gross, J., Etkind, S. N., & Selman, L. 2020. Uncertainty and COVID-19: How are we to respond? ***Journal of the Royal Society of Medicine,*** 113(6), 211–216.

Kouamé, S., & Liu, F. 2021. Capturing emotions in qualitative strategic organization research. ***Strategic Organization,*** 19(1), 97-112.

Kunisch, S., Blagoev, B. & Bartunek, J.M. 2021. Complex times, complex time: The pandemic, time-based theorizing and temporal research in management and organization Studies. ***Journal of Management Studies***, 58: 1411-1415.

Langley, A. 1999. Strategies for theorizing from process data. ***Academy of Management Review***, 24(4), 691–710.

Larson, M.S. 1977. ***The rise of professionalism: A sociological analysis***. Berkeley: University of California Press.

Leavitt, K., Reynolds, S. J., Barnes, C. M., Schilpzand, P., & Hannah, S. T. 2012. Different hats, different obligations: Plural occupational identities and situated moral judgments. ***Academy of Management Journal***, 55(6), 1316-1333.

Lefsrud L.M.& Meyer, R.E. 2012. Science or science fiction? Professionals' discursive construction of climate change. ***Organization Studies***, 33 (11), 1477-1506.

Lidskog, R., & Löfmarck, E. 2015. Managing uncertainty: Forest professionals' claim and epistemic authority in the face of societal and climate change. ***Risk Management***, 17(3), 145–164.

Lifshitz-Assaf, H. 2018. Dismantling knowledge boundaries at NASA: The critical role of professional identity in open innovation. ***Administrative Science Quarterly***, 63(4), 746–782.

Light, D.W. 1979. Uncertainty and control in professional training. ***Journal of Health and Social Behavior***, 20: 310-22.

Light, D. W. 1980. ***Becoming psychiatrists: The professional transformation of self***. New York, NY: Norton.

Lockett, A., Currie, G., Finn, R., Martin, G., & Waring, J. 2014. The influence of social position on sensemaking about organizational change. ***Academy of Management Journal***, 57(4), 1102-1129

Lofland, J., Snow, D., Anderson, L. & Lofland, L.H. 2006. ***Analyzing social settings: A guide to qualitative observation and analysis***. Belmont: Wadsworth/Thomson Learning.

London AJ, & Seymour CW. 2023. The ethics of clinical research: Managing persistent uncertainty. ***Journal of the American Medical Association***, 329(11), 884–885.

Maitlis, S., & Ozcelik, H. 2004. Toxic decision processes: A study of emotion and organizational decision making. ***Organization Science***, 15(4), 375-393.

Maitlis, S., Vogus, T. J., & Lawrence, T. B. 2013. Sensemaking and emotion in organizations. ***Organizational Psychology Review***, 3(3), 222-247.

Martin, G.P., Currie G. & Finn, R. 2009. Reconfiguring or reproducing intra-professional boundaries? Specialist expertise, generalist knowledge and the 'modernization' of the medical workforce. ***Social Science & Medicine***, 68(7), 1191-1198.

McVernon J., 2023. WHO keeps Covid-19 a public health emergency of international concern. ***British Medical Journal***, 380.

Miles, M. B. & Huberman, A. M. 1994. ***Qualitative data analysis: An expanded sourcebook.*** (2nd ed.). Thousand Oaks, CA: Sage Publications.

Milly, P. C. D., Wetherald, R. T., Dunne, K. A., & Delworth, T. L. 2002. Increasing risk of great floods in a changing climate. ***Nature***, 415(6871), 514-517.

Moore, W. 1970. ***The professions: Roles and rules***. New York: Russell Sage Foundation.

Morton, A. 2010. Epistemic emotions. In P. Goldie (Ed.), ***The Oxford handbook of philosophy of emotion***: 385–399. Oxford: Oxford University Press.

Nerantzaki, K., Efklides, A. & Metallidou, P. 2021. Epistemic emotions: Cognitive underpinnings and relations with metacognitive feelings. ***New Ideas in Psychology***, 63, 100904.

Nelson A.J. & Irwin, J. 2014. "Defining what we do—all over again": Occupational identity, technological change, and the librarian/Internet-search relationship. ***Academy of Management Journal,*** 57 (3): 892-928.

Nigam, A., & Dokko, G. 2019. Career resourcing and the process of professional emergence. ***Academy of Management Journal,*** 62(4), 1052-1084.

Parsons, T. 1954. ***Essays in Sociological Theory***, New York, NY: Free Press

Pekrun, R. & Linnenbrink-Garcia, L. 2014. ***International handbook of emotions in education***. New York, NY: Routledge.

Pradilla C.A., da Silva J.B. & Reinecke J. 2022. Wicked problems and new ways of organizing: How Fe Y Alegria confronted changing manifestations of poverty. In Organizing for Societal Grand Challenges, ***Research in the Sociology of Organizations***, Volume 79, 93–114.

Pratt, M. G., Rockmann, K. W., & Kaufmann, J. B. 2006. Constructing professional identity: The role of work and identity learning cycles in the customization of identity among medical residents. ***Academy of Management Journal,*** 49(2), 235–262.

Reid, E. & Ramarajan L. 2021. Seeking purity, avoiding pollution: Strategies for moral career building. ***Organization Science*** 33(5):1909-1937.

Rittel, H. W., & Webber, M. M. 1973. Dilemmas in a general theory of planning. ***Policy Sciences***, 4(2), 155-169.

Sans Pinillos, A., & Magnani, L. 2022. How do we think about the unknown? The self-awareness of ignorance as a tool for managing the anguish of not knowing. In (Eds.) ***Embodied, extended, ignorant minds*** 191-207). Cham: Springer International Publishing.

Schabram, K. & Maitlis, S. 2017. Negotiating the challenges of a calling: Emotion and enacted sensemaking in animal shelter work. ***Academy of Management Journal***, 60(2): 584-609.

Smets, M., Morris, T.I.M. & Greenwood, R. 2012. From practice to field: A multilevel model of practice-driven institutional change. ***Academy of Management Journal***, 55(4), 877-904.

Svensson, R., 1996. The interplay between doctors and nurses—a negotiated order perspective. ***Sociology of Health & Illness,*** 18(3), pp.379-398.

Tannert, C., Elvers, H. D., & Jandrig, B. 2007. The ethics of uncertainty: In the light of possible dangers, research becomes a moral duty. ***EMBO reports***, 8(10), 892-896.

Timmermans S. & Angell A. 2001. Evidence-based medicine, clinical uncertainty, and learning to doctor. ***Journal of Health and Social Behavior***, 42(4), 342-359.

Timmermans, S. & Kolker, E.S., 2004. Evidence-based medicine and the reconfiguration of medical knowledge. ***Journal of Health and Social Behavior***, 45, 177-193.

Toubiana, M., & Zietsma, C. 2017. The message is on the wall? Emotions, social media and the dynamics of institutional complexity. ***Academy of Management Journal***, 60(3), 922-953.

Waring, J., & Currie, G. 2009. Managing expert knowledge: Organizational challenges and managerial futures for the UK medical profession. ***Organization Studies***, 30(7), 755-778.

Wears, R., & Sutcliffe, K. 2019. ***Still not safe: Patient safety and the middle-managing of American medicine***. Oxford: Oxford University Press.

Wiedner, R., Barrett M., & Oborn, E. (2017) The emergence of change in unexpected places: Resourcing across organizational practices in strategic change. ***Academy of Management Journal,*** 60(3), 823-854.

Woodruff, S.C. 2016. Planning for an unknowable future: Uncertainty in climate change adaptation planning. ***Climatic Change***, 139, 445–459.

Wright, A. L., Zammuto, R. F., & Liesch, P.W. 2017. Maintaining the values of a profession: Institutional work and moral emotions in the emergency department. ***Academy of Management Journal***, 60(1), 200–237.

Wright , A.L., Irving, G. & Thevatas, K.S. 2021a. Professional values and managerialist practices: Values work by nurses in the emergency department. ***Organization Studies***, 42(9), 1435–1456.

Wright, A.L., Meyer, A.D., Reay, T., & Staggs, J. 2021b. Maintaining places of social inclusion: Ebola and the emergency department. ***Administrative Science Quarterly***, 66(1), 42-85.

TABLE 1
Data Sources

Data Source	Details	Use in the analysis
Semi-structured interviews with physicians (74; 1,100 pages transcript)	74 physicians (80% of total) with a direct and continuous professional exposure to Covid-19 patients during the first outbreak (March-August 2020) Demographic details (see Appendix I): • Age (range: 31-62) • Years of service (range: 1-23) • Gender (female/total: 41%) • Medical specialty: – Internal medicine specialties (50%); – Surgical specialties (35%); – Emergency and intensive care (15%.) • Activity during the Covid-19 first outbreak: – Frontline care for Covid-19 patients in wards – Frontline care for Covid-19 patients in ER or ICU – Other activities (hospital checkpoints, communication management between Covid-19 patients and families, coordinating work of colleagues)	Identify and trace over time professionals' work practices Elicit professionals' emotional dynamics and the perceived impact of the Covid-19 outbreak as knowledge disturbance
Semi-structured interviews with managers (7; 98 pages transcript)	Core hospital staff managing C-Hospital during the first outbreak (7) - General Director, Head of Human resource office and staff, Chief Operations Officer, Head of the Information Technology department	Analyze the organizational contextual factors affecting professionals' work and interactions
Internal communication and organizational archival materials (195)	• Internal organizational procedures (e.g., procedures for reconverting and restructuring the wards) • Internal email exchanges and diaries • Internal self-recorded videos for information and training purposes • Public interviews and public podcasts released by physicians and hospital staff • Hospital press releases	Analyze the organizational contextual factors affecting professionals' work and interactions Study professionals' interactions
Scientific publications, video presentations at scientific conferences (215)	• Scientific publications authored by physicians of C-Hospital (scientific articles, commentaries, medical guidelines and recommendations) • Video-presentations at scientific conferences • Training courses and educational initiatives	Reconstruct professionals' interaction with the scientific community

TABLE 2
Phase I: Main Constructs, Second and First-Order Codes and Additional Quotes

Main Constructs (Second-Order Codes)	Detailed First-Order Codes and Additional Quotes
1. Uncertainty generated by the knowledge disruption	
Uncertainty in defining the imminent knowledge disruption	*Lack of professional knowledge about the Covid-19 disease:* Normally as physicians, we have the pillars of our professional knowledge to which we anchor ourselves. Instead this is a pathology that we do not know and this is at the same time formative but extremely challenging (ED physician 4) *Lack of professional knowledge on how to face the Covid-19 disease (unlike other critical events):* When one faces an emergency in his own field, one knows what he is managing, one has studied about it, one has learnt it, so one has the expertise that here *we did not have* (Gastroent 2, interview)
2. Negative epistemic emotions	
Confusion	*Feeling disoriented for the contradictory information about the Covid-19 disease:* In February, one would hear some stories from China, some ideas about guidelines to face the disease but one day one heard A and the following day one heard Z so just a great confusion (Nephrologist 1, interview) *Feeling disoriented for lack of scientific knowledge:* We all felt at loss as we were going to face something for which we did not have any certain scientific data. and this was something completely different from what we normally do (General surgeon 4, interview)
3. Positive moral emotions	
Relief	*Feeling again in control of oneself and the situation:* At the entrance I saw every day the sad faces of my colleagues, the fear in their eyes, the tension, but all of them extremely determined [to do their part], serious, concentrated. I did not hear any moaning (Eye physician 1, podcast) *Feeling reassured (for being useful):* It was good to see that we could do things, that we could solve those practical problems in a short time…We felt, maybe an illusion, more secure (Cardiologist 1)
4. Professional sense of moral duty	
Moral duty to act	*Having as physician the moral duty to act:* As we are all physicians we had to do what was necessary to do! So we just rolled up our sleeves from the very beginning (Cardiovascular surgeon 1, interview) *Feeling the duty to put oneself at the disposal of the community and organization:* I could not call myself out of all what had started to happen. Remaining at home with my kids was possible but I had to provide my contribution, I had to say: "Here am I", that I was present and committed to do something (Orthopedic surgeon 2, interview)
5. Failed attempts to mitigate uncertainty	
Knowledge-based strategies	*Trying unsuccessfully to collect and study any information available about Covid-19 (Phase I):* I would watch on TV those virologists who talked about Covid-19 hoping to understand something certain but they were just pseudo-experts because in reality nobody really knew anything (Nephrologist 2, interview)
6. Physicians' responses: Initiating service-oriented practices	
Collegial work	*Improvising collaborative solutions to common problems to support the hospital:* One of the problems we had at the beginning was that we needed a filter zone between outside and the ward [..] we had to solve the problem fast as we needed to organize the ward. I asked "Why don't we create some form of mobile screen?.", went to the Medical Director, proposed the solution and in one afternoon everything was decided… (Cardiologist 2, interview)
Humanistic work	*Volunteering to take on mundane tasks (for the sake of colleagues and patients):* From the very early days I volunteered to do my own part. There was a need to stand at the entrances and check if physicians displayed any symptom when entering the hospital. […] I went beyond that, talking to people, exchanging some words of encouragement with them instead of just asking the routine questions (Orthopedic surgeon 2, interview)

TABLE 3
Phase II: Main Constructs, Second and First-Order Codes and Additional Quotes

Main Constructs (Second-Order Codes)	**Detailed First-Order Codes and Additional Quotes**
1. Uncertainty generated by the knowledge disruption	
Uncertainty in identifying solutions and forecasting outcomes	*Unpredictable evolution of the disease:* [Covid-19] Patients could display the same starting condition and symptoms but then each his own progression, his own evolution of the diseases and it was unpredictable (Endocrinologist 1, interview) *Unpredictable outcomes of physicians' clinical acts:* Of course, we know how to do intensive care procedures but, in this case, we applied knowledge to a disease we did not know anything about and that was the most disarming aspect: not having the certainty that whatever we were doing could give positive results (ICU physician 3, interview)
2. Negative epistemic emotions	
Hopelessness	*Feeling powerless:* Many times, it felt disheartening as one could not do anything for a patient. At one point we called our ICU colleagues to see if he could be transferred to the ICU and saved. But we were just powerless with respect to their decision and to the evolution of the disease (Gastroenterologist 2, interview) *Feeling disheartened:* We saw many patients all together, with the same problem but being uncertain about therapies and seeing patients arrive, have a first positive response to our intervention but then after two days knowing they had died or were in intensive care put us all in a state of dejection (ED physician 3, interview)
3. Positive moral emotions	
Elevation	*Feeling proud for collective achievement:* It has been an incredible collective effort, a very important lesson for all of us doctors, yet at the same time a huge boost as no one of us at any time had the feeling of being alone. […] We went from the sensation that we could not face a situation bigger than each of us to the feeling that, by teaming up, we could do much more than each individual could do. There is great beauty to all of this! (Cardiovascular surgeon 1, interview) *Feeling admiration for colleagues' dedication:* I am impressed with what my colleagues did, that we did, I don't know "the plastic surgeon", who stopped doing all they were doing before, moved to Covid-19 wards and served there….this impressed me a lot (Hepatic surgeon 2, interview)
4. Professional sense of moral duty	
Moral duty to do good	*Having to fulfill the profession's mission to help others in need:* In working with Covid-19, despite all the despair, I felt clearly the mission of the medical profession to help others and be useful to those in need (ED physician 4, interview) *Having to safeguard patients' health as the utmost priority of a physician:* Each of us had the immediate feeling of being useful to something, that our everyday work [in the Covid-19 wards] served the purpose of making the entire system go ahead and that the system worked in order to lose as few lives as possible (Cardiovascular surgeon 2, interview)
5. Failed attempts to mitigate uncertainty	
Knowledge-based strategies	*Failing to cure by applying solutions derived from protocols and guidelines:* On March 23rd the Italian Society of Infectious Diseases came out with some treatment guidelines and we created a pathway around it but it was useless as we could not solve the respiratory problems of the patients, some behaved one way, others totally different so that standard treatment protocol was ineffective (Cardiologist 3, interview)
6. Physicians' responses: Prioritizing service-oriented practices	
Collegial work	*Creating a climate of peer synergistic relations:* Everybody made the effort to be at the same level, beyond hierarchies, seniority or roles. It was about taking a step back from one's own role and let

	whoever in the unit appeared to know something more, help you and lead you for the sake of the patients (Cardiovascular surgeon 1, interview) *Taking clinical decisions based on a collective experiential logic:* For us the situation was really tough because it [Covid-19] is not our "cup of tea" but in the end unity is strength, we were a fantastic group and the ICU physicians were in the ward every day, more than once a day, and we would evaluate cases in a collegial manner with them and with the pulmonologists. It was a fantastic teamwork, something big for me, a reason to be proud (Nephrologist 3, interview)
Humanistic work	*Seeing the patient as person:* I tried to understand the morale and the feelings of the person behind the patient. Sometimes they could be euphoric and wanted to get rid of the oxygen, other times they were utterly depressed when they discovered they could not even walk two steps (Nephrologist 2, interview) *Removing impersonality and connecting empathically with patients and families:* We gave more to these patients in terms of human relation, in terms of closeness, of what we do normally. We were like their family, their only reference while in the ward. We demonstrated more affection to them (General surgeon 2, interview)

TABLE 4
Phase III: Main Constructs, Second and First-Order Codes and Additional Quotes

Main Constructs (Second-Order Codes)	**Detailed First-Order Codes and Additional Quotes**
1. Uncertainty generated by the knowledge disruption	
Uncertainty in finding solution to the knowledge disruption	*Uncertain effectiveness of known treatments for Covid-19:* Certain clinical evidence that there is a miracle cure, that one of the things we tried can be a cure is not there, we don't have (Heart surgeon 2, interview) *Uncertain capacity of the profession to provide solutions to all the problems:* Now we know that in medicine 100% certain does not exist. We should all be aware of this uncertainty, that it is not sure that we can solve a problem (Heart surgeon 2, interview)
2. Negative epistemic emotions	
Anguish	*Feeling anguished at the idea of going back to care for Covid-19 patients:* None of us wants to go back [to the Covid-19 wards] and see again the nightmare we have witnessed (Nephrologist 2, interview) *Feeling anguished at the idea that physicians cannot solve all problems:* We now feel as physicians much more vulnerable, we thought we were on top of techniques, treatment, research but in reality this virus was able to make us see the sad reality (ED physician 4, interview)
4. Professional sense of moral duty	
Moral duty to do well	*Having the duty to collaborate for the sake of the patient:* The experience with Covid-19 made us realize that we have to look at things together with more collaboration and unity among us physicians (Hepatic surgeon 8, interview) *Having the duty to keep an empathetic and close relationship with patients and relatives:* After spending 30 years of career with a different approach I now [after Covid-19] see things in a different way. Now I see that a close relationship with the patient brings some added value and it cannot be any different (Cardiovascular surgeon 1, interview)
5. Failed attempts to mitigate uncertainty	
Knowledge-based strategies to mitigate uncertainty	*Searching uselessly for some scientific certainty about cure for Covid-19 in research studies:* I read papers and so on…in the end those treatments that we have are not specific for Covid-19 and research is not clear if they work or not (ED physician 10, interview)
6. Physicians' responses: Consolidating service-oriented practices in professional work	

Collegial work	*Consolidating new relationships as professional ties:* Now we are not only friends but also much more collaborative from a professional viewpoint. When I call the colleague, he does not say "Who are you?", he says: "Come over and I'll take care of it". I receive calls from colleagues who ask: "I have a patient that you should be seeing" (Surgical oncologist 2, interview) *Connecting different bodies of specialized knowledge in patient care:* Now I look at the patient in a different way and take into account other aspects that normally pertain to other specialists but that in contact with my colleagues during Covid-19 I have refreshed in my mind. This is now helping me in evaluating better my patients in my daily practice (ICU physician 2)
Humanistic work	*Keeping empathic communication with patients and relatives:* I am now much more empathic with relatives and I try to speak to them more, understanding that it is a moment of difficulty also for them not only for the patient and one has to be able to connect with them (Rheumatologist 1, interview) *Strengthening communication with patients for problem-solving:* In the end a lot can be achieved by communicating with the patient, beyond all the technology and the drugs that a physician can use (Endocrinologist 2, interview)

FIGURE 1
Conceptual Model of Findings: Italian Physicians' Response to the Covid-19 Pandemic in the Workplace

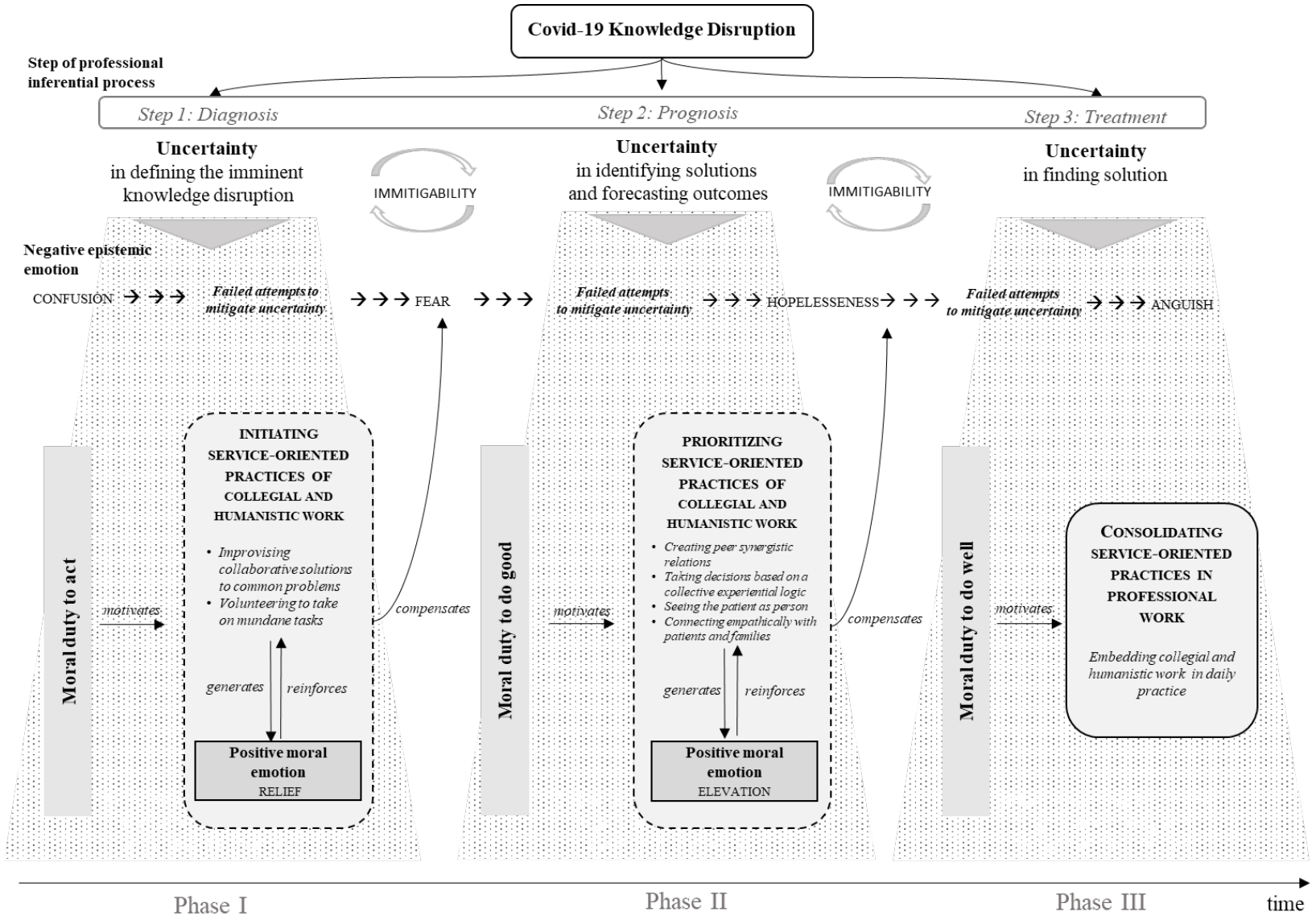
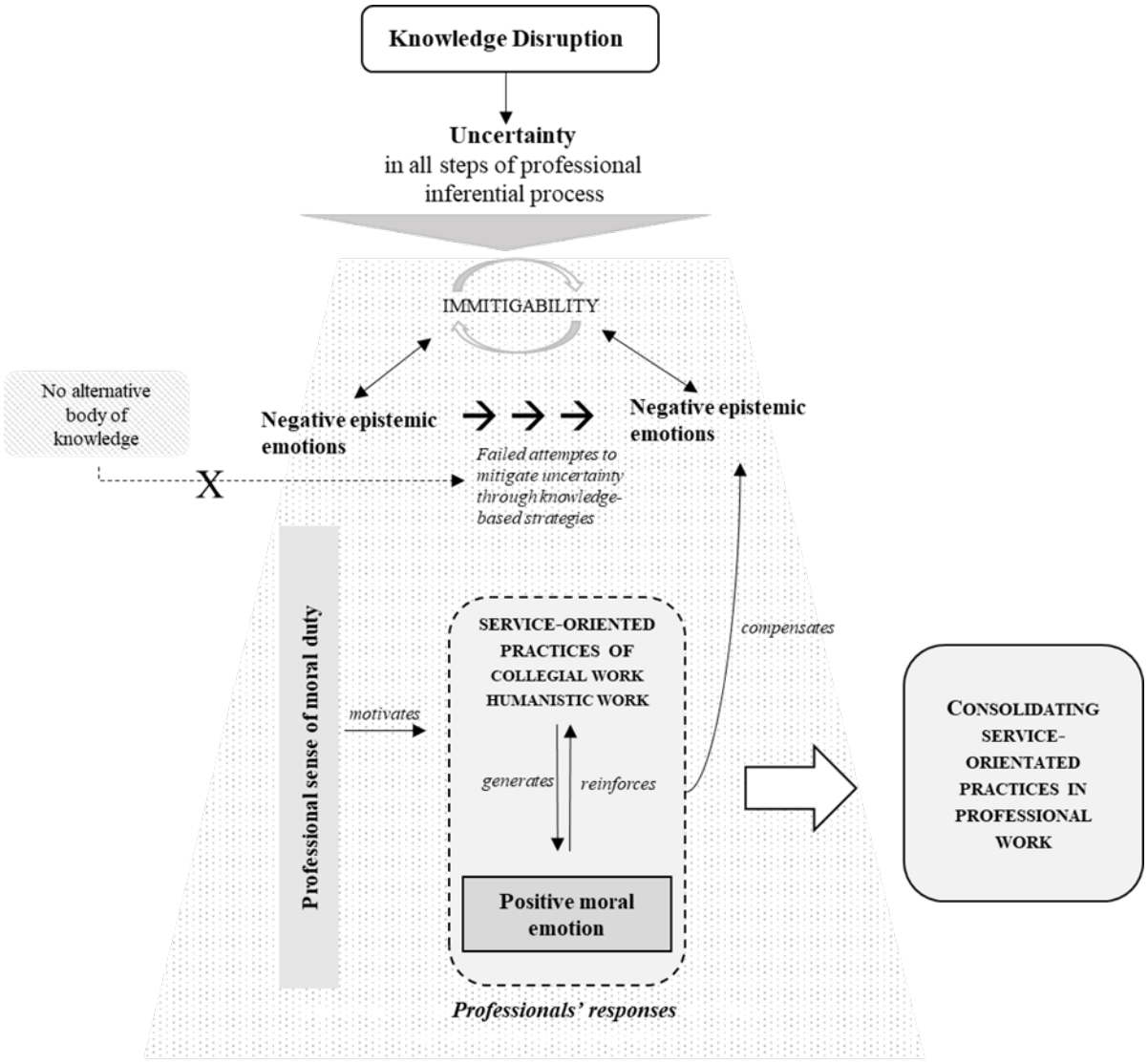


FIGURE 2
Core Model of Professional Response
to a Knowledge Disruption of Unmitigable Uncertainty



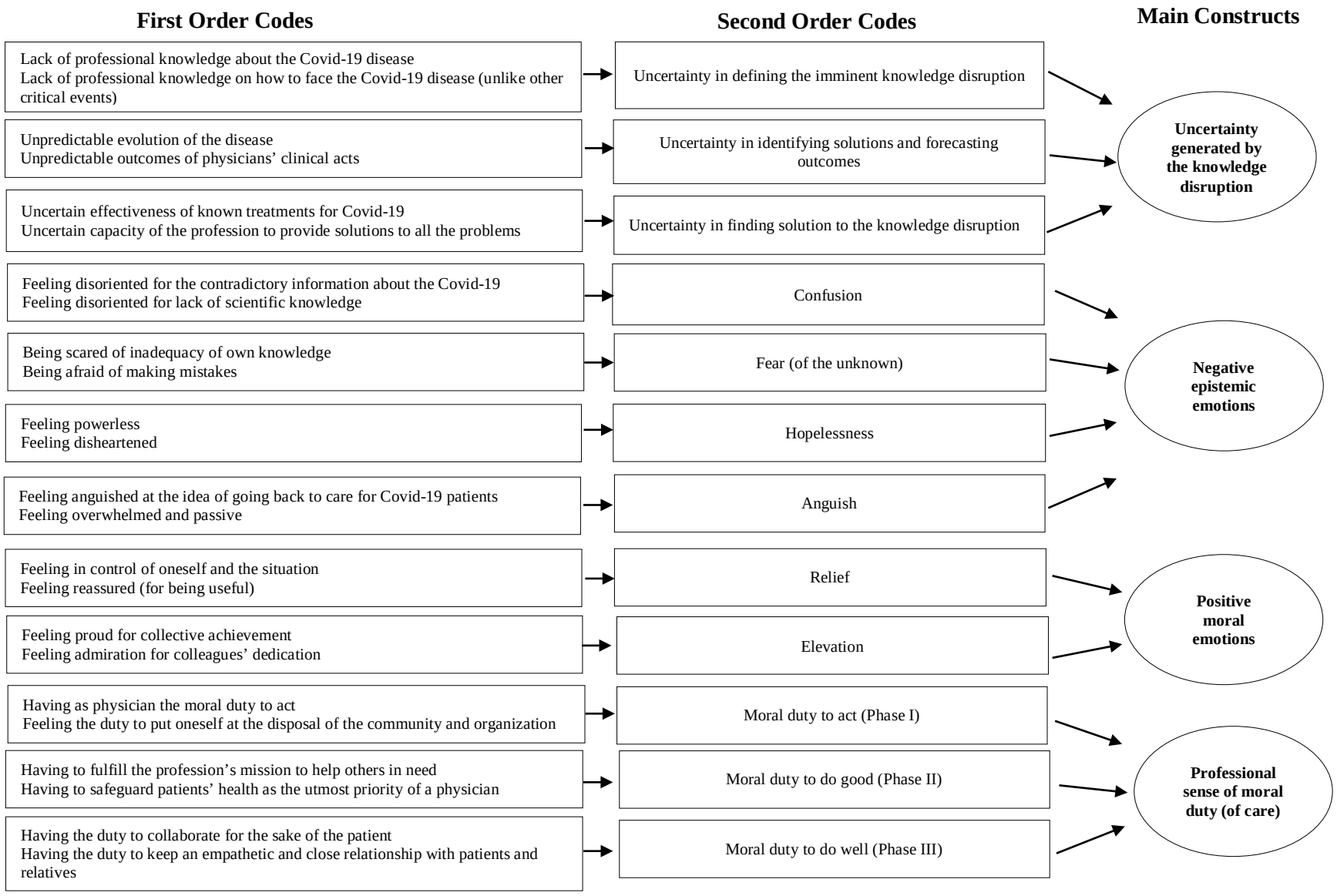
APPENDIX I
Demographics of Informants

ID	Informant's pseudonym	Medical Specialty	Broader Specialty	Gender	Age	Role
1	Cardiologist 1	Cardiovascular Disease	Internal Medicine specialties	F	51	Consultant
2	Cardiologist 2	Cardiovascular Disease	Internal Medicine specialties	F	53	Consultant
3	Cardiologist 3	Cardiovascular Disease	Internal Medicine specialties	M	34	Consultant
4	Cardiovascular surgeon 1	Vascular Surgery	Surgical specialties	F	61	Head of Unit/Department
5	Clinical immunologist 1	Immunology	Internal Medicine specialties	M	43	Consultant
6	Clinical immunologist 2	Immunology	Internal Medicine specialties	F	48	Head of Unit/Department
7	ED physician 1	Emergency Medicine	Emergency and intensive care	M	35	Consultant
8	ED physician 2	Emergency Medicine	Emergency and intensive care	M	53	Head of Unit/Department
9	ED physician 3	Emergency Medicine	Emergency and intensive care	F	39	Consultant
10	ED physician 4	Emergency Medicine	Emergency and intensive care	M	29	Consultant
11	ED physician 5	Emergency Medicine	Emergency and intensive care	M	57	Consultant
12	ED physician 6	Emergency Medicine	Emergency and intensive care	F	45	Consultant
13	ED physician 7	Emergency Medicine	Emergency and intensive care	F	42	Consultant
14	ED physician 8	Emergency Medicine	Emergency and intensive care	F	43	Consultant
15	ED physician 9	Emergency Medicine	Emergency and intensive care	F	36	Consultant
16	ED physician 10	Emergency Medicine	Emergency and intensive care	M	48	Head of Unit/Department
17	Endocrinologist 1	Endocrinology	Internal Medicine specialties	M	39	Consultant
18	Endocrinologist 2	Endocrinology	Internal Medicine specialties	M	51	Head of Unit/Department
19	Endocrinologist 3	Endocrinology	Internal Medicine specialties	M	47	Consultant
20	Endocrinologist 4	Endocrinology	Internal Medicine specialties	M	48	Head of Unit/Department
21	Endoscopist 1	Endoscopy sub-specialty	Internal Medicine specialties	M	47	Head of Unit/Department
22	Endoscopist 2	Endoscopy sub-specialty	Internal Medicine specialties	F	39	Consultant
23	Eye physician 1	Ophthalmology	Internal Medicine specialties	M	49	Consultant
24	Gastroenterologist 1	Gastroenterology	Internal Medicine specialties	F	40	Consultant
25	Gastroenterologist 2	Gastroenterology	Internal Medicine specialties	F	34	Consultant
26	Gastroenterologist 3	Gastroenterology	Internal Medicine specialties	F	52	Consultant
27	Gastroenterologist 4	Gastroenterology	Internal Medicine specialties	F	37	Consultant
28	General surgeon 1	General Surgery	Surgical specialties	F	42	Consultant
29	General surgeon 2	General Surgery	Surgical specialties	M	63	Head of Unit/Department
30	General surgeon 3	General Surgery	Surgical specialties	F	36	Consultant
31	General surgeon 4	General Surgery	Surgical specialties	M	37	Consultant
32	General surgeon 5	General Surgery	Surgical specialties	M	44	Head of Unit/Department
33	Gynecologist	Gynecology	Internal Medicine specialties	M	38	Consultant
34	Heart surgeon 1	Cardiac surgery	Surgical specialties	M	46	Consultant

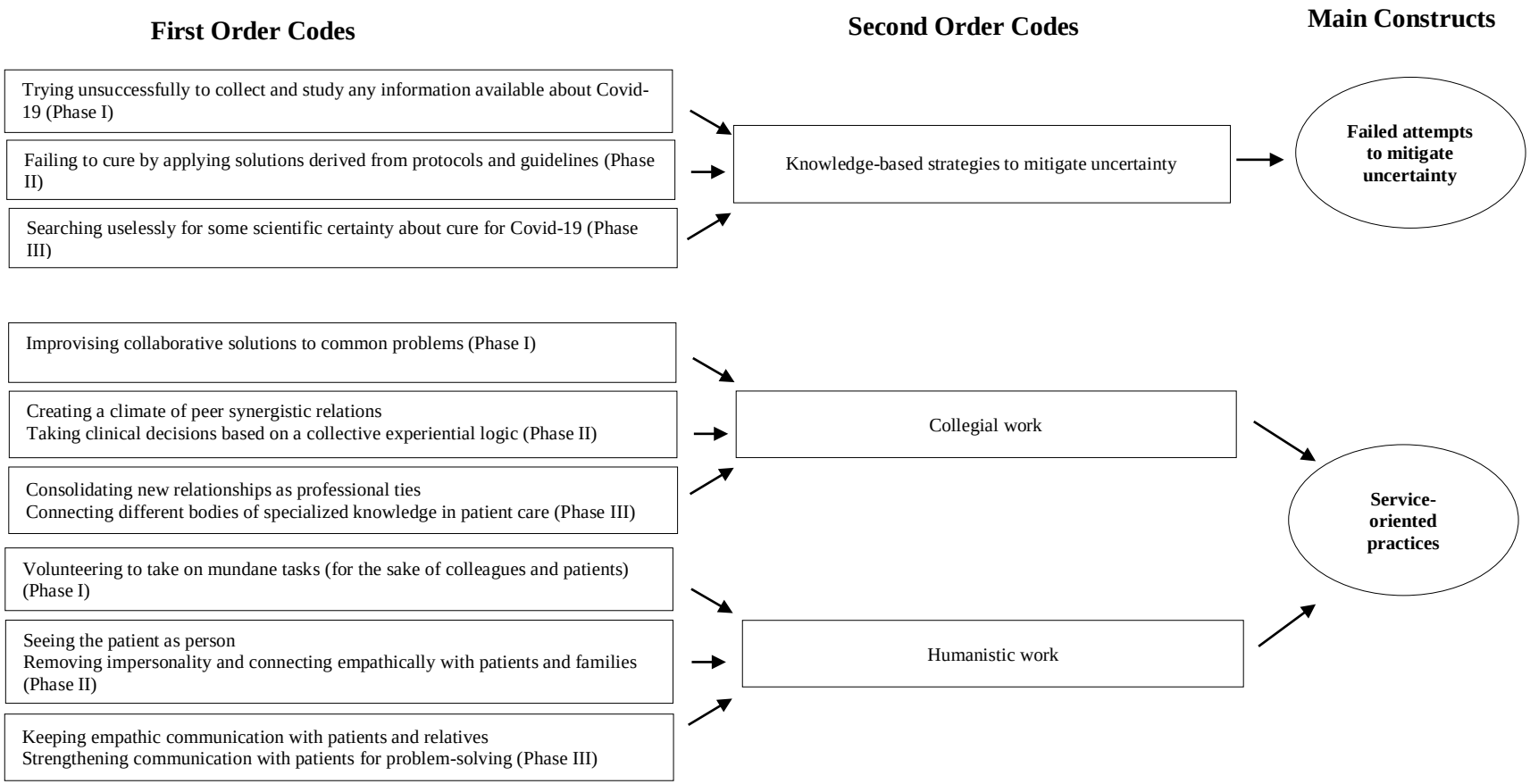
35	Heart surgeon 2	Cardiac surgery	Surgical specialties	M	39	Consultant
36	Heart surgeon 3	Cardiac surgery	Surgical specialties	F	40	Consultant
37	Hepatic surgeon 1	Liver Surgery	Surgical specialties	M	38	Consultant
38	Hepatic surgeon 2	Liver Surgery	Surgical specialties	F	54	Consultant
39	Hepatic surgeon 3	Liver Surgery	Surgical specialties	M	61	Head of Unit/Department
40	Hepatic surgeon 4	Liver Surgery	Surgical specialties	M	37	Consultant
41	Hepatic surgeon 5	Liver Surgery	Surgical specialties	M	32	In training
42	Hepatic surgeon 6	Liver Surgery	Surgical specialties	M	46	Consultant
43	Hepatic surgeon 7	Liver Surgery	Surgical specialties	F	45	Consultant
44	Hepatic surgeon 8	Liver Surgery	Surgical specialties	M	58	Head of Unit/Department
45	Hepatic surgeon 9	Liver Surgery	Surgical specialties	M	43	Consultant
46	Hepatic surgeon 10	Liver Surgery	Surgical specialties	M	40	Consultant
47	Hepatologist 1	Hepatology	Internal Medicine specialties	M	45	Head of Unit/Department
48	Hepatologist 2	Hepatology	Internal Medicine specialties	F	44	Consultant, Professor
49	ICU physician 1	Anesthesiology	Emergency and intensive care	F	43	Consultant
50	ICU physician 2	Anesthesiology	Emergency and intensive care	F	55	Consultant
51	ICU physician 3	Anesthesiology	Emergency and intensive care	M	39	Consultant
52	ICU physician 4	Anesthesiology	Emergency and intensive care	F	42	Consultant
53	ICU physician 5	Anesthesiology	Emergency and intensive care	F	39	Consultant
54	Nephrologist 1	Nephrology	Internal Medicine specialties	M	55	Head of Unit/Department
55	Nephrologist 2	Nephrology	Internal Medicine specialties	F	45	Consultant
56	Nephrologist 3	Nephrology	Internal Medicine specialties	M	62	Head of Unit/Department
57	Oncologist 1	Medical oncology	Internal Medicine specialties	F	37	Consultant
58	Orthopedic surgeon 1	Orthopedic Surgery	Surgical specialties	M	48	Head of Unit/Department
59	Orthopedic surgeon 2	Orthopedic Surgery	Surgical specialties	M	47	Consultant
60	Orthopedic surgeon 3	Orthopedic Surgery	Surgical specialties	M	53	Consultant
61	Pulmonologist 1	Pulmonary Disease	Internal Medicine specialties	M	59	Head of Unit/Department
62	Pulmonologist 2	Pulmonary Disease	Internal Medicine specialties	F	36	Consultant
63	Radiologist 1	Radiology	Internal Medicine specialties	F	42	Consultant
64	Radiologist 2	Radiology	Internal Medicine specialties	M	58	Head of Unit/Department
65	Radiologist 3	Radiology	Internal Medicine specialties	F	48	Head of Unit/Department
66	Radiologist 4	Radiology	Internal Medicine specialties	M	38	Consultant
67	Rheumatologist 1	Rheumatology	Internal Medicine specialties	F	45	Consultant
68	Rheumatologist 2	Rheumatology	Internal Medicine specialties	M	36	Consultant
69	Rheumatologist 3	Rheumatology	Internal Medicine specialties	M	47	Head of Unit/Department
70	Surgical oncologist 1	Surgical Oncology	Surgical specialties	M	38	Consultant
71	Surgical oncologist 2	Surgical Oncology	Surgical specialties	F	34	Consultant
72	Surgical oncologist 3	Surgical Oncology	Surgical specialties	M	34	Consultant

73	Surgical oncologist 4	Surgical Oncology	Surgical specialties	M	51	Consultant
74	Urologist 1	Urology	Internal Medicine specialties	M	38	Consultant
75	Medical Directorate Staff	Medical Directorate	Public Health and Preventive Medicine	F	/	Staff
76	Medical Director	Medical Directorate	Public Health and Preventive Medicine	M	/	Head of unit
77	Head of ISO	Information System Office	Engineering	M	/	Head of unit
78	Head of COO	Chief Operation Office	Engineering	M	/	Head of unit
79	HR Officer	Human Resource Office	Management	F	/	Staff
80	Head of HR	Human Resource Office	Management	M	/	Head of unit
81	General Director	General Directorate	Management	M	/	General Director

APPENDIX II
Data Structure



APPENDIX II
Data Structure (continued)



Amelia Compagni (amelia.compagni@unibocconi.it) is Associate Professor in the Department of Social and Political Sciences, Bocconi University and Director of the Centre for Research on Health and Social Care Management, SDA Bocconi School of Management. She received her PhD from the University of Vienna. Her research interests include organizational and policy change in the public sector, professions and technological innovation.

Giulia Cappellaro (giulia.cappellaro@unibocconi.it) is Assistant Professor in the Department of Social and Political Sciences, Bocconi University, and affiliate of the Centre for Research on Health and Social Care Management, SDA Bocconi, and of the Research Center for Work, Technology and Organization, Emlyon Business School. She received her PhD from the University of Cambridge. Her research examines dynamics of collaboration and change in sectors of public interest, with a specific focus on professional work and innovation.

Amit Nigam (amit.nigam.1@city.ac.uk) is Professor of Management and Head of Faculty of Management at Bayes Business School at City, University of London. He received his PhD at Northwestern University. His research examines processes of organizational and institutional change, career-related processes by which new professions emerge, mostly in healthcare settings.