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Conceptualizing the digitalization of healthcare work: A metaphor-based Critical Interpretive Synthesis

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ABSTRACT

The digitalization of healthcare work has gained center stage in academic debates spanning disciplines as diverse as medicine, sociology and STS. The different analytical interests and methodological traditions of these three strains of scholarship have, however, resulted in quite diverging approaches to this issue. Points of interest have ranged from the (disattended) promise of increased efficiency of healthcare work, to dynamics of task delegation, (re-)professionalization and (re-)distribution of invisible work, to the disruption of informal organization. Instead of studying these dynamics in practice, in this paper we foreground the potentiality for theory-making inherent in the systematic cross-contamination of different theoretical and disciplinary perspectives. We perform a Critical Interpretive Synthesis (CIS) centering the ways the digitalization of healthcare work has been investigated in recent STS, sociological and medical literature. To open up assumptions and insights intrinsic to each body of literature for scholars and practitioners in other fields, we propose here a metaphor-based variation on CIS approaches. We probe, in turn, what slime molds can teach us about STS's focus on interconnections and materiality, how we can better understand sociological analyses of invisible work exploring them through theatrical performances, and which lessons river engineering offers concerning medical scholarship's discussion of efficiency and proper healthcare work. Thinking through these metaphors, we conceptualize the digitalization of healthcare work as a phenomenon spanning, at once, the directionality of technological innovation trajectories and the open-endedness of situated changes in work practices. Based on our analysis, we propose focusing on technological scripts, and various forms of invisible work and informal organization as entry points into the study of the tension between directionality and open-endedness in the context of the digitalization of healthcare work.

1. Introduction

Digitalization, 'the simultaneous collection, analysis, and manipulation of digital data in real-time,' (Trittin-Ulbrich et al., 2020, p. 10), has been discussed in the last few years as the inevitable and promising future of healthcare. This conviction spans medical literature (Blease et al., 2019; Bourla et al., 2018; Smith Glasgow et al., 2018), consultancy reports (EIT Health and EIT Health and McKinsey and Company, 2020; Topol Review, 2019), as well as national and international governance strategies (Hoeyer and Wadmann, 2020). The coupling of digital technologies and healthcare is posited as benefitting healthcare systems through increased efficiency, improved access, better allocation of scarce economic and human resources, and more resilience in the face of emerging demographic challenges (Andreassen et al., 2018; Greenhalgh et al., 2019; May et al., 2001; Stevens et al., 2018). Especially in the medical literature, however, there is a general recognition that many of these promises have so far failed to materialize. Although many digital technologies have entered the market, issues such as nonuse, resistance and workarounds continue to plague their embedding in the healthcare work practices (Callen et al., 2006; Li et al., 2019). Recently, the NHS-commissioned Topol Review (2019) has identified the broad category of digital healthcare technologies, spanning genomics (genome reading and genome editing), digital medicine (ranging from telemedicine to VR), AI (from natural language processing to predictive analytics), and robotics, as potentially bearing the greatest impact for the practices of the healthcare workforce.

Building on this, it is our assumption here that issues pivoting on embedding of new technologies in work practices are not simply a

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question of individual unwillingness to engage with innovation, but have to do with the ongoing reconfiguration of the healthcare workforce spurred by digital healthcare technologies. Previous work building on the sociology of profession testifies to the far-ranging implications that technological innovation bears for work-related dynamics (De Bont et al., 2016; Meyer and Paré, 2018; Zetka, 2001). This urges us to move away from individualized solutions centering improved education of and communication with the healthcare workforce, often proposed in the medical literature (Schuster et al., 2018; Smith Glasgow et al., 2018), and to take tensions and workarounds seriously.

In what follows we look at the digitalization of the healthcare field in its professional and organizational dimensions. Dynamics of technologically-driven professional change have been analyzed across many academic disciplines, yielding varying conceptual approaches and empirical findings. Yet, despite the apparent diversity, it is our contention here that different approaches and findings can be reconciled into a nuanced but coherent framework. We thus conduct a Critical Interpretive Synthesis (CIS; Dixon-Woods et al., 2006) bringing together theorizations and insights from (medical) sociology, (digital) medicine and Science and Technology Studies (STS). Our main research question is: How have the implications of digital technologies for healthcare professionals and organizations been conceptualized and described in the medicine, sociology, and STS literature, and what lessons can we learn by bringing together these insights? If sociology can offer insights into the professional dynamics of digitalization and the medical literature grants us access to emic conceptualizations and first-hand experiences of working in digitalized healthcare, the STS literature provides us with valuable tools to foreground the specific role of technologies in this sociotechnical transformation. As we discuss below, the CIS methodology enables us to foster conceptual and empirical cross-pollinations between different academic fields.

2. Methodology

Formalized by Dixon-Woods et al. (2006), Critical Interpretive Synthesis (CIS) is a review methodology geared towards theory production. Unlike aggregative syntheses, CIS looks at the literature not so much as a source of data, but rather as a repository of concepts. This allows to bring together studies rooted in different disciplinary and methodological traditions (Flemming, 2009) – which, in turn, makes it possible to establish "cross-disciplinary knowledge translation[s]" (Abrishami et al., 2017, p. 14). CIS's focus on theory-making translates into quality appraisal criteria that center the relevance and insightfulness of the concepts produced by the literature examined, rather than its methodological rigor (Dixon-Woods et al., 2006; Flemming, 2009). The 'critical' part of CIS is thus directed to problematizing the way issues are framed in the literature, and the assumptions underpinning this framing (Dixon-Woods et al., 2006), with the overarching goal of generating new ways of looking at the issue at hand, and new possibilities for tackling it (Abrishami et al., 2017).

CIS enabled us to synthetize insights from medicine, sociology and STS – bodies of literature rooted in different methodological and epistemological traditions, but that have demonstrated a keen interest in the question of the digitalization of healthcare work.

2.1. Literature search

We conducted our literature search among articles published after 2000 in the top 10 journals for each field considered. To identify the relevant journals, we relied on the 2018 Impact Factor ranking, as listed on Web of Science's *Journal Citation Report*. We added to it thematic journals of particular interest, such as journals focusing on medical sociology, critical data studies, or digital medicine (cf. Table 1 and supplementary file 1). Two of the included journals, *Digital Health* and *Social Science & Medicine*, despite consistently publishing STS research, were intrinsically interdisciplinary, and thus did not fit easily within disciplinary boundaries. For these journals, we categorized articles on a case-by-case basis, based on how author(s) framed each article (for more details, cf. supplementary file 1).

Table 1
Selected journals per discipline (* indicates interdisciplinary journals).

Selected STS journals	Selected sociology journals	Selected medicine journal
1. Science, Technology & Human Values; 2. Social Science & Medicine*; 3. BioSocieties; 4. Social Studies of Science; 5. Technology in Society; 6. Science as Culture; 7. Big Data & Society; 8. AI & Society; 9. Philosophy & Technology; 10. Digital Health*.	1. Sociology: The Journal of the British Sociological Association; 2. Sociology of Health & Illness; 3. Journal of Health and Social Behavior; 4. Social Theory & Health. 5. Information and Organization; 6. New Technology, Work & Employment; 7. Organization Science; 8. Work and Occupations; 9. Work, Employment & Society; 10. Gender, Work & Organization.	1. JAMA – Journal of the American Medical Association; 2. BMJ – British Medical Journal; 3. Annals of Internal Medicine; 4. PLOS Medicine; 5. BMC Medicine; 6. Mayo Clinic Proceedings; 7. Journal of Medical Internet Research 8. The Lancet Digital Health; 9. Journal of Healthcare Informatics Research; 10. Journal of the American Medical Informatics Association.

Our search strategy, which combined manual and database searches, is described in detail in our protocol (cf. supplementary file 1). We first selected articles based on their title, and determined further inclusion based on the criteria listed in box 1.

Our search retrieved a total of 126 articles. For 27 of these, the application of the specified criteria was not uncontroversial. These cases were discussed jointly by the first two authors until consensus was reached. As a result, 18 of these articles were excluded, bringing the total number of included articles for the three disciplines to 108 (Figs. 1–3).

2.2. Data analysis

CIS builds on an abductive approach (Timmermans and Tavory, 2012), which entailed progressively refining our "tentative, fuzzy and contested" review question through the encounter with the literature (Dixon-Woods et al., 2006).

Our aim was to create a multidisciplinary conceptual framework to articulate and investigate the digitalization of healthcare work. Based on our review question, and on a sample of 15 articles (5 per discipline, selected based on the relevance of their title and abstract), the first two authors jointly defined some preliminary variables for the analysis. Like the review question, these variables were also abductively refined as the literature was coded (Table 2) (see Table 3).

We generated 33 codes for sociology, 31 for STS, and 32 for medicine. Most of these codes overlapped somewhat across disciplines, and fitted into the previously specified variables. As detailed in Table 2, after several rounds of consultation between the first two authors, we decided to split the variables 'What are the consequences for professionals?' into several sub-variables traced along different axes of professional work: nature of work, social relations with patients, social relations with other professionals, and emotional and psychological implications. This process allowed us to both obtain further analytical sophistication, and to do justice to previously unexpected points of interest consistently present in the literature. The following step in the CIS method required us to generate synthetic constructs that would interpret empirical evidence and transform it "into a new conceptual form" (Dixon-Woods et al., 2006). Since our final aim was to bring three different disciplinary fields into conversation with one another, synthetic constructs needed to select and tie together the main themes in of each corpus, while also

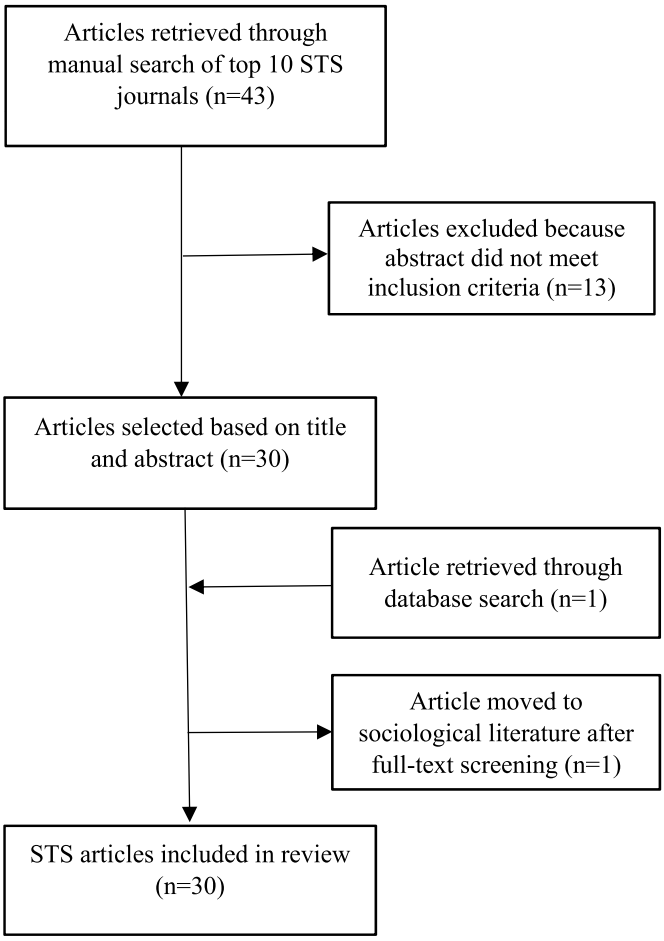

Fig. 1. Selection flow chart for STS.

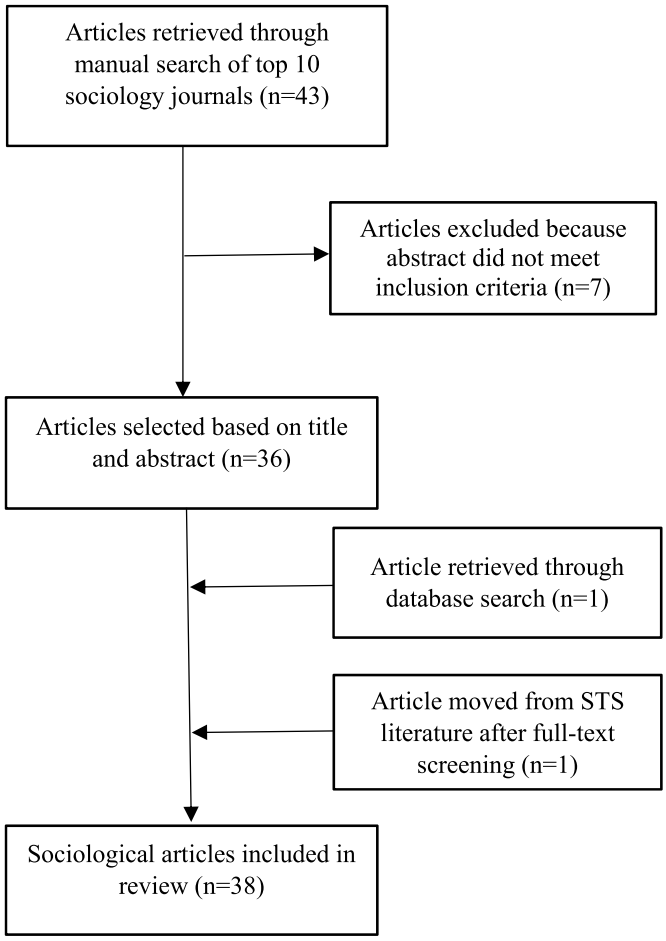

Fig. 2. Selection flow chart for sociology.

articulating their assumptions and main insights.

We tackled this challenge by creating metaphors. Lakoff & Johnson's (1980) cognitive theory of metaphors shows how metaphors provide concrete, familiar, and often embodied signifiers enabling to understand abstract concepts. The creation of cognitive metaphors is thus integral parts of social processes, and scholars have analyzed the ethico-political performativity of metaphor creation and, especially, naturalization (Felt, 2014; Puschmann and Burgess, 2014; Wyatt, 2021). Albeit less conscious and recognizable than poetic metaphors, cognitive metaphors also suggest specific visions and emphasize certain aspects of reality, while hiding others (Lakoff and Johnson, 1980). This non-innocence warrants scrutiny of technology metaphors in particular (Wyatt, 2004): metaphors hide certain aspects of technologies and naturalize others. Building on this, Wyatt (2021) has recently urged critical scholars to not only deconstruct 'metaphors of the powerful,' but to engage themselves in the 'careful and imaginative' (p. 406) production of new ones.

Our endeavor partially responds to her plea. The metaphors we selected build on often implicit and naturalized metaphors already circulating in each field. So, for instance, mobilizing slime molds enables us to explore the ever-emerging networks central to STS, while theatrical performances articulate the tension between visible and invisible, formal and informal stages that runs across sociological articles. Finally, river engineering allows us to focus on the assumptions and consequences of the concept of workflow – a metaphor as omnipresent in medicine as it is under-problematized. This abductive exercise in metaphor creation thus enables systematizing and making explicit metaphors (at least partially) present in each field's predominant conceptualizations. Metaphors let us foreground tensions, assumptions and insights inherent in each field's conceptualization, thus moving beyond particular cases and bringing the contribution of a specific body of literature to a more abstract yet operationalizable plane. Moreover, the fact that our metaphors build on implicit ones already mobilized, and sometimes naturalized, in each of the disciplines we analyzed, ensures that our choice of metaphors is not an arbitrary one. Although we do not aim here to produce metaphors to reimagine technological futures, as Wyatt (2021) calls for, the metaphors we propose, in their describing prevalent conceptualizations in different strands of literature, can hopefully be productive in stimulating scholars' engagement in reflexive metaphor creation.

3. Results

In this section, we describe the main themes emerging from each body of literature analyzed. As summarized in Table 2, we focus on the two variables "How is the relationship between the technology and professionals conceptualized" and "Which implications are described?" (with its sub-variables). Combined, these two variables provide insights into the ways each corpus conceptualizes and describes the digitalization of healthcare work. Even within a single discipline, however, analytical foci and empirical findings often differ greatly, as summarized in Table 3. To facilitate our synthesis, we mobilize three metaphors, one for each discipline. We think of these metaphors as focusing tools, pointing our attention to specific contributions of each body of literature and materializing connections amongst the most prevalent themes within it. Thinking through metaphors enables us to articulate assumptions and practical implications emerging from each body of literature.

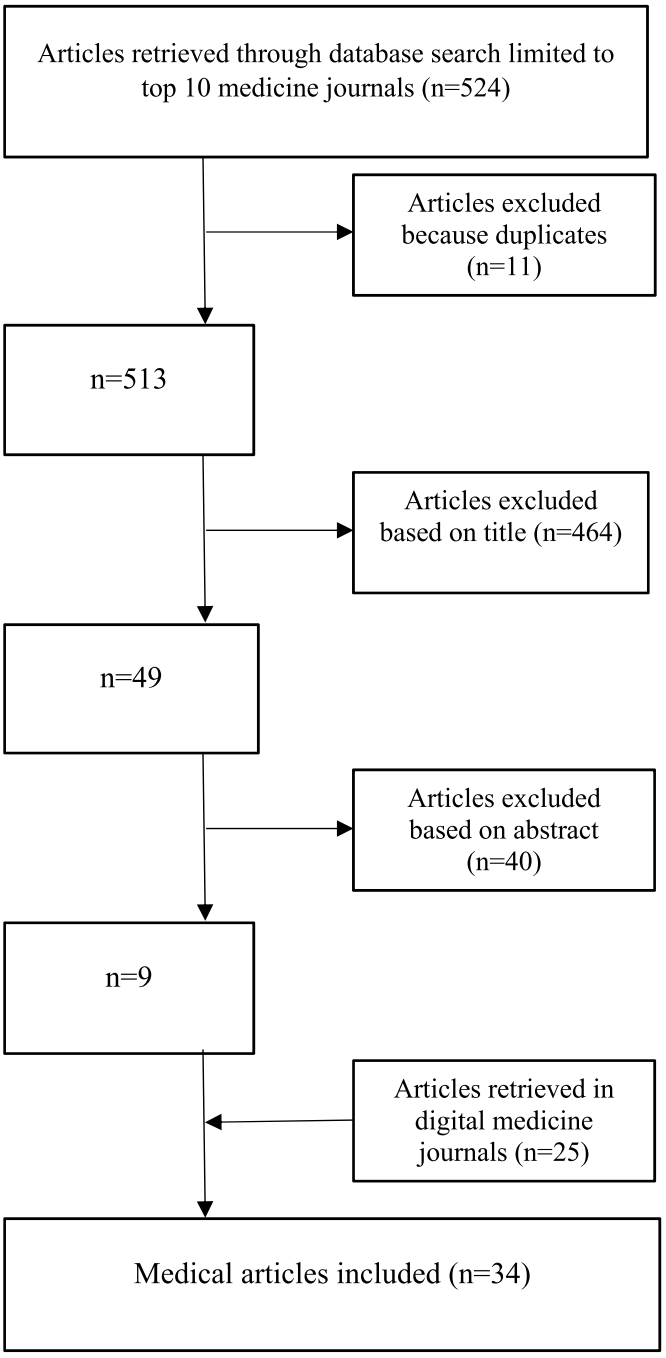

Fig. 3. Selection flow chart for medicine.

Table 2
Overview of variables.

Variables	How were they obtained?
• Which technology is considered? • Which professionals are considered? • In which country is the analysis conducted? • How is the relationship between the technology and professionals conceptualized?	Deduced from review question and literature sample

• Which implications are described?
  • Implications for individual professionals (nature of work/practices);
  • Interprofessional implications;
  • Implications for patient-provider relationship;
  • Emotional implications;
  • Tradeoffs.
	Specified through coding the literature

Table 3
Themes and metaphors per body of literature.

	STS	Sociology	Medicine
Conceptualizing the digitalization of healthcare work	**Network**: the way a specific technology is embedded in professional practices is predicated on a process of negotiation at the intersection between several human and nonhuman actors; **Materiality**: the material characteristics of the technology steer the process of negotiation and the shape the network assumes.	**Technology-in-practice**: embedding of digital healthcare technologies in everyday professional work is an open empirical question; **Steered innovation**: digital healthcare technologies align in their functioning and requirements with managerial objectives imposed top-down.	**Disattended promises**: digital healthcare technologies have the potential to make healthcare work more efficient and meaningful, but often fail to deliver in practice; **Good design**: to deliver on their promises, technologies' design must fit with existing practices and meet professionals' needs.
Implications for individual professionals (nature of work/ practices)	**Multiple and unpredictable**: the introduction of new digital healthcare technologies opens up possibilities for multiple reconfigurations; **Aligned**: ex-post, implications observed point towards an increased reliance on quantification and connected changes in the diagnostic process.	**Uneven**: different professional groups experience different implications, depending on the extent to which they are involved in innovation projects and their professional identities are embedded in technologies.	**Rationalization**: digital healthcare technologies simplify workflows, make it easier to access information, can decrease error rates and alleviate documentation burden; **Desktop medicine**: digital healthcare technologies increase computer-based clerical work, working hours, and non-meaningful tasks.
Implications for patient-provider relationship	**Invisible work**: digital healthcare technologies enable more frequent communication, but they also require extra invisible work from professionals; **Task delegation**: technologies make possible to delegate to patients tasks formerly performed by professionals.	**Invisible work**: digital healthcare technologies create invisible work of explaining, reassuring, reminding, (re) establishing rapport with patients.	**Erosion of physician's authority**: digital healthcare technologies try to involve patients more actively in their care trajectories; this can make patients more inquisitive and hinder communication; **Invisible work**: physicians need to engage in extra sensory and emotion work.
Interprofessional implications	**Boundary renegotiation**: professional boundaries shift when new digital healthcare technologies are embedded in a network; this can lead to tensions and mobilization of professional identities; **Communication**: quantitative information is more	**Hierarchy and task allocation**: traditional hierarchies can be inscribed in technologies; however, visibility encourages clearer task division and redistribution of invisible work; **Communication**: interprofessional information transfer is simplified and structured, but	**(Proposed) task delegation**: when digital healthcare technologies create extra work for physicians, some menial tasks can be delegated to other professionals.

(*continued on next page*)

Table 3 (*continued*)

	STS	Sociology	Medicine
	easily exchanged between professionals across space and time.	contextual information is lost or must be supplemented informally.	
Emotional implications	**Emotion work in the patient-provider relationship**: establishing rapport with patients takes extra emotion work.	**Distance and closeness in patient-provider relationship**: more emotion work is required to establish rapport with patients; easier to maintain emotional distance from patients.	**Burnout**: menial tasks take time away from the meaningful work of patient care, increasing exhaustion and likelihood of burnout.
Tradeoffs of technological innovation	**Patient-provider information transfer**: qualitative and contextual information is not easily transferred and recorded in patient-provider interactions, and risks being lost.	**Interprofessional information transfer**: contextual, uncertain and subjective information is lost in interprofessional communication, or must be integrated informally; **Professional judgement**: technologies constrain the conditions under which professional judgements are formulated, resulting in less embodied, long-term and idiosyncratic knowledge of patients.	**Time and meaning**: menial tasks are crucial for digital healthcare technologies to function, but they take time and make healthcare work less meaningful.
Key metaphor	**Slime mold**: focus on open-ended exploration, information exchange and interconnections.	**Theatrical performances**: focus on the importance of unseen spaces and interactions in enabling performance.	**River engineering**: focus on directionality and unintended consequences of forceful changes.
Main insight from metaphor	Networks can be steered; their final configuration is not predictable, but interconnections are vital in ensuring an optimal one.	Digital healthcare technologies do not guarantee positive change in healthcare work; invisible work is always necessary for coordination and information flow.	Goal-setting and visions are crucial in driving change in healthcare organizations, but they can backfire when imposed forcefully.

3.1. Thinking like a network: how slime mold helps us bring together the STS literature

Building on the prevalence of network thinking in STS analyses and its importance in tying together the main themes, we propose slime mold as synthetic metaphor. Slime mold (*Physarum Polycephalum*) is a peculiar organism: a single, giant cell comprising many nuclei that share the same cell walls. Thanks to this, information (in the form of a not-yet-quite-specified signaling molecule) can flow across its organism, carried by rhythmic peristaltic movements (Pringle, 2019). These movements, and the information exchange they enable, allow *Physarum* to exhibit a behavior that has been described as 'learning,' 'remembering,' 'solving problems,' 'making decisions,' despite its lack of a central nervous system (Jabr, 2012).

Slime mold is intelligent not because of the presence of a brain, but because of a constant, distributed flow of information across the interconnected parts of its body. It is able to explore its surroundings by sending out its tendrils to explore its habitat, sensing resource-rich patches, or porridge oats positioned by scientists. It "explores territories in multiple directions simultaneously" (Barnett, 2014), covering surfaces in complex interconnected patterns. Once it finds food, it rearranges its body into the configuration that allows it to "optimally eat and reproduce" (Pringle, 2019) by retracting all but the shortest tendril connecting its body to the food. Slime mold 'works' because it is a network. And slime mold is a network that works. As such, it is uniquely positioned to help us explore the STS literature. In what follows, we explore how this metaphor enables us to synthetize the diverse insights of the STS literature, uncover their assumptions and articulate their implications. We argue that slime mold teaches us to think like a network: to focus our attention on interconnections and their temporariness, to stay open to reconfigurations, to not consider unpredictability a problem in itself.

3.1.1. Conceptualizations: networks and materiality

The STS literature mostly considers digital healthcare technologies in their process of becoming part of a network of human and nonhuman actors. The networks STS postulates are "a densely interconnected assemblage of actors, actions, and relationships" spanning "users, other technologies, rules and regulations, institutions, and a variety of other heterogeneous elements …" (Nicolini, 2006, p. 2756; cf. also Pols, 2011; Winthereik et al., 2007). Like slime mold, which is itself a living network incorporating particles of different origin, STS networks are pulsating, constantly integrating new elements. *Physarum*'s relationship to the surrounding environment is also a good signifier for the exploratory nature of the network-making described in the STS literature. Within the networks that STS postulates, agency is diffused among humans and nonhumans, and materializes in mutual negotiations between technologies and human actors. Similarly, each extremity of a slime mold is endowed with agency, tinkers with the environment (surfaces, food, other parts of the slime mold) and creates new connections.

Not unlike slime molds behavior, network-making in STS is also an exploratory endeavor, proceeding in multiple directions: through tinkering, human actors try out different ways of integrating new technologies within pre-existing practices (Danesi et al., 2020, p. 18). The outcome of this tinkering is hard to predict, and networks are always open to reconfigurations (Greenhalgh and Stones, 2010) – just like slime molds reconfigures its body if a patch is depleted of resources, or if new food is introduced in their environment. Nonetheless, not just *any* reconfiguration is possible: the semiotic-material aspects of technology are crucial. STS concepts such as technological scripts (Danesi et al., 2020; Galetsi et al., 2019; Greenhalgh and Stones, 2010; Nicolini, 2006; Oudshoorn, 2011; Winthereik et al., 2007) and affordances (Abrishami et al., 2014; Trondsen et al., 2018), emphasize how technologies embody values and visions for practice, and how their material and symbolic properties prescribe specific uses and users (Spatar et al., 2019).

If tinkering happens within pre-designed boundaries (Danesi et al., 2020; Pols, 2011; Trondsen et al., 2018), its results are an open-ended, empirical question:

> … the patterns of use inscribed in the artifact by the designers only come to life in the context of the daily activity of the users. When put to work, the concrete anticipations and restrictions of future patterns of use embodied in the technological artifact interact in complex ways with the existing work practices of the users. The result is a process of negotiation between the innovation and the work activity. The outcome of such negotiation determines, on the one hand, how the innovation is used "in practice"; at the same time, it produces some kind of change in the work practice, usually along lines which

reflect (to some extent) the desires and intentions of the designers and their sponsor (Nicolini, 2006, p. 2757).

Changing work practices through the introduction of technology is thus anything but a straightforward process with a certain, foreseeable outcome: it depends on a process of negotiation in which multiple actors are involved. However, concepts such as technological scripts and affordances teach us that technology can be a powerful way to steer the growth of a network. Likewise, slime mold does not grow just anywhere: it looks for resource-rich patches in its environments. As bioartists explain, when working with *Physarum*, steering can only be a partial accomplishment. A network's behavior can be guessed, but not controlled: 'the slime mold has the final say in the creative process' (Barnett, 2014).

3.1.2. Which implications are described?

3.1.2.1. Clashing implications for practice. The STS literature does not describe the implications of digital healthcare technologies as coherent and unidirectional. Although it is acknowledged that the introduction of new technologies inevitably entails a change in professionals' (and patients') practices, technologies are mostly observed to open a range of (potentially contradictory) possibilities for change. All sorts of implications are described, to the extent that synthesizing them in a coherent narrative is acknowledged as problematic: as Petrakaki and colleagues sum up, (2012), 'possibilities are endless' (p. 436).

Thinking through slime mold, however, we can come to embrace unpredictability and situated tinkering. Not unlike STS, slime molds also point our attention towards distributed agency. In the case of slime mold, agency is about direction. *Physarum* is *Polycephalum*, has many heads and each of them moves simultaneously in a different direction. Each head is responsible for optimally interacting with the environment. In STS terms, they do their own, independent yet interconnected, form of tinkering. Slime mold begs us to shift our attention from the final shape of the network to the ongoing dynamic of network-making. Slime mold can continue its work of exploration as long as information can circulate through its body. And for that flow to happen, interconnections between different parts of the body are crucial.

Though avoiding deterministic stances, STS literature acknowledges that digital healthcare technologies steer healthcare practices in a specific direction. Analyses often point to an increased reliance on quantitative data in the diagnostic and treatment process, and the (potential) loss of qualitative information (Mort et al., 2003; Reich, 2012).

3.1.2.2. Patient-provider relationships: invisible work and delegation. Invisible work is required for individual professionals to accommodate technologies into their daily practices, especially in patient-provider interactions. This kind of work, necessary but unacknowledged by organizations, is mostly relational, geared towards explaining technologies to patients and reassuring them of their abilities to operate them and making the interaction with patients smoother in spite of interruptions caused by the technology (Mort et al., 2003; Nicolini, 2006). Invisible work made necessary by the limitations of a technologically-mediated patient-provider interaction also spans "sensory work" (Maslen, 2017) – the exploratory work necessary for professionals to find ways to sense through technological sensors, to integrate their measurements into their diagnostic process, and to establish rapport with patients, technological mediation notwithstanding.

Digital healthcare technologies are often discussed as facilitating patient-provider communication overcoming limitations associated with geographical distances (Nicolini, 2006; Pols, 2011; Trondsen et al., 2018). However, making things possible is not the same as making things work. STS literature points us towards the fact that not geographical, but also "relational distance" should be considered crucial in patient-provider relationships. Technologies like telemedicine magnify the relational distance already existent between patients and providers: they work in relationships in which trust has been established, but "add to the strangeness or indifference experienced" (Pols, 2011, p. 466) when they connect strangers.

When human interconnections are mediated by technology, they need to be reestablished at both the communication and the sensorial level. Likewise, making stable connections takes work on the part of the slime mold: its body is stretched out, then retracted, severing the interconnections that do not 'fit.' This is where invisible work emerges in the STS literature: when old relationships are replaced by new, complex and unstable ones, actors in the network (especially professionals) need to go to extra lengths in order to make the new connections 'work.'

3.1.2.3. Interprofessional relationships: boundary renegotiation. When it comes to interprofessional relationships, STS literature generally acknowledges that digital healthcare technologies lead to a renegotiation of professional boundaries. Pre-existing professional roles can be expanded and take up new tasks (Burri, 2008; Danesi et al., 2020; Winthereik et al., 2007), new roles can emerge (Galetsi et al., 2019), and tasks and responsibilities can be delegated to other professionals (Burri, 2008; Maslen, 2017; Mort et al., 2003). These negotiations can lead to tensions between professional groups, that react by mobilizing their professional identities (Burri, 2008; Greenhalgh and Stones, 2010).

Digital healthcare technologies (especially EHRs and telemedicine) are also acknowledged to facilitate interprofessional communication across space and time. They enable more frequent, more structured and faster exchanges of information among professionals, and for the creation of larger, geographically dispersed networks (Lehoux et al., 2008; Nicolini, 2006). However, not all information travels easily among professionals. Particularly in the absence of relationships of trust among professionals, whereas quantitative information (measurements, images) is trusted, qualitative information (e.g., opinions, speculations, patient histories) is easily dismissed (Greenhalgh and Stones, 2010). Technologies mediating interprofessional communication thus often fail to contextualize quantitative information: they 'take the histories out of patients,' but that qualitative 'knowledge about patients (their psychosocial states, anxieties, worries, and fears; their family circumstances, and so forth) has to be rebuilt later' through 'a patchwork of other kinds of activities and materials, such as reassurance, explanation, history taking, intuitive investigation, skin and blood samples' (Mort et al., 2003, p. 285). This exemplifies the sort of invisible work required to make technologies work in the interactions with other professionals.

3.1.2.4. Tradeoffs of technological innovation. The way slime mold retracts its body when new interconnections have been forged is a good visualization of the implicit but virtually omnipresent assumption in the STS literature that, when there is a reconfiguration of the network, something is bound to be lost. In the context of the provider-patient relationship, loss is about qualitative information about the patient, the recording of which clashes with the scripts embedded in some digital healthcare technologies. A similar loss of information, this time sensory and non-verbal, stems from the technical limitation of some technologies that mediate the diagnostic process. In the context of technologically-mediated interprofessional communication, qualitative and non-measurable information is also likely to be lost or disregarded, especially in the absence of a pre-existing relationship of trust among professionals. Interprofessional relationships themselves are threatened, in a context in which in-person communication is made unnecessary by technology. In most cases, (possible) loss is seen to directly threaten the diagnostic process and the possibility of providing care – and to require invisible work on the part of professionals.

3.1.3. Main insights

Slime mold's behavior teaches several things about the way the STS literature looks at the digitalization of healthcare work. Firstly, we learn

how expanding networks is an exploratory endeavor, hard to control or to predict, in which individuals tinker with the environment and its resources, with technologies and their affordances, trying out different possibilities. Far from grand narratives of technologically-afforded innovation, it is through this work of exploration, adaptation, incorporation, and potential establishing of new interconnections that change happens. This is a major insight afforded both by slime mold and STS analyses: changes in healthcare practices cannot be centrally planned, little control can be exerted over the implications that technological innovation has for practices and practitioners. One can work *with* slime mold and its daily, mundane negotiations, not *on* it.

Secondly, this metaphor encourages us to focus on the interplay between pre-existing relationships and the materiality of newly introduced technologies. Slime molds live in a state of constant negotiation with the surrounding environment: they explore several, often opposite, possibilities for connections at once. But not just any connection is possible: although specific interconnections cannot be planned, slime mold can be steered to grow in a certain direction. This is acknowledged in the STS literature: the material-semiotic properties of a specific technology can, at least, encourage specific reconfigurations. Some interconnections can be discouraged, or radically changed. Materiality is powerful ways of steering the direction of the network's growth. We thus need to attend to technological scripts and affordances to better understand changes in work practices in healthcare.

Finally, slime mold urges us to reframe the very question guiding our review. The impossibility to predict how the network will ultimately reconfigure sometimes subtracts critical power from the STS analyses we considered. If we trust slime molds, we can speculate that what matters is not the final shape of the network, but the strengths of the interconnections that allow various forms of information to circulate among its different parts. STS literature is particularly interested in how the network's reconfigurations impact pre-existing relationships between different actors (professionals, patients, technologies), or create new ones. Slime mold helps us foreground STS's call to focus on relationships rather than on outcomes. The strength of interconnections between the nodes of the network is what allows slime mold to behave intelligently even in the absence of centralized decision-making. If strong interconnections are preserved, information can circulate, and the network finds a way to thrive. What emerges from both slime mold and the STS literature is the necessity to preserve and support the interconnections that matter, and to attempt to steer the growth of the network in the desired direction through limited, but existing, technological means.

3.2. Understanding the sociological literature through theatrical performances

The synthetic metaphor we propose for sociology centers theatrical performance – a domain central in sociological theory since Goffman's (1959) dramaturgical theory. However, whereas Goffman's discussion centers the dichotomy between frontstage and backstage in order to make a point about self-presentation in different social situation, here we foreground the necessary coexistence of frontstage and backstage as the most striking contribution of the sociological literature to the conceptualization of the digitalization of healthcare work. If we usually think of performances as the work of actors on a stage, sociological analyses refocus our attention to include the incessant and unseen work of the backstage crew, and its crucial importance in enabling a smooth performance onstage.

The visible part of a performance takes place on a stage, and consists of the enactment of a script by a cast. Actors need to learn the script by heart, move on the stage and interact with each other and with props. Scripts determine how many actors are necessary, and assign to them different roles, from leads to extras; they can also be more or less strict in the directions they provide, ranging from scenarios, broadly sketching the main lines of the dramatic development, to play texts providing performers with strict directions. Even in the case of strict scripts, however, directors (sometimes in consultation with actors) retain the freedom to deviate from them in their staging of the performance – for instance by reassigning or rewriting lines, suggesting specific movements, and deciding on stage props in consultation with the stage manager.

During the performance, a considerable amount of work is done in the backstage and not seen by the audience. The stage crew, comprising several stagehands, set up the stage and operate lights, sound, different kinds of props and special effects. Their work is coordinated by the stage manager, who oversees the production throughout rehearsals and performances, spreading necessary information throughout artistic and technical departments, bringing the director's vision to life. During the performance, stage managers sit in a booth connected to the backstage and, communicating with the stage crew, they 'make sure that the actors turn up whenever there's a scene change, …that everyone discharges their duties correctly, and there's no danger to anyone.' (Donaldson, 2013). As we elaborate in the following sections, this coordination work is crucial to sociology's conceptualization of the digitalization of healthcare work.

3.2.1. Conceptualizations: technology-in-practice

The 'technology-in-practice' approach dominates sociological accounts of the digitalization of healthcare work (Bailey et al., 2020; Peiris et al., 2011; Reed et al., 2016). This approach is rooted in STS approaches and, as such, presents strong overlaps with the network conceptualization (cf. above). It encourages researchers to reframe technology as an actor in itself, postulating that 'what it does and how it accomplishes something remains an open empirical question' (Timmermans and Berg, 2003, p. 104), thus sidestepping both technological determinism and social essentialism. This translates into a focus on the micropolitics of sociotechnical change, which considers technology's influence on medical practices as 'multifaceted and unfolding' (Reed et al., 2016, p. 738), as well as situated within a network shaping the conditions for action and meaning-making. Technologies are thus investigated as central actors in the 'construction and reproduction of novel worlds' (Timmermans and Berg, 2003, p. 108).

Transposed to theatrical performances, the technology-in-practice approach encourages us to extend the concept of acting to a variety of nonhumans. Not only actors enact a performance: this work is distributed across a number of materials, ranging from script, stage and props, as well as audience and backstage crew. Moreover, the same cast is likely to perform the same piece in quite different ways from one day to the next. Similar to technology-in-practice, this metaphor teaches us that performances, albeit scripted and rehearsed, are difficult to control in their unfolding. This warrants open, empirical approaches to the study of the digitalization of healthcare work.

3.2.2. Conceptualizations: technology as steering

The technology-in-practice approach coexists with more normative conceptualizations, range from institutional ethnography-inspired views describing technologies as tools to 'advance a hospital's strategically designed purposes' (Campbell and Rankin, 2017, p. 366), to an empirically-grounded acknowledgment of the tendency to 'deploy technologies to standardize and control work' (Findlay et al., 2017, p. 118). Despite being analyzed as actors, technologies are often described as only taking up specific tasks and being aligned with specific managerial logics. If professionals' interactions with technologies can lead to new sociotechnical configurations, it is also true that this reframing tends to feature specific characteristics: it aims to make care provision more calculable and objective (Campbell and Rankin, 2017) and to meet 'targets imposed "from above"' (Mueller et al., 2008, p. 3). Therefore, technologies are conceptualized here as 'bring[ing] norms to the clinic … that aim to direct [professionals] and patients to particular ways of caring' (Pols, 2010, p. 377). The digitalization of healthcare work thus unfolds in a polarized political arena, with professionals caught up 'in

the midst of a battlefield between their profession and the organisation … set by management' (Fältholm and Jansson, 2008, p. 26).

Thinking through theatrical performances helps us understand how these two dominant conceptualizations need not be mutually exclusive. Like scripts, technologies can be more or less directive in the instructions the provide to performers. This sensitizes us to the fact that, in the case of technologies aimed at imposing strong constraints to professional practices, the implications of digitalized healthcare work may be less of an open empirical question than in others. Moreover, even though scripts are embedded in specific dramaturgical traditions and assign roles, lines, and movements to actors, their enactment is an open question, shaped by the distinct but (ideally) aligned choices made by the director, the production, the backstage crew, and the actors themselves. The so-called theatrical hierarchy is thus a good parallel for sociological literature's insight into the managerial agency in reshaping healthcare work by enacting digitalization through specific technologies.

3.2.3. *Which implications are described?*

3.2.3.1. Professional hierarchy and uneven consequences. Sociological analyses thematize the unevenness of technologies' implications for different professionals, materializing in the fact that only some professionals are in a position to be involved in the design and implementations of digital healthcare technologies (Fältholm and Jansson, 2008; Petrakaki et al., 2016; Pols, 2010). Consequently, some professionals have the opportunity to tailor technologies to their needs and values, while others need to adapt their practices to technologies' requirements (Barrett et al., 2012). Differential professional power thus engenders what Findlay et al. (2017) term a 'polarization in [job quality]' (p. 118), with some professionals losing autonomy and control over their tasks while others experience an 'enhanced … professionalism' (Barrett et al., 2012, p. 1463). This polarization is symptomatic of how innovation, by pitting some groups' occupational professionalism against the norms and values embedded in technologies, ends up restricting some professionals' possibilities for engaging with the technology to resistance, nonuse, and workarounds (Dupret, 2017; Håland, 2012; Mueller et al., 2008). Even when the relationship between professional hierarchy and undesired implications of technologies is not linear, and the latter generate unwanted tasks for professionals high in the hierarchy (Bar-Lev, 2015; Petrakaki et al., 2016), a power differential materializes in professional groups' varying abilities to delegate unwanted tasks. Petrakaki and Kornelakis (2016), for instance, found that doctors using a new EHR system kept delegating to nurses 'time--consuming and unchallenging tasks that failed to match their perceptions of their work and role as doctors' (p. 216), such as data and order entry.

Theatrical performances teach us that not all roles are created equal: some of them have more stage time and more lines than others. This depends greatly on the characteristics of the selected script. Directors, however, have the ability to change the script, and to reassign lines. The possibility, predicated on one's position in the hierarchy, to access those in charge of the performance thus bears significant consequences for how each actor is able to tailor their assigned role to their personal preferences. However, the sociological literature makes clear that, no matter how strongly a director intervenes on a script, the performance itself will always need intense, unseen work in the backstage. Each modification of the script creates new, invisible coordination work for the stage manager and the stagehands, as we unpack in the next section.

3.2.3.2. Visible and invisible work. The sociological literature centers invisible work, and consistently finds that "[t]echnology does not replace human actors but introduces work for patients and healthcare professionals that is not represented in dominant discourses …" (Oudshoorn, 2008, p. 283; cf. also Fältholm and Jansson, 2008). Analyses center invisible work as emerging in the patient-provider relationship in the form of tasks such as introducing patients to new technologies, reassuring them of their ability to use it, and reminding them to use it (Mossfeldt Nickelsen, 2019; Schwennesen, 2019). In technologically-mediated patient-provider relationships, emotional work is also needed to (re-)create intimacy (Heath et al., 2003; Lupton and Maslen, 2017). In interprofessional relationships, invisible work is about making technologies work in practice, and coordinating them with the work of other professionals (Bailey et al., 2020; Håland, 2012). Repair work is also necessitated by professionals' workarounds, for instance when their selective use of technologies invalidates the reliability of alarms and flagging mechanisms (Pols, 2010).

The backstage crew supporting and enabling the performance on the stage, and in particular the work of the stage managers, provide the most fitting metaphor for the invisible work described in this literature. The unseen work performed backstage is crucial in bringing together scripts, actors, technical props, and directors' vision in a seamless performance. Without this work of coordination, complex productions could simply not take place, and would be disrupted at the first technical hiccup. The work of the backstage crew is both determined during the rehearsals, thus based on a director's interpretation of the script, and ongoing, constantly adapting to the specific circumstances of a particular performance.

Sociological literature also presents accounts casting technologies geared towards transparency and accountability as redistributing invisible work across the professional hierarchy. In this case, technologies such as the EHR are said to work 'as a mechanism that … imposes fairness, ensuring a clear division of labour between professional groups' (Petrakaki and Kornelakis, 2016, p. 234; cf. also Bar-Lev, 2015). As mentioned above, the illusion of the seamlessness of theatrical performances is predicated upon the invisibility of the work carried out backstage.

3.2.3.3. Implications for interprofessional relationships. As we have begun to see in the previous paragraphs, repercussions on professional hierarchies found in this literature are contrasting. Sociological accounts often find that technologies are designed with traditional hierarchies in mind. Once inscribed into technologies, interprofessional relationships ossify, and hierarchies become harder to negotiate. Technological mediation of interprofessional relationships results in a reinforcement of professional hierarchies (Halford et al., 2010). A typical example of this is the fact that EHRs often restrict access to some clinical information to some categories of professionals (Bar-Lev, 2015). Formalizing interprofessional relationships can thus have contrasting implications, and this has to do with the varying ways professional hierarchies are built into technologies' design. Similarly, scripts need to be interpreted by directors and actors in order to adapt them for a specific performance.

Clashing implications are also described with reference to interprofessional communication. On the one hand, technologies facilitate information transfer, providing 'legible clinical notes and requests, fast exchange of information, instant capture and access to data and increased visibility of diagnoses, procedures and test results' (Petrakaki et al., 2016). On the other hand, technologically-mediated interprofessional communication is less tailored to the specific interlocutor and, being accessible by more parties (different professionals, patients, and legal actors in case of lawsuits), tends to be reduced to the transfer of strictly necessary and quantitative information. 'Subjective information, uncertain information and additional practical or 'extra' information' (Engesmo and Tjora, 2006, p. 182) is thus lost – an argument against the complete formalization or technological mediation of interprofessional communication (Bailey et al., 2020; Maiers, 2017). Vital information circulates informally, as testified by the work of stage managers. To communicate with the rest of the crew and with actors, stage managers are connected to the backstage through a complex apparatus of audio technologies, switches and light cues. However, this communication

needs to remain unseen in order to be effective and not to disrupt the performance itself.

3.2.3.4. Tradeoffs of technological innovation. Not unlike STS, the sociological literature also reflects on the losses associated with the digitalization of healthcare work. This pivots on the tension among different modes of knowing embodied by different professionals. Digital technologies are described as implicated in the production of objective knowledge, anchored in quantitative clinical data. This contrasts with the more idiosyncratic, embodied and long-term knowledge of patients and their health that can be developed by healthcare professionals (Halford et al., 2010; Maiers, 2017).

Technologies aimed at structuring the knowing, such as strict assessment forms embedded in EHRs (Bar-Lev, 2015) or algorithms allocating timeslots for consultations (Campbell and Rankin, 2017), constrain the conditions of professional judgment (how and what is known about a patient). For technologies such as clinical decision support systems, that aim at doing (part of) the knowing, the lack of a fit between human and technological modes of knowing results in the selective reliance on the technology itself in the process of diagnosis (Bailey et al., 2020; Maiers, 2017). External pressures for legitimation, cost-cutting and efficiency may increase the reliance on these technologies in the process of diagnosis, which would end up 'potentially removing idiosyncratic knowledge of particular patients from the constellation of information by which clinicians determine patient conditions' (Maiers, 2017, p. 927). Based on similar reflections, the sociological literature urges to acknowledge both the limitations of technological innovations, and the 'abilities, work practices and … social competencies' of the professionals that some of these technologies aim to replace (David et al., 2009, p. 935).

3.2.4. Main insights

Looking at sociological analyses through the metaphor of theatrical performances helps bring together some of the important insights they provide. Firstly, sociological conceptualizations of the digitalization of healthcare work nuance our understanding of the steering potential of technologies. As also articulated in the STS literature, technologies present specific affordances that imprint directionality to the changes in digitalized healthcare work. However, technology, on its own, underdetermines changes in healthcare work. Considering theatrical performances, we have learnt that directors and actors can change how a script is enacted. It is a question of power and time: only the directors and some actors have a say in this process, and after decisions are made in the initial stages of a production, it becomes progressively harder to change the script. In the context of healthcare work, this means that implementation choices (and who is involved in them) matter in how healthcare work changes, and that they progressively ossify, becoming more difficult to unmake.

Theatrical performances and the stage-backstage duality also shows us that invisible work is always needed to coordinate professionals and technologies. This is especially true for the embedding of new technologies into preexisting situated professional practices and organizational structures: this requires extra invisible work, just like the work of stage managers is intensified by modifications to the script or disruptions to the performance. A major lesson from the sociological literature thus concerns the importance of recognizing the value of invisible work without trying to make it visible, but rather providing spaces within organizational structures for carrying it out.

3.3. Medicine: understanding workflow digitalization through river engineering

The medical literature often uses metaphorical language that has consequences for how healthcare work is imagines. In this section, we build on the concept of workflow and its casting of healthcare work as something that needs to 'flow.' We thus attempt to probe the assumptions and implications of this conceptualization by reimagining the digitalization of healthcare work through the metaphor of river engineering.

In order to make rivers and their cycles more useful and less disruptive to their activities, humans have been engaging in various forms of river engineering for centuries. Engineering interventions have aimed at straightening the course of rivers to improve navigability or speed up their flow. Indeed, although rivers naturally flow in one direction, their course often meanders, which decreases the speed of their flow. Dams and dikes have been built to manage river flow and prevent flooding, which is a part of the natural cycle of most rivers. If the goal of river engineering is to foster the fit between rivers' nature and human needs, river engineering has been often associated with several risks and unintended consequences (EPA, 2016). Many of these interventions backfire: straightening rivers makes the water flow more rapidly, thus increasing the risk of floods downstream. Dikes only protect the area around them, but can increase flooding and water pressure both up- and downstream.

In what follows, we show how the idea of workflow bears implications for conceptualizations of healthcare work in the medical literature, and how reading these analyses through the metaphors of river engineering enables us to materialize their insights.

3.3.1. Conceptualizations: promises of meaningful and efficient work

The medical literature conceptualizes digital healthcare technologies as holding two overlapping promises for healthcare professionals: making their work more meaningful and more efficient. Meaningful work generally coincides with patient care (Blease et al., 2019; Grünloh et al., 2016; O'Malley et al., 2015; Westbrook et al., 2013; Zadvinskis et al., 2018). The meaning of patient care emerges negatively, from its opposition to supposedly menial tasks such as documentation and technology-related clerical work (Callen et al., 2006; O'Malley et al., 2015; Sieja et al., 2019; Tai-Seale et al., 2019; Tran et al., 2020; Zadvinskis et al., 2018).

What makes the tension between meaningful and non-meaningful work particularly painful is the fact that time is, for healthcare professionals, a particularly scarce resource. This turns the tension between meaningful and non-meaningful work into a zero-sum game, and sets the terms for identifying tasks which can be delegated to technology (Vogel et al., 2015). Indeed, the automation of these menial tasks is considered desirable and straightforward. The fact that automation is discussed within a context of time scarcity turns the digitalization of healthcare work into a quest for efficiency, an attempt to get rid of unnecessary tasks, or at least speed them up (Grassl et al., 2018; Hains et al., 2012; O'Malley et al., 2015; Sieja et al., 2019; Vogel et al., 2015).

If we think healthcare work through the metaphor of river engineering, we can think of meaningless work as meandering. River engineering, and the straightening of rivers in particular, point us to the importance of efficiency as discussed in the medical literature. The goal of accomplishing as much as possible as quickly as possible, and with the least possible effort, is never questioned in this literature. However, by nature, rivers meander and slow down. Engineering interventions are needed to speed them up. Minimizing the deviations of the river flow allegedly results in more directedness, less waste of energy, a better accomplishment of human goals. Similarly, the quest for efficiency in healthcare is framed as requiring technological innovation: workflows become something that digital technologies can streamline (Hains et al., 2012; Lærum et al., 2003). And streamlining workflows also means reducing deviations, making healthcare work more focused on its meaningful components. Thus, technology is hardly questioned in its role as solution to the problem of time scarcity.

3.3.2. Conceptualizations: disattended promises and the importance of design

The medical literature acknowledges that digital healthcare

technologies often fail to deliver on their promises. Like operations of riverbed straightening, intervening on healthcare work through digital technologies entails risks. In some cases, things do go as planned, and the flow of work is not hindered (Petersson and Erlingsdóttir, 2018). In other cases, river engineering can make the river flow more dangerous, increasing the chances of flooding. Technologies are found to cause interruptions to workflow, introduce new errors (Tran et al., 2020) and time-consuming tasks (Strand et al., 2017; Tai-Seale et al., 2019; Westbrook et al., 2013), disrupt interprofessional communication and patient-provider relationships, and sometimes drive the early retirement of physicians. Professionals react to technologies' malfunctioning with resistance, workarounds, or inefficient and selective use (Fisher Wilson, 2009).

The medical literature frames the fact that technologies disattend their promise of more meaningful and efficient work predominantly as a problem of bad design, oblivious to the fact that technology "needs to fit with the workflow of physicians and within the organizational framework of accepted practices, norms and structures" (Callen et al., 2006, p. 644). Bad technological design is thus anything that contradicts the promise of streamlining, from complicated interfaces (Fisher Wilson, 2009) to workflow blocks generating workarounds (Grünloh et al., 2016; Li et al., 2019; Vogelsmeier et al., 2008). Some articles broaden the issue of design by emphasizing the need to redesign workflows as part of the implementation process (Vogelsmeier et al., 2008), and to give physicians the possibility to customize the technologies (O'Malley et al., 2015).

Centering technological design as a way to address the disattended promises of digital technologies for healthcare work enables the medical literature to maintain its pro-engineering stance without disavowing the promissory value of technology. Allegedly, the problem does not lie in the river straightening operation in itself, but rather in the bad fit between the specific way the water flows in a certain river and the way the artifacts have been designed and built into the river itself. Bad technology design can be addressed by taking more seriously current workflows and needs of professionals.

3.3.3. *Which implications are described?*

3.3.3.1. Work practices: positive implications. Some of the articles we analyzed aimed at empirically testing technologies' promises, or the commonly held assumption that these promises are not met in practices. In a few cases, results were positive: patient information was more thorough and easier to access, EHR-initiated reminders were experienced positively, and workflows were simplified (Zadvinskis et al., 2018). Some transcription technologies alleviate burden of documentation (Vogel et al., 2015) and are found to decrease error rates in medication management (Westbrook et al., 2013). Enthusiasm for new technological systems also stemmed from the fact that they did not cause expected disruptions, for instance by not worsening patient-provider relationships nor increasing documentation requirements (Grünloh et al., 2016).

3.3.3.2. Provider-patient relationships. The medical literature often expresses concerns as to the limitations imposed by technology-mediated communication, and how this affects the relationship to patients (e.g., physicians' ability to pick up on nonverbal cues and emotions, loss of empathy; Schuster et al., 2018; Blease et al., 2019). However, relationships with patients are found not to be negatively affected by the use of digital healthcare technologies, although it is acknowledged that maintaining them entails different degrees of effort from different specialists (Cresswell et al., 2018; Vorderstrasse et al., 2014).

Another major issue in this sense is the alleged erosion of physicians' authority (Cresswell et al., 2018; Grünloh et al., 2016), especially in the context of shared decision-making. This materializes in particular in EHR's potential to give patients access to their own health data. Giving patients access to EHRs often results in changes in physicians' documentation practices. To protect themselves legally and not to cause distress to their patients, physicians tend to limit the amount of information they record, thus 'watering down' the EHR (Grünloh et al., 2016; Petersson and Erlingsdóttir, 2018). Transposed to the river metaphor, the already very visual concept of watered-down EHRs reminds us of dikes and dams being overwhelmed by an increased waterflow as a result of a new tributary being connected to the river. In this case, new, informal ways of damming the river flow need to be devised.

3.3.3.3. Desktop medicine, emotional implications and burnout. The medical literature acknowledges that healthcare work is highly stressful in and of itself. However, some articles point to technologies as making the situation worse. One of the main implications of the digitalization of healthcare work is identified in the increased documentation requirements and prominence of what is often termed 'desktop medicine' – "the computer-based clerical work associated with patient care" (Sieja et al., 2019, p. 793) and that often takes up most of physicians' time (Tran et al., 2020, p. 809). Desktop medicine, epitomized by the EHR, is the clearest manifestation of technology's disattended promise of increased efficiency: not only does it take time away from patient care, but it creates a 24/7 work environment that, coupled with user interface issues and excessive amounts of notifications, drastically increase work-related stress and frustration:

> A growing research literature suggests that time spent by physicians on the EHR has been linked to their reduced satisfaction with work. … over 50 percent of their time is spent on desktop medicine tasks … it is important to carefully examine the relationship between pivotal aspects of desktop medicine and physicians' well-being (Tai-Seale et al., 2019, pp.1073-4).

These issues are usually analyzed as related to physicians, and are associated with the risk of burnout and early retirement. Emotional consequences for nurses are considered far less frequently, and point to the stress generated by the need to navigate communication and relationships with patients through online portals, as well as frustration when task delegation from doctors is perceived as excessive. Still, delegation of 'non-meaningful' tasks to other professionals is frequently proposed as a way of dealing with physicians' risk of burnout (O'Malley et al., 2015; Tai-Seale et al., 2019).

The medical literature acknowledges that both stress and some degree of clerical work are inescapable components of healthcare work: similarly, rivers naturally flood, meander and slow down throughout their course. However, just like with river engineering, technologies can worsen this situation by, for instance, increasing documentation requirements, or introducing the need for remediating technological disruptions to the workflow. Interestingly, however, the solutions proposed for this issue are generally the redistribution of tasks generated by technology, improved design of technology, or automation of time-consuming tasks. Technology can be tweaked and adjusted, but the pro-engineering stance of the medical literature prevents it from substantially questioning the conceptualization of technology as a solution.

3.3.3.4. Main insights. River engineering shows us several things about medical literature's conceptualization of healthcare work. Rivers capture its naturalistic depiction of the essence of this work: like rivers flow in one direction, healthcare work also has a natural course, geared towards care delivery. Like healthcare work, rivers are unpredictable (rainfalls can always cause them to overflow), periodically flooding, naturally meandering, slowing down and speeding up at different points of their course. The engineering metaphor highlights how encouraging the direction of (work)flow is the role that the medical literature assigns to technological interventions. Indeed, the promise of technologically-attained efficiency and meaningfulness is a crucial motor for technological innovation in healthcare. In practice, however, many digital technologies make some water overflow, thus wasting important

resources and frustrating professionals.

Rivers and their engineering can help us reflect on some of the tensions inherent in medical literature's conceptualization of the digitalization of healthcare work, and give us insight into the reasons of the persistently hard fit between technologies and medical practice. A first tension concerns the pro-engineering stance of the medical literature, and its subsequent singling out of technological design as a crucial dimension for improving the fit between technologies and practices in healthcare work. As pointed out throughout this section, although technologies mostly disattend their promises, their promises of improved care delivery and working conditions are never disavowed, and are instead turned into a quest for more 'fitting' design.

Secondly, we have learnt that river engineering does not only intervene on the water flow in the exact point in which the infrastructure is installed. Engineering a specific part of the river, by either straightening its course or tinkering with its banks, despite perhaps decreasing the risk of flooding in that area, can actually increase risks up- or downstream. This points us to the problem of task delegation as a solution to physicians' technologically-driven increased risk of burnout. Delegating unwanted tasks to other professionals may hide them from sight, but will not get rid of them. The generation of unwanted tasks is not a negligible inconvenience, but a serious consequence of introducing digital healthcare technologies. How we deal with it is a crucial political question.

4. Synthetizing argument

4.1. How do metaphors fit together?

Metaphor have taught us several things about the digitalization of healthcare work. River engineering's lessons centered the fact that digitalization follows a specific direction, geared towards efficiency, rationalization, transparency. We have learnt that there is a direction in which the medical field wants healthcare work to develop, made of cost-cutting and time-saving, and that goal-setting is fundamental in fostering innovation. But we have also learnt that forceful streamlining can cause flooding: relying on a single view of healthcare work as efficient and rationalized can engender a host of problems for the healthcare workforce. Slime molds help us here: as living networks, they taught us that healthcare practices change not through a top-down imposition of a disruptive vision, but through feeding interconnections among humans, and between humans and technologies. From slime molds we learn that we can steer a network's growth through feeding it in a certain direction – but the shape the network itself will actually assume is a matter of co-creation. Finally, the coexistence of front- and backstage in theatrical performances has taught us about the importance of the unseen work that supports network growth – about what it takes for information to flow within the slime mold's organism. Without stage managers and stage crew, performances on the stage would not be possible. This foregrounds the value of informal, unseen spaces of interaction for the meaningful embedding of technologies.

Following Dixon-Woods et al. (2006), in this section we endeavor to systematize the relationships among the themes surfaced by each discipline into a synthesizing argument. Our argument aims at providing a multidisciplinary framework addressing the dynamics of work-related change set in motion by the digitalization of healthcare work. This will enable us, in turn, to propose conceptual entry points for studying dynamics of digitalization of healthcare work in a way that tries to reconcile apparent tensions emerging from different bodies of literature.

4.2. Directionality and open-endedness

Across the bodies of literature we analyzed, an apparent tension emerged between the open-ended negotiations of technologies in practice, and the fact that most of the configurations resulting from these negotiations are aligned in a direction of increased automation, datafication, rationalization and transparency. Exemplified by the tension between the two conceptual 'souls' of the sociological literature (technology-in-practice and technology as steering), the coexistence of open-endedness and directionality also appears in STS and medical literature. STS acknowledges the steering power of materiality, while medicine laments the disconnect between technological promises and their failure to materialize in practice. Directionality, the property of innovations aimed at enacting a specific type of systemic change (Weber and Rohracher, 2012), is present in all three metaphors. Slime mold will grow in the direction of areas that are (made) rich in resources. Theatrical scripts are embedded in specific dramaturgical traditions and steer the performance in a certain direction. River engineering interventions also center (uni)directionality, especially when straightening the water flow. Nonetheless, the directionality inherent in all three metaphors does not exclude the possibility for situated open-endedness: slime molds' tendrils explore patches of the surrounding environments in all directions; actors and directors decide how exactly to interpret or deviate from traditions in a specific performance; and, although rivers flow in one direction towards their outlet, they need to be given the space to meander, lest their water overflows.

Based on the three bodies of literature we considered, we propose here that technological scripts, invisible work and informal organization can be singled out as sensitizing concepts enabling scholars in these fields to productively study, in turn, the directionality of the digitalization of healthcare work and its open-ended negotiation in practices. Technological scripts capture directionality in their materializing values and visions for the future of healthcare. The three literatures agree on this point: STS in its foregrounding how technologies' materiality make only some interconnections possible; sociology in its analysis of the steering power of technologies; and medicine in casting digital technologies as tools to streamline workflows. Scripts thus emerge as an entry point into the directionality of the digitalization of healthcare work: they are material articulations of (allegedly) desirable future practices, roles, responsibilities (Akrich, 1992). As such, they endeavor to give directionality to the digitalization of healthcare work.

Scripts must, however, be negotiated in practice, and it is in this process of domestication, often accomplished through invisible work, that open-endedness comes in. Scripts interact in unpredictable ways with the practices and relationships that are already there. This suggests that 'fitting with' practices is not so much a property of technologies, as the medical literature assumes, but a relational process of entangling materiality and work practices. This resonates with a well-known argument in studies of IT infrastructure, centering

> the ever-present tension between the general (standardized) and the local (situated), which people attempt to bridge through articulation or tinkering (the steps taken to get things done as work unfolds in real-time, despite material limitations, regulatory constraints, imperfect data, conflicting priorities, reluctant colleagues, etc.) (Greenhalgh et al., 2019, pp. 2–3).

We argue that the tension between directionality and open-endedness is what this tension between the general and the situated looks like in the context of digitalized healthcare work. What Greenhalgh and colleagues describe as articulation and tinkering resonates with the different forms of invisible work and informal organization described by the three bodies of literature we analyzed. The focus on the open-ended work of situating directionality emerged from STS's attention to preserving strong interconnections, from sociology's engagement with invisible work, and from medicine's concern to make digital technologies fit into work practices. Informal interactions and invisible ways of coordinating healthcare work are crucial aspects of the open-ended process of situating directionality, and as such, combined with technological scripts, they provide an apt entry point into the tension between directionality and open-endedness.

5. Discussion and conclusion

In this review, we have analyzed articles addressing the digitalization of healthcare work from three different disciplinary perspectives. If reviews of the impact of digitalization on work practices are not absent in sociology (e.g., Timmermans and Berg, 2003), our CIS harnesses and updates this discussion, shedding light on how classic sociological themes such as invisible work are reconfigured in the context of new digital healthcare technologies. Our CIS also contributes to the STS literature, traditionally shy of middle-range theories (Beaulieu et al., 2007), by trying to move its empirical findings to a more abstract plane. Finally, we contribute to the medical literature by adding an interpretive layer to the systematic reviews usually produced in that field. Synthetizing literature from STS, sociology and medicine has shown us how the directionality of innovation trajectories clashes and yet coexists with the open-endedness of situated changes in work-related practices. Based on our synthetizing argument, we have proposed that finding dimensions to study both the directionality and open-endedness of the digitalization of healthcare work is crucial. Technological scripts and different form of invisible work offer us entry points to study interactions between directionality and open-endedness.

Methodologically, we proposed a novel way of performing a CIS of multidisciplinary literature through metaphors. Metaphors enable to systematize the contributions of each body of literature, to articulate underpinning assumptions, and to explore the main insights each discipline provides. We argue that, in the context of CIS, metaphors can be deployed as synthetizing constructs, allowing to transform entire disciplinary approaches into new constellations of themes, and to bring them together in a synthetizing argument.

Our methodology presents several limitations. Firstly, we have presented bodies of literature as bounded and homogenous entities. However, the disciplinary boundaries we have traced are – as all disciplinary boundaries – porous and somewhat artificial. Several of the journals we looked at are intrinsically interdisciplinary, and several of the authors included habitually cross disciplinary boundaries. As discussed above, we have incorporated these considerations in our methodology. Moreover, since the contribution of our CIS lies, first, in systematizing the most recurrent themes in each discipline and, second, in synthetizing insights across fields, interdisciplinarity and fuzzy boundaries do not end up substantially impacting our findings.

Secondly, in our search strategy we relied on impact factors to identify the top journals for each discipline. This inclusion criteria builds on the assumption that top-tier journals are more likely to capture major debates in a field. Nonetheless, this search strategy might have led us to exclude relevant contributions, not lastly because it skewed our results towards English-language publications. Moreover, the digitalization of healthcare work spans many more disciplines than the three we have analyzed (e.g., HTA, implementation studies, management science, innovation studies, design studies). Although STS, sociology and medicine provided relevant insights, we might disregard some important dimensions of this dynamic. We hope to have inspired scholars to explore whether the tension between directionality and open-endedness also resonates in other disciplines.

Finally, as discussed above, metaphors are not transparent devices (Puschmann & Borgess, 2014). Although our metaphors build upon and deconstruct concepts already present in each literature, none of them was able to completely cover the often quite disparate foci emerging from each corpus. A biological (though not evolutionary, cf. Wyatt, 2004) metaphor convey STS's focus on ever-emerging networks, a social one the sociological attention for social relations, and a technical one the engineering stance inherent to medicine, giving substance to abstract conceptualizations (Lakoff and Johnson, 1980; Wyatt, 2004). However, they are to be read as syntheses, not exact reflections of each body of literature: each of them leaves something out. Our analytical strategy ensured that the selected metaphors align with the most prevalent conceptualizations in each discipline and are recognizable to scholars in the field.

To conclude, we formulate several recommendations for practitioners, designers and policymakers. We build on the general observation that even seemingly non-disruptive technologies (Hwang and Christensen, 2008) call for fundamental readjustments in work practices. Even when technologies apparently 'fit' with and streamline preexisting routines, they end up causing disruptions in the practices of healthcare staff (and of patients) – and disruptions require repair work. Our first recommendation thus aligns with Elish & Watkins's (2020) emphasis on the political and practical value of acknowledging, valuing and supporting the invisible work necessary for digital technologies to become embedded in practices (without striving to make such forms of work fully transparent).

Relatedly, our reading of the literature invites to reflect on the epistemic tradeoffs associated with the digitalization of healthcare work. Crucial knowledge exceeding quantitative data is likely to be lost through technological mediation. In implementing digital technologies, it is thus necessary to preserve some spaces of informal interprofessional and patient-provider interaction, where information can be exchanged without leaving (legally binding) traces.

Our final recommendation entails a rethinking of the idea of 'fitting' innovation within preexisting work practices. Any new digital technology is likely to reconfigure the network in which it is embedded. Because of this fluidity, the concept of 'fitting' appears misplaced. We urge developers, practitioners and managers alike to think of innovation in relational terms, as an ongoing process of experimentation and network-making, guided by a specific directionality but nonetheless intrinsically open-ended.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.114572.

Box 1
Inclusion criteria

An article's abstract is included if its title meets the following criteria:
a. Refers to medicine and/or health or some variant thereof AND
b. Refers to data and information technologies (either in general or to a specific one);
An article will be included if its abstract meets all of the following criteria:
- Primarily focuses on health care professionals;
- Primarily focuses on digital healthcare technologies (either in general or on a specific one);
- Focuses on technologies used by professionals (also jointly with patients or relatives);
- Is based on empirical research or on a review of relevant literature (i.e., no opinion pieces or commentaries);
- Establishes a link between technology use and (changes in) work or professional practices;
- If focused on doctor-patient communication, clearly discusses implications for doctor's role.

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