Social Science & Medicine 345 (2024) 116650

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

# Speed, accuracy, and efficiency: The promises and practices of digitization in pathology

Olsi Kusta [a,b,c,*], Margaret Bearman [b,d], Radhika Gorur [e,f], Torsten Risør [g,h,i], John Brandt Brodersen [g,j,k], Klaus Hoeyer [l,m]

[a] Department of Public Health, University of Copenhagen, Denmark
[b] Centre for Research in Assessment and Digital Learning (CRADLE), Deakin University, Melbourne, Australia
[c] Øster Farimagsgade 5 opg. B, Building: 15-0-11, 1014, Copenhagen, Denmark
[d] Centre for Research in Assessment and Digital Learning (CRADLE), Deakin University, Level 12, Tower 2, 727 Collins St, Docklands, Melbourne, VIC, 3008, Australia
[e] School of Education, Deakin University, Melbourne, Australia
[f] Deakin University (Deakin), 221 Burwood Hwy, Burwood, VIC, 3125, Australia
[g] Centre for General Practice, Department of Public Health, University of Copenhagen, Denmark
[h] Norwegian Centre for E-health Research, UiT The Arctic University of Norway, Tromsø, Norway
[i] Øster Farimagsgade 5 opg. Q, Building: 24-1, 1014, Copenhagen, Denmark
[j] Primary Health Care Research Unit, Region Zealand, Denmark
[k] Øster Farimagsgade 5 opg. Q, Building: 24-1-21, 1014, Copenhagen, Denmark
[l] Section for Health Services Research, Department of Public Health, University of Copenhagen, Denmark
[m] Øster Farimagsgade 5 opg. B, 1353, København K, Copenhagen, Denmark

ARTICLE INFO

Handling Editor: Medical Sociology Office

ABSTRACT

Digitization is often presented in policy discourse as a panacea to a multitude of contemporary problems, not least in healthcare. How can policy promises relating to digitization be assessed and potentially countered in particular local contexts? Based on a study in Denmark, we suggest scrutinizing the politics of digitization by comparing policy promises about the future with practitioners' experience in the present. While Denmark is one of the most digitalized countries in the world, digitization of pathology has only recently been given full policy attention. As pathology departments are faced with an increased demand for pathology analysis and a shortage of pathologists, Danish policymakers have put forward digitization as a way to address these challenges. Who is it that wants to digitize pathology, why, and how does digitization unfold in routine work practices? Using online search and document analysis, we identify actors and analyze the policy promises describing expectations associated with digitization. We then use interviews and observations to juxtapose these expectations with observations of everyday pathology practices as experienced by pathologists. We show that policymakers expect digitization to improve speed, patient safety, and diagnostic accuracy, as well as efficiency. In everyday practice, however, digitization does not deliver on these expectations. Fulfillment of policy expectations instead hinges on the types of artificial intelligence (AI) applications that are still to be developed and implemented. Some pathologists remark that AI might work in the easy cases, but this would leave them with only the difficult cases, which they consider too burdensome. Our particular mode of juxtaposing policy and practice throws new light on the political work done by policy promises and helps to explain why the discipline of pathology does not seem to easily lend itself to the digital embrace.

## 1. Introduction

Governments in the Global North have invested heavily in the digitization of health services. In the USA, the HITECH Bill involved massive investments in electronic health record systems with the expectation of higher quality, increased efficiency, and a lower cost of care (Greene, 2022). The European Union (EU) has promoted the digital transformation of healthcare through strategy papers like Digital Europe

* Corresponding author. Department of Public Health, University of Copenhagen, Denmark.
*E-mail addresses:* olsi.kusta@sund.ku.dk (O. Kusta), margaret.bearman@deakin.edu.au (M. Bearman), radhika.gorur@deakin.edu.au (R. Gorur), torsten.risor@sund.ku.dk (T. Risør), jobr@sund.ku.dk (J.B. Brodersen), klho@sund.ku.dk (K. Hoeyer).

https://doi.org/10.1016/j.socscimed.2024.116650
Received 21 August 2023; Received in revised form 17 December 2023; Accepted 2 February 2024
Available online 9 February 2024

(European Commission, 2021, p. 355) and initiatives such as the European Health Data Space (Official Journal of the European Union, 2021). Denmark is one of the digital frontrunners among EU member states with a highly digitalized healthcare sector (Kierkegaard, 2013), and therefore a relevant place to study how such political promises of digitization relate to and affect everyday practices.

How should researchers and practitioners address these policy promises? We suggest that it is possible to question policy promises in illuminating ways by juxtaposing them systematically with everyday practices and, in the process, uncovering the types of political work that policy promises do. Digitization is promoted at a time when pathology departments in Denmark and across the Global North face two main challenges: a rising number of cancer patients in need of a pathology diagnosis and a shortage of pathologists. In Danish policy discourse, digitization is expected to address these challenges and change the routine work of pathologists and departments. Petersen (2018) remarks how exuberant policy expectations of digital innovation often manage to mobilize resources and actors but often fail to deliver on those expectations. Discrepancies between policy promises and everyday practices are, of course, not a new insight (Merton, 1936). In fact, paying attention to unexpected outcomes by focusing on practices has become a key contribution of social scientists to many policy processes. The contribution of this paper is that it compares policy promises and practices as unfolding together rather than as phases that occur one after another, which allows us to describe the relatively specific political implications of policy promises. We will show how policy promises mobilize stakeholders, redistribute resources, sustain the dynamics of local, regional, and global inequality, and legitimize investments with budgets meant for other agendas. These political implications need attention to create more socially robust digitization.

Our approach to policy promises and current practices is inspired by Science and Technology Studies (STS) and the sociology of expectations. We pose simple empirical questions: Who is it that wants to digitize pathology, and what do they think they will gain? We then explore these expectations – these policy promises – in light of how digitization is already unfolding in routine work practices. We thereby arrive at a better understanding of the performativity of promises in the present. First, we present an introduction to social science engagement with pathology, digitization, and the sociology of expectations. Then, we outline our methodological approach before presenting our analysis in two parts: one outlining who wants to digitize pathology and why, and the other analyzing how digitization unfolds in everyday pathology practices. We end by discussing the political implications of policy discourse as well as the potential implications of artificial intelligence (AI) for routine practices.

## 2. Social studies of pathology practices and sociology of expectations

Pathology has long attracted the attention of social scientists as part of understanding the clinical approach to disease (Foucault, 1973; Jewson, 1976). It has been described as central to ongoing specialization and new understandings of how body and disease relate to each other (Tybjerg, 2022), and it has been named “the prototypical discipline of laboratory medicine” (Keating and Cambrosio, 2000, p. 355). Foucault (1973), in The Birth of the Clinic, described how pathology emerged in the 19th century in tandem with a change in medical thinking whereby clinical examination began to focus more on the affected organs, tissues, and cells rather than the symptoms. More recently, scholars have pointed to pathology as central to understanding collaboration in treatment teams (Gross, 2009) and the development of precision medicine (Bergeron et al., 2020). From a social studies of medicine perspective, pathology is thus well situated to elucidate pertinent developments in biomedicine.

The knowledge practices of pathology are based on distinct epistemic objects. The microscope and glass slides have played a crucial role in routine pathology work for many years (Carboni, Wehrens, van der Veen and de Bont, 2023). Remarking that cancer has long been considered a ‘pathologist’s disease’, Close-Koenig (2013) argues that microscopic slides have served to define specific therapies for patients. For example, pathologists were involved in establishing radiation therapy. With such a close connection between the epistemic objects in pathology and its knowledge practices, shifts in pathology technology deserve close attention. Gaudillière (2013), for example, has looked at the introduction of the electron microscope during the 1940–1980 period in France. He argues that slides are complex arrangements of different laboratory materials and that the manual treatment of slides has implications for medical knowledge-making. In his work on cytogenetic laboratories, Turrini (2012) similarly argues for the need to embrace the complexity of manual labor and the training it takes to produce valid knowledge. He points out how it is a social act to learn to ‘see’ what is ‘normal’ in flows of endless biological variation and shows how this training is the very basis for the knowledge that these laboratories produce.

Digitization is a more recent technological innovation currently gaining traction in many pathology departments (Carboni et al., 2023). It involves the creation of a digital image, which is then examined on a screen, instead of the pathologist sitting with the microscope and examining a slide. Based on a study of a Dutch pathology department, Carboni et al. (2023) describe three features of digitization that give rise to uncertainty or lack of confidence in the technology: a lack of qualitative detail in digital slides; a disembodied way of engaging with digital slides; and a missing step of quality control (p. 3). These characteristics create resistance among some pathologists who do not want to use digital slides for diagnostic work (Carboni et al., 2023). They argue that uncertainty can help explain resistance to digitization among pathologists, and without the embrace of digital slides, there is no foundation for developing AI. Based on an Italian study, Turrini (2013) has explored the digitization of another microscopy-based discipline, cytogenetics, and he too argues that digital images present opportunities as they are easier to share among colleagues, even though digital images can also distort and flatten the image.

Digitization presents an important affordance: it potentially enables the use of AI for diagnostics (De Togni, Erikainen, Chan and Cunningham-Burley, 2021). The resistance mentioned by Carboni and colleagues might be one reason for pathology not seeing the same advancement with digitization and AI as radiology, another visual diagnostic discipline where AI is already replacing radiologists for some examinations (Selanikio, 2022). Below, we will point out other reasons. Still, many researchers in pathology are very interested in AI (De Togni et al., 2021).

Together with these studies, there is a growing body of work in social science and medicine that critically explores digitization in healthcare. Several scholars have investigated policy visions and ambitions for data-driven healthcare initiatives (Green et al., 2022; Hoeyer, 2019; Haase et al., 2023); issues with digital technologies in diverse healthcare settings (Carboni, Wehrens, van der Veen and de Bont, 2022; Marent and Henwood, 2023; Timmermans and Kaufman, 2020; Ziebland et al., 2021); digital diagnostics (Neumark, 2023); and ethical and socio-political issues in the use of AI in healthcare (Morley et al., 2020; Onno et al., 2023; Siala and Wang, 2022). While these studies have illustrated clear gaps between policy promises and everyday practices, more work is needed to understand how to reveal the specific political implications of such gaps in each setting.

How may policy promises about technologies be studied, and what political work do they do? A broad range of literatures have explored ways of studying the future or what in STS has been called sociotechnical imaginaries (Jasanoff and Kim, 2015), including the anthropologies of the future (Lanzeni et al., 2022), of potentiality (Taussig et al., 2013), of hope (Mattingly, 2010), and the sociologies of risk (Beck, 1993; Luhmann, 2005) and expectations (Brown and Michael, 2003). We are particularly inspired by the ways in which the sociology of expectations describe the dynamics of expectations in innovation initiatives, where

the concept of 'expectation' integrates imaginaries, hopes (aspirations), perceptions of risk (concerns) and anticipation (potentiality). Brown and Michael suggest a basis for mapping and modeling the change of expectations over time in relation to the actors' needs, helping both social scientists and policymakers make sense of past and present expectations (Brown and Michael, 2003, p. 5). In this tradition, Borup et al. (2006) regard promissory articulations in policy discourses as performative and generative. According to the sociology of expectations, promises for the future *do* something in the present: they mobilize actors and action (Borup et al., 2006; Brown and Michael, 2003; Nightingale and Martin, 2004). This tradition thus seeks to inspire scholars to explore who mobilizes whom, for what, and with what potential and actual implications. We take inspiration from the sociology of expectations to unpack what promises do, not just in a research setting but in everyday clinical settings fraught with limited resources, and illustrate how to mobilize local expectations in ways that can challenge policy discourses (Bruun and Krause-Jensen, 2022; Lanzeni et al., 2022).

## 3. Context, materials, and methods

In this article, we juxtapose an analysis of documents from Danish policy and healthcare institutions with observations of routine pathology work and interviews with pathologists. The Danish healthcare system is organized at three political and administrative levels: national (ministry and authorities), regional (5 regional entities), and local (98 municipalities) (Ministry of Health, 2017). National institutions like the Ministry of Interior and Health and The Danish Health Authority have mainly supervisory and supporting functions in healthcare. Five regions are responsible for healthcare provision, including hospitals, general practitioners, and psychiatric care. The municipalities are responsible for most primary care services and elderly care (Christiansen and Vrangbaek, 2018). There are 19 pathology departments servicing a population of 5.857.000 (Erichsen et al., 2010).

To identify the policy actors making the case for digitization, we searched for documents using specific keywords about digital pathology using the Google search engine and the search engines of the official webpages of Danish institutions according to each level of the healthcare structure. Out of 100 documents initially collected, we focused on 14 of them issued by national institutions (2), regions (8), hospitals (2), and news media (2) because they were most elaborate on expectations. The identified policy documents constitute the backbone for the analysis of the digital promises. The documents are in Danish, and all quotes are translations by the authors.

To understand practices, we combined observations and interviews. The observations took place in two pathology departments (Department A and B from now on), belonging to different administrative regions and representing different stages of digitization. While Department A mostly used digital pathology for secondary purposes like remote diagnosis (pathologists working from home) and treatment evaluation of breast cancer, Department B digitized the laboratory and diagnostic workflow for most subspecialties. The observations were not intended as ethnographic fieldwork, but as means for identifying elements that could be probed and confirmed with pathologists through interviews. Our comments on practices thereby reflect the perceptions – and expectations – of pathologists, more so than our own observations. The first author conducted the fieldwork in English and collected most of the data. There were two rounds of observations, one in each department, both in 2021 (February to October). In Department A (first round), the first author observed laboratory work for preparing digital slides to evaluate the effect of breast cancer treatment over two working days. He also observed three pathologists during their routine work (3 h with each). During the second round, in Department B (five working days), he initially observed laboratory work and followed each day one pathologist during routine diagnostic work (3 h each). Adding to the observations, we conducted eight open-ended interviews with pathologists. The first author conducted the first interview of the project with the last author and the following seven interviews alone. Six interviews either followed or were conducted during the observations. Seven interviews were tape-recorded and transcribed, but one was not, at the request of the participants.

The participants in the observations and interviews are de-identified, and we refer to them based on the subspecialty in which they work. All participants were provided with a description of the study and signed informed consent forms. We de-identify the hospitals and do not specify the regions or policymakers, to underscore that we do not seek to expose particular individuals but to analyze institutional roles and discourses. Still, the documents are part of the public domain and can, of course, be identified.

For the analysis, we employed thematic coding (Bailey and Madden, 2016) in an iterative process throughout the fieldwork (Hammersley and Atkinson, 2019). The analysis of observations started with writing a narrative account of field notes. We analyzed the policy papers based on two empirical questions: Who wants to digitize pathology? What do they expect from digitization? We then coded observations and interviews in light of the identified policy expectations.

## 4. Digitization as a policy promise

Who are the key actors wanting to digitize pathology? Judging from the online search, both national and regional policymakers in Denmark want to digitize pathology, while municipalities hold no opinion on this type of specialized service. It even seems that the different regions and departments compete about who is at the forefront of digitization and that there is enthusiasm for digitization at all organizational management levels. Indeed, you find positive expectations in documents from the previously named Ministry of Health[1] (Ministry of Health, 2017; Sundhedsministeriet, 2021), the health committees of Danish Regions (Sundhedsudvalget Region Hovedstaden, 2018), individual regional boards (Digitaliseringsudvalget Region Syddanmark, 2018), and pathology department heads (Christensen, 2020; Skeem, 2019). In a response from one of the hospitals about the regional cancer plan (Herlev og Gentofte Hospital, 2021, p. 2), they articulate digital pathology as a solution to key problems that these departments are facing:

> It is important to be aware of the challenges in relation to the increased demand for pathology examinations and, […] a critical shortage of pathologists in Denmark […]. It is therefore essential to ensure sufficient capacity for pathology diagnostics in the region. A solution could be the implementation of digital pathology, which entails the possibility of using image analysis tools and other AI solutions.

Similarly, the chair of the Digitization Committee in one of the regions articulates digitization of pathology as a solution to increased pressures on pathology departments:

> We know that the number of cancer patients will increase in the coming years […]. By digitizing the pathology at our hospitals, we can offer even better quality in patient treatment across the entire region. Patients will get answers faster to tissue and cell test results and more efficiently regarding a suspected cancer. We are also strengthening professional collaboration across our hospitals. And at the same time, we are taking a big and exciting step into the digital world with possibilities of using artificial intelligence (Christensen, 2020).

Note how both quotes point to the same basic problem (lack of pathologists and increased need for pathology services), and both present digitization as part of the solution, emphasizing the possibility of AI. Specific and immediate expectations are also articulated in these quotes

[1] Currently called Ministry of Interior and Health, but we use the name to match the referenced documents.

and elaborated on in various documents. They relate to the *speed* of diagnosis, *patient safety* and *diagnostic accuracy*, and *efficiency*. What do key actors say about these expectations in the policy documents?

First, *speed* is seen as important for cancer survival and for adhering to policy performance measures embedded in cancer pathway packages (Sundhedsudvalget Region Hovedstaden, 2019). Representatives from pathology departments state in the minutes of a regional health committee that faster response times through digital pathology are essential to avoid delaying the cancer pathway process (Sundhedsudvalget Region Hovedstaden, 2019). The health committee in one region elaborates on how digitization will contribute to speeding up the process as "pathology results will be obtained faster than they currently are" (Sundhedsudvalget Region Hovedstaden, 2018, p. 103). Such arguments relate to activities that can be studied in practice (as we will do below).

When it comes to *patient safety* and *diagnostic accuracy* as reasons for digitization, a leading pathologist and a laboratory scientist stated in an interview in a magazine article that this technology will provide "safer" and "[more] accurate diagnostic responses" leading to better cancer treatment (Skeem, 2019). It is stated in minutes from a regional health committee meeting that "patient safety is increased, as the glasses are automatically associated with the correct patient requisition via barcodes right when scanned. This reduces the need to check the patient's identity" (Sundhedsudvalget Region Hovedstaden, 2018, p. 103). Again, expectations are only vaguely argued, but there are some aspects that can be probed by looking at current practices, which we do below.

With respect to *efficiency* as a reason for digitization, the arguments tend to be a little more developed. In several policy documents, digital pathology is associated with a better use of material and human resources (Digitaliseringsudvalget Region Syddanmark, 2018; Herlev og Gentofte Hospital, 2021). The digitization committee in one of the regions articulates workflow efficiency as a reason for digitization (Digitaliseringsudvalget Region Syddanmark, 2018). This regional council justifies this with the need for a 'dynamic workflow' (Sundhedsudvalget Region Syddanmark, 2020). In the other region, the health committee writes:

> Time consumption for sorting and transporting glass slides will be optimized. […] The scanned slides are thus immediately available to the pathologists without physically moving the glass ones. The need for archiving slides is minimized [as] the scanned glass slides can be stored digitally, which means staff need to spend less time on archiving and finding glass slides. Facilitation of second opinion [Da; sparring] across pathology departments is improved. (Sundhedsudvalget Region Hovedstaden, 2018, p. 103).

These descriptions point directly to observable practices, and indeed, probing these expectations is what we do below, though the effects we see are not all the same. In the documents, it is also noted that the digitization committee has had to allocate additional funds to integrate the old pathology system with the new digital pathology system (Digitaliseringsudvalget Region Syddanmark, 2020). It is thus hoped and expected that it will be more efficient, but policymakers also acknowledge that it demands investments. If pathology is to become cheaper through digitization, the savings will have to materialize sometime in the future.

As emerges from the analysis of the policy documents, the key actors in digitization seem to agree on the pressing challenges that Danish pathology departments are facing. They also converge on the reasons why digitization is desirable and the policy ambitions they want to achieve with it. However, the claim that digitization can deliver on speed, patient safety, accuracy, and efficiency, thereby alleviating the shortage of pathologists, is mostly postulated rather than argued. It seems a fourth ambition – using AI for routine work in pathology – is required if digitization is to constitute a solution to the current challenges. This is noteworthy because the AI tools for diagnostics are not fully developed yet. Furthermore, the various documents that point to AI as a solution rarely elaborate on how it will specifically tackle the current and future challenges in pathology (Christensen, 2020; Herlev og Gentofte Hospital, 2021; Skeem, 2019; Sundhedsudvalget Region Hovedstaden, 2018; Sundhedsudvalget Region Syddanmark, 2020). This lack of detail is in itself not surprising – these are policies after all, not procedural manuals – but the emphasis on technologies that are not yet developed points to a need for understanding everyday experiences and hopes among the pathologists who are to use these future technologies if we are to uncover what policy promises instigate.

## 5. Digital pathology in everyday work practices

We now turn to how digitization unfolds in the everyday work of pathologists, beginning with each of three policy ambitions: speed of diagnosis, patient safety and accuracy, and efficiency. When looking closely at the practices, we see that there is limited reason to expect digitization to deliver directly on the policy promises.

### 5.1. Speed of diagnostic response

To understand how the digitization of pathology affects the speed of diagnosis, we must first describe the everyday routine work observed in the two pathology departments, A and B. Digitization pertains to both laboratory work (digitization of slides), which is what is typically understood as 'digital pathology', and also to communication tools (digitalizing the communication of the diagnostic response). Beginning with the digitization of slides, it mainly revolves around handling specimens. These are tissues and cells that undergo a number of laboratory processes to become a glass slide. We could observe how laboratory staff must dehydrate the tissue or cell into a paraffin block and then insert it into a glass slide, which is stained to display the structure of the tissue or cell. The usual and most commonly used stain is the combination of hematoxylin and eosin, but pathologists may also request immunohistochemical staining or other stains. The laboratory processes of fixation, dehydration, and staining are partly but not fully automated. Once turned into a glass slide, the specimen is ready to be examined under a microscope by a pathologist.

To create a digital image, this glass slide needs to be made first. It is only after the glass slides are stained and ready that laboratory staff load them into the scanner to produce a digital image. Then, after scanning, the digital slides go through quality control to check the resolution. The digital slides are simultaneously sent to the main storage server and to the Image Management System (IMS), ready for the pathologist to view them. Pathologists access the slides through the IMS, which displays the digital slides as whole slide images (WSI)[2] (Hanna and Pantanowitz, 2019). WSI is a photographic image of the glass slides, not in layers (which is how glass slides are visible in the microscope), but as a single picture with high resolution. With digital pathology, the examination takes place at the WSI workstations, where pathologists look at the digital slides on the computer screen. While Turrini (2013) observed that digitization in the cytogenetic labs he studied replaced practices associated with the microscope such as "the classical toolbox of film, photographic paper, developer, scissor, glue, and the bench with a few easy devices like the digitiser board, keyboard, and mouse" (p. 86), digitization in the pathology departments we observed did not replace practices *but instead added extra steps to the laboratory workflow*.

In contrast to the policy promise of increased speed through digitization, we thus see how digitization is not quicker in any obvious way. Furthermore, what becomes important for speed are technicalities such as time spent scanning or rescanning slides of poor quality. For instance, a breast pathologist in Department A stated that the heavy workload and the slow speed of the scanner are the main reasons for not fully digitizing

[2] We use the term because both pathology departments refer to the digital pathology system as IMS to denote the digital slides that pathologists can access through the WSI workstations.

the routine diagnostics in this department and added:

> I use the microscope in the laboratory system and it is still faster for me to work with it than a digital slide. But, I suppose with time and a better integration between these two systems [main pathology system and IMS], I could work at least just as fast as with the microscope, probably even faster.

Note how this pathologist mostly hopes to work 'at least just as fast' with digital pathology and not faster. Conversely, a breast pathologist in Department B argues that in their routine work with WSI, they work as fast *as* with the microscope. For them, the only delay relates to the extra step of digitizing the glass slides. In some instances, the breast pathologist in Department B argued that when assessing the priority cases of breast metastases, the digital slides enable a faster appraisal because they convey a clear overview of the cases with advanced metastasis. However, in general, pathologists in both departments agree that there is no speeding up of the diagnostic process because of the extra steps in digitizing the glass slides.

The diagnostic examination begins with looking at the digital slides on the WSI workstations and continues with describing what they see in the diagnostic report accessed through the pathology laboratory system. This marks the beginning of the digital communication routine. This is mostly already digitized in both departments, as observed. To dictate the microscopic description, pathologists use a microphone with speech recognition software. Then, they assign specific codes (SNOMED) to indicate the diagnostic category, sign out the diagnostic report, and send it to the referring clinician or surgeon and the pathology registry (called *Patobank*). Unlike the digitization of slides (what is typically seen as digital pathology), some digital communication tools do seem to facilitate speed, but they are mostly already implemented. We turn now to the expectation that digitization will improve safety and accuracy for cancer patients.

### 5.2. Patient safety and diagnostic accuracy

Patient safety and diagnostic accuracy are key concerns for pathologists. Patient safety is multidimensional and can refer to both clinical outcomes and social risks such as cybersecurity, hacking, unauthorized re-use of slides, and so forth (Holub et al., 2023). Despite the fact that authorities usually recognize the importance of cyber security, pathologists typically talk about safety in terms of clinical outcomes. When reflecting on this type of safety, they mostly discuss getting the right diagnosis (accuracy) to the right patient (avoiding mix-ups). Let us again trace everyday practices to understand how digitization interacts with such safety issues.

To ensure consistent patient identification, standardized procedures are in place for each step of the laboratory procedures, right from the point when they receive the patient's specimen. In Department B, we could observe how a unique barcode assigned to the patient ties the specimen with all the other clinical and laboratory data, i.e., the patient casefile. In this case file, the laboratory staff specify all the laboratory procedures that the specimen will undergo and who among the laboratory staff is responsible for each of these procedures. With the digitization of slides, we could observe how the laboratory staff first attached the barcodes to the glass slides, and then the digital slides became associated with the same barcode. Barcoding is key to avoiding the mixing of patient specimens (Sundhedsudvalget Region Hovedstaden, 2018), and it is indeed a digital technology. It is, however, not specific to 'digital pathology', and, as just described, digitization only adds a step to the procedure. If it is not the barcode, how does digital pathology improve patient safety and diagnostic accuracy?

When pathologists reflect on diagnostic accuracy, the 'tactile' aspects of working with glass slides versus digital images come to the fore (see also Carboni et al., 2023). As a resident in Department B explains:

> By using light microscope, you can scroll on the slide and this scrolling could help you to see several levels of the tissue, […] this could help you differentiate if something is mitosis or not. Being able to see mitosis is helpful when differentiating between a malignant and a benign tumor. This could be an advantage of light microscopy.

From this quote, we can see how the materiality of glass slides for some pathologists points to a risk of missing something when relying only on digital slides (see also Carboni et al., 2023). Similarly, another resident in Department A laments the lack of depth of the WSI and digital slides:

> You know, in the microscope the resolution is just better than the one that the scanner [digital slides] gives you. What this scanner does is really good, and for me it is definitely usable. But some [pathologists] will say it is still not good enough and you lose the third dimension. Because these scanners are recording just in two dimensions, whereas what you have in the microscope is still two dimensions but you can still adjust a little bit, so you get a slight 3D feeling.

So listening to the practitioners talk about their routine diagnostic work, it remains uncertain how digitization *improves* accuracy. Nevertheless, those who prefer glass slides appear to be seen as 'old school'. While some feel confident that digitization does not decrease accuracy, and while systematic reviews of digital pathology confirm that digital slides perform on par with glass slides (Azam et al., 2021), *improvements* in accuracy do not seem as obvious from a practice perspective as the policy rhetoric suggests.

If accuracy means finding only clinically relevant pathologies, the question becomes more complicated. As we were conducting a systematic review to assess the diagnostic performance of digital pathology (Kusta et al., 2022), we could observe how existing studies only measured the ability to identify pathologies without inserting measurements to detect potential overdiagnosis. If accuracy really is increased, it might imply finding pathologies that would not otherwise cause the patient any harm, i.e., overdiagnosis (Brodersen et al., 2018). If these cases that were falsely identified through overdiagnosis were to be treated, the treatment could be harmful. Overdiagnosis needs to be assessed based on how digital pathology performs in practice, which (unlike most of the features we discuss here) will only be known *after* implementation. It is thus up for discussion what counts as accuracy. Having seen the complexity of the relationship between digitization, patient safety, and accuracy, we now take a look at the last policy ambition, efficiency.

### 5.3. Efficiency

In the quest to address the challenges that Danish pathology services are facing, we saw above that policymakers and pathologists expect digitization to enable increased efficiency. As with the two previous ambitions, efficiency relies on the digitization of slides and the digitalization of communication. Efficiency involves ways of optimizing workflows and an economic aspect of saving costs and resources. When observing routine pathology practices and listening to pathologists' accounts, it looks like digitization does not in any obvious way reduce the workload. Rather, the departments need to buy new equipment, and the laboratory staff have to change work routines and retrain for the digital workflow.

Department B has installed a robotic arm to manage the scanned glass slides. The robotic arm discards the glass slides after pathologists have examined the corresponding digital slides. In this way, laboratory staff do not have to archive these glass slides. However, the laboratory staff now has new tasks in relation to the robotic arm: feeding the scanned glass slides into the arm and responding to technical errors. Whether the workload has actually been reduced is unclear.

The digitization of slides and their digital communication through

the IMS have prompted a new way of working and collaborating. With the IMS, pathologists can now work remotely from their home WSI workstations, have remote consultations with other colleagues, supervise residents, and departments can recruit external collaborators. The thoracic pathologist in Department A describes the experience of working remotely through WSI:

> I personally have benefited a lot [from digital pathology], because I had some health issues that required me to stay home for a long period. […] I worked remotely, so fortunately it was this opportunity, and they had just established this system [points to the IMS].

Some pathologists also remark that the IMS makes it easier to collaborate with pathologists from other departments. While it makes life easier for some, it does not alleviate the overall shortage of pathologists. In fact, a hematopathologist in Department B explains that more specialized departments with a heavy workload now get more requests for second opinions:

> It gets easier to get a second opinion […]. So the work is organized in our region with our department, the highly specialized one, and then we have three smaller departments, which are not so highly specialized. And which way do you think the flow will go with the second opinions? It will not go this way [points from their department to the smaller ones]. It will always go this way [from the smaller departments to theirs].

Senior pathologists and residents observed in Department B praised digitization for the opportunity to supervise across devices, and in turn, it might very well increase accuracy, but for now, it comes with a cost. Moreover, residents in this department used IMS to discuss interesting cases in weekly meetings. Digital pathology also seems to have important advantages for educational purposes. It remains to be seen whether this will play a role in recruiting medical students to specialize in pathology and thereby alleviate the shortage of pathologists. One aspect where digitization has helped, though, is in the recruiting of pathologists from other countries or other departments (part-time), as the thoracic pathologist in Department A recounts:

> We have two consultants in Netherlands who are still collaborating with us, and then there is also another person working part time here. She lives in [City deleted for anonymity] and comes to [Hospital deleted for anonymity] some days a week or a month, and the rest of the time, she works from home with this system. So digital pathology is very handy.

Recruiting pathologists internationally is certainly a step forward in alleviating the local shortage. It does not, however, alleviate the overall shortage globally; it shifts the location of the shortage. Now the pathology departments that can pay the most may get pathologists from regions with fewer resources. What comes across as efficiency for some might be a loss for others.

Finally, it is important to remember that when it comes to economic efficiency, digitization introduces extra costs, as also noted in the policy documents (Digitaliseringsudvalget Region Syddanmark, 2020). There have been non-negligible costs for scanners, user licenses, and WSI workstations, as well as ongoing maintenance costs (Herlev og Gentofte Hospital, 2019). While digitization might make some workflows easier, it is not the same as ensuring economic efficiency. It is still an investment. Having presented the gaps between the policy accounts and everyday practices relating to the three ambitions, we now turn to the promise of AI.

### 5.4. AI use in pathology

We have already seen that policymakers and pathologists have high expectations for AI as a fourth ambition and see such technologies as contributing to achieving speed, accuracy, and efficiency. However, though AI solutions are being tested, there are currently no AI applications in routine use at the departments we observed. Smith et al. (2022) remark in a study of digital pathology that many Danish clinicians, pathologists, and laboratory staff expect AI to advance diagnostics, but they also express concern regarding the political pressure to implement digitization and AI before the technology and workflow can fully support it. We could observe two AI applications for breast cancer image analysis in Department B, both being tested and used for research purposes. The pathologists working with them saw potential for improving the speed, accuracy, and efficiency of breast cancer diagnostics, but they too mentioned reasons for concern. Let us briefly elaborate on these two applications to learn from practice when we assess policy promises.

One of the AI applications is being developed for detecting breast cancer metastasis in lymph nodes, a routine case in breast pathology. The breast pathologist must manually activate this application, which is integrated into the WSI workstation. A rectangular cursor examines the digital slide by moving on it from left to right and then from up to down. It scans the digital slide very slowly (more than 10 min) and is currently less accurate than pathologists for identifying metastases. The breast pathologist explains that for this tool to be valuable, it should become as accurate as them and demand no manual labor, so that it could run automatically overnight. This might save time for pathologists.

This pathologist also elaborated on another AI application for image analysis as a potentially efficient solution in the near future. Together with two of the laboratory staff specifically trained for this purpose, they prepared the same biopsy for digital slides with two different stains. Then, the pathologist manually placed the slides adjacent to one another, adjusted the symmetry, and ran the image analysis application to find those with invasive tumor cells and those without. This application is clinically validated, which means that it has been proven to be accurate for examining whether the breast biopsy is sensitive to a specific treatment. The value of this application could be to delegate work from pathologists to laboratory staff, but, as the breast pathologist states, it is not ready yet.

> My hope at that time was that when the stains [digital slides] were completed, the technicians [laboratory staff] could do the scoring and just serve it to the pathologist to spare pathologist time. But it is time consuming to do the [trade name of the AI application]. I can do it easier and quicker myself.

In their current state, AI applications are not faster or more accurate than pathologists. Routine use of AI is nevertheless foreseen as the third revolution by some pathologists (Salto-Tellez et al., 2019), and it might very well become a game changer. As AI has replaced some radiology examinations (Selanikio, 2022), some expect AI to do the same in pathology. However, the majority of the pathologists who were observed or interviewed are certain that they won't be replaced by computers. This diagnostic specialty is too complex, they think, to be outsourced to software (as Friis (2020) describes for AI in radiology). A breast pathologist in Department A makes an interesting remark about this perspective:

> I have heard since I started in pathology people saying 'well very shortly you will have a chip that will read anything from the tumor so we will not need pathologists'. Quite the opposite, they need pathologists more than ever and they need more of us than ever before.

This pathologist uses *past futures* (Brown and Michael, 2003) – old promises and expectations – to question current promises. The thoracic pathologist in the same department also asserts that to replace them, algorithms would need to be "transparent, explainable, […] reliable and possibly better, significantly better than experienced pathologists" – and it would take pathologists to make that assessment. AI would probably not replace the laboratory staff either; instead, the latter might have to re-specialize further to work with AI. They will still be needed for servicing the robots.

The second perspective that pathologists spoke most about is that AI

will help execute mundane diagnostic tasks or that image analysis algorithms will 'diagnose' easy cases instead of them. The mundane tasks relate to counting or measuring within the digital slides (see also Carboni et al., 2023). There is a subjective aspect to what counts as an 'easy case'. One example is breast metastases in lymph nodes, where the pathologists just assign a diagnostic (SNOMED) code without describing the morphology. A dermatopathologist in Department B pointed out that if all the easy cases were diagnosed by AI, pathologists would be left with only complex cases. However, a balance of easy and difficult cases would be better for pathologists, she said, as they "just don't want too many difficult cases in a day" (quote from observations). It would tire them to do only difficult cases all day, and this could introduce new risks of human error. In contrast to how important work in the anthropology of the future has focused on how AI can lead to deskilling (e.g., Jørgensen et al., 2022), pathologists seem to be fearing a too demanding and skill-intensive workload.

All in all, image analysis with AI might *speed* up the diagnosis of breast metastases, but a pathologist might not be as fast if working only with difficult cases and may need additional controls. Similarly, a pathologist working only with difficult cases may be less *accurate*. Furthermore, when costs are carefully assessed (and the increased time for preparation of slides, new equipment, licenses, and retraining taken into account), it is not obvious that AI is a much more economically *efficient* way of working.

## 6. Conclusion

We have shown how the simple act of juxtaposing policy promises with everyday experiences of digitization within two Danish pathology departments can help challenge and question the type of political work promises do. We propose this as an addition to the important work in the sociology of expectations and other strains of social science engagement with the future as well as to the long-standing tradition of studying the social practices and implications of pathology. Readers may say that we have the privilege of studying a field where the technologies associated with hyperbolic promises are already being rolled out and that, in most cases, the future belongs to the future only. However, we contend that no technological innovation emerges from a clean slate. There will always be some type of organizational dynamic that can be observed and compared to new technology. Furthermore, the actors in the field have hopes, concerns, and anticipations, and they have experienced promises before. Such "past futures" (cf. Brown and Michael, 2003) can be helpful as counterpoints to narratives of disruption, not because they are "true" and the promises "false", but because the future is likely to be shaped by people already doing something that technology promises to change. It is helpful to understand their perceptions and experiences and their understanding of the problems that new technology is said to address. Adams et al. (2009) argue that the "anticipatory mode turns problems of the future into present urgencies while it effaces and undermines engagements with the problems of the present" (p. 188). The type of juxtaposition we present here helps bring the problems of the present back to the fore.

As is often the case, the policy promises mobilized resources and effected change (Borup et al., 2006). However, the main practices of pathology remain remarkably durable: preparing the specimen as a glass slide and examining it either through a microscope (as before) or on a screen (once digitized). Attending to the micro-practices might help explain why pathology has not kept up with radiology in terms of automation and use of AI. Superficially, both practices are about visual pattern recognition, but in current practices, radiological images are born digital. Furthermore, digital pathology does not necessarily improve safety and accuracy compared to the microscope. In contrast to radiology, there is a shift from 3D to 2D in digital pathology, and with this shift comes a potential loss of information. Many pathologists are therefore still attached to the materiality of glass slides when it comes to accuracy (cf. Carboni et al., 2023). It becomes evident in cases when they are uncertain about the diagnosis while looking at the screen: they order a glass slide.

When it comes to the mobilization of resources for the investments, it is important to reflect just a little more on how expectations relate to practices because it might help us understand why so many actors articulate expectations that appear unrealistic. While there is some funding for digitization in general from the Regions (Sundhedsudvalget Region Syddanmark, 2020), the clear majority of funding for digital pathology comes from the National Cancer Plans (Region Syddanmark, 2019). It implies that the money used to build infrastructure for future technological solutions comes from a budget earmarked to assist cancer diagnostics in the present (Sundhedsministeriet, 2021; Sundhedsudvalget Region Hovedstaden, 2018). It means that promises of *future* AI help to legitimize investments in digitization (supporting actors with research interests), using a budget that is, strictly speaking, aimed at ensuring diagnostic capacity right now. This not only exemplifies the ways in which 'expectations' do political work in the present, as Borup et al. (2006) suggested, but also helps us see how uncertainty about technologies can be circumvented and be made to appear irrelevant. It is a common feature of strategies in this field to describe imaginaries of AI as inevitable and yet in need of necessary investments (Bareis and Katzenbach, 2021; Tucker, 2023), and here we see how such expectations manage to redirect funding from everyday healthcare to research and innovation with an uncertain return. By combining several social science approaches to the future we can thus capture the interplay between local and embodied hopes, concerns, as well as wider political and economic implications.

Why do most policymakers and pathologists support these investments in technology? What makes digital pathology so attractive? Besides the general allure of digitization, we have seen that it offers those in relatively privileged positions new opportunities. It opens interesting avenues for research and education (see also Pantanowitz et al., 2018). Digitization also provides flexibility in the work conditions for specialized pathologists. It provides access to second opinions for those less specialized departments that have a budget to support their requests, and it facilitates the redistribution of human resources so that those with the most capital can attract labor from around the country and even around the globe. Digital pathology thereby seems to sustain known forms of inequality.

The political promises of speed, safety, and efficiency work to hide these social dynamics by presenting the expected changes as purely 'technical' and pertaining to diagnostic outcomes only. It is also worth noting that while all management levels are pressured to *do* something to solve the shortage of pathologists, there are no obvious solutions. They do not know what to do. The promises of digitization at least provide the feeling of potent action. As such, promises supply rhetorical resources to those mandated to do something but with no obvious means available.

By juxtaposing the policy promises of digitization with everyday experiences, we suggest an engaged way to rethink what pathology stands to gain from digitization and believe this can open new avenues for studying the digitization of pathology and digital administration of healthcare in general. Furthermore, we use this attention to practice to point out the ways in which digital pathology is not only a technological innovation but also a social change with potential political implications for the local and global distribution of resources. Without attending to such political implications, there is limited chance of building socially sustainable ways of living with new technology.

## CRediT authorship contribution statement

**Olsi Kusta:** Conceptualization, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Margaret Bearman:** Conceptualization, Supervision, Writing – review & editing. **Radhika Gorur:** Conceptualization, Supervision, Writing – review & editing. **Torsten Risør:** Conceptualization, Supervision,

Writing – review & editing. **John Brandt Brodersen:** Conceptualization, Supervision, Writing – review & editing. **Klaus Hoeyer:** Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review & editing.

## Data availability

The data that has been used is confidential.

## Acknowledgements

We want to thank our research participants for sharing their experiences and the heads of two pathology departments for their support. We are grateful to two anonymous reviewers for their useful comments that have helped to improve this article.

## References

Adams, V., Murphy, M., Clarke, A.E., 2009. Anticipation: technoscience, life, affect, temporality. Subjectivity 28, 246–265.
Azam, A.S., Miligy, I.M., Kimani, P.K., Maqbool, H., Hewitt, K., Rajpoot, N.M., Snead, D. R.J., 2021. Diagnostic concordance and discordance in digital pathology: a systematic review and meta-analysis. J. Clin. Pathol. 74 (7), 448–455. https://doi.org/10.1136/jclinpath-2020-206764.
Bailey, C., Madden, A., 2016. Time reclaimed: temporality and the experience of meaningful work. Work. Employ. Soc. 31 (1), 3–18. https://doi.org/10.1177/0950017015604100.
Bareis, J., Katzenbach, C., 2021. Talking AI into being: the narratives and imaginaries of national AI strategies and their performative politics. Sci. Technol. Hum. Val. 47 (5), 855–881. https://doi.org/10.1177/01622439211030007.
Beck, U., 1993. Risk Society. Towards a New Modernity. SAGE Publications, London.
Bergeron, H., Castel, P., Vézian, A., 2020. Beyond full jurisdiction: pathology and interprofessional relations in precision medicine. New Genet. Soc. 40 (1), 42–57. https://doi.org/10.1080/14636778.2020.1861543.
Borup, M., Brown, N., Konrad, K., Van Lente, H., 2006. The sociology of expectations in science and technology. Technol. Anal. Strat. Manag. 18 (3–4), 285–298. https://doi.org/10.1080/09537320600777002.
Brodersen, J., Schwartz, L.M., Heneghan, C., O'Sullivan, J.W., Aronson, J.K., Woloshin, S., 2018. Overdiagnosis: what it is and what it isn't. BMJ Evidence-Based Med. 23 (1), 1–3. https://doi.org/10.1136/ebmed-2017-110886.
Brown, N., Michael, M., 2003. A sociology of expectations:retrospecting prospects and prospecting retrospects. Technol. Anal. Strat. Manag. 15 (1), 3–18. https://doi.org/10.1080/0953732032000046024.
Bruun, M.H., Krause-Jensen, J., 2022. Inside technology organisations: imaginaries of digitalisation at work. In: The Palgrave Handbook of the Anthropology of Technology, pp. 485–505.
Carboni, C., Wehrens, R., van der Veen, R., de Bont, A., 2022. Conceptualizing the digitalization of healthcare work: a metaphor-based Critical Interpretive Synthesis. Soc. Sci. Med. 292 https://doi.org/10.1016/j.socscimed.2021.114572.
Carboni, C., Wehrens, R., van der Veen, R., de Bont, A., 2023. Eye for an AI: more-than-seeing, fauxtomation, and the enactment of uncertain data in digital pathology. Soc. Stud. Sci. https://doi.org/10.1177/03063127231167589, 3063127231167589.
Christensen, B.K., 2020. Region Syds Patologer Håber På Mere Effektive Arbejdsforhold Ved Digital Omstilling. Retrieved from. https://onkologisktidsskrift.dk/diagnostik/1771-region-syds-patologer-haber-pa-mere-effektive-arbejdsforhold-ved-digital-omstilling.html.
Christiansen, T., Vrangbaek, K., 2018. Hospital centralization and performance in Denmark-Ten years on. Health Pol. 122 (4), 321–328. https://doi.org/10.1016/j.healthpol.2017.12.009.
Close-Koenig, T., 2013. Histopathology slides from medical research to medical practice in interwar strasbourg. Hist. Philos. Life Sci. 35 (3), 341–361.
De Togni, G., Erikainen, S., Chan, S., Cunningham-Burley, S., 2021. What makes AI 'intelligent' and 'caring'? Exploring affect and relationality across three sites of intelligence and care. Soc. Sci. Med. 277, 113874 https://doi.org/10.1016/j.socscimed.2021.113874.
Digitaliseringsudvalget Region Syddanmark, 2018. Minutes of the Meeting in 22. October 2018. Retrieved from Denmark.
Digitaliseringsudvalget Region Syddanmark, 2020. *Minutes of the Meeting in 20 January 2020* Retrieved from Denmark.
Erichsen, R., Lash, T.L., Hamilton-Dutoit, S.J., Bjerregaard, B., Vyberg, M., Pedersen, L., 2010. Existing data sources for clinical epidemiology: the Danish national Pathology registry and Data Bank. Clin. Epidemiol. 2, 51–56.
European Commission, 2021. DIGITAL EUROPE: European Digital Innovation Hubs Work Programme 2021-2023. European Union, Brussels.
Foucault, M., 1973. The Birth of the Clinic : an Archaeology of Medical Perception. Tavistock, London.
Friis, J.K.B.O., 2020. Enactive Hermeneutics and Smart Medical Technologies. Ai & Society. https://doi.org/10.1007/s00146-020-00944-w.
Gaudillière, J.-P., 2013. Changing the scale: slides and electron microscopy at the virus laboratory of the pasteur institute. Hist. Philos. Life Sci. 35 (3), 395–414.
Green, S., Carusi, A., Hoeyer, K., 2022. Plastic diagnostics: the remaking of disease and evidence in personalized medicine. Soc. Sci. Med. 304, 112318 https://doi.org/10.1016/j.socscimed.2019.05.023.
Greene, J.A., 2022. The Doctor Who Wasn't There: Technology, History, and the Limits of Telehealth. University of Chicago Press.
Gross, S., 2009. Experts and 'knowledge that counts': a study into the world of brain cancer diagnosis. Soc. Sci. Med. 69 (12), 1819–1826. https://doi.org/10.1016/j.socscimed.2009.09.017.
Hammersley, M., Atkinson, P., 2019. The process of analysis. In: Atkinson, H.a. (Ed.), Ethnography: Principles in Practice, 4 ed. Routledge, Milton, pp. 158–190.
Hanna, M.G., Pantanowitz, L., 2019. Digital pathology. In: Encyclopedia of Biomedical Engineering, pp. 524–532.
Herlev og Gentofte Hospital, 2019. Referat 52. Møde SFR Patologi (Retrieved from Denmark).
Herlev og Gentofte Hospital, 2021. Høringssvar fra Herlev og Gentofte Hospital til den regionale kræftplan – del II. Region Hovedstaden, Denmark.
Hoeyer, K., 2019. Data as promise: reconfiguring Danish public health through personalized medicine. Soc. Stud. Sci. 49 (4), 531–555. https://doi.org/10.1177/0306312719858697.
Holub, P., Müller, H., Bíl, T., Pireddu, L., Plass, M., Prasser, F., Brázdil, T., 2023. Privacy risks of whole-slide image sharing in digital pathology. Nat. Commun. 14 (1), 2577.
Haase, C.B., Ajjawi, R., Bearman, M., Brodersen, J.B., Risor, T., Hoeyer, K., 2023. Data as symptom: doctors' responses to patient-provided data in general practice. Soc. Stud. Sci. 3063127231164345 https://doi.org/10.1177/03063127231164345.
Jasanoff, S., Kim, S.-H., 2015. Dreamscapes of Modernity : Sociotechnical Imaginaries and the Fabrication of Power. The University of Chicago Press, Chicago ;London.
Jewson, N.D., 1976. The disappearance of the sick-man from medical cosmology, 1770-1870. Int. J. Epidemiol. 38 (3), 622–633. https://doi.org/10.1093/ije/dyp180.
Jørgensen, B., Gad, C., Winthereik, B.R., 2022. Organising artificial intelligence and representing work. In: An Anthropology of Futures and Technologies, pp. 93–104.
Keating, P., Cambrosio, A., 2000. Biomedical platforms. Configurations 8 (3), 337–387. https://doi.org/10.1353/con.2000.0021.
Kierkegaard, P., 2013. eHealth in Denmark: a case study. J. Med. Syst. 37 (6), 9991. https://doi.org/10.1007/s10916-013-9991-y.
Kusta, O., Rift, C.V., Risor, T., Santoni-Rugiu, E., Brodersen, J.B., 2022. Lost in digitization - A systematic review about the diagnostic test accuracy of digital pathology solutions. J. Pathol Inform 13, 100136. https://doi.org/10.1016/j.jpi.2022.100136.
Lanzeni, D., Waltorp, K., Pink, S., Smith, R.C., 2022. An Anthropology of Futures and Technologies. Taylor & Francis Group, Milton.
Luhmann, N., 2005. Risk : a sociological theory. In: New Brunswick, Paperback edition. Transaction Publishers, , N.J.
Marent, B., Henwood, F., 2023. Digital health: a sociomaterial approach. Sociol. Health Illness 45 (1), 37–53. https://doi.org/10.1111/1467-9566.13538.
Mattingly, C., 2010. The Paradox of Hope : Journeys through a Clinical Borderland. University of California Press, Berkeley, CA.
Merton, R.K., 1936. The unanticipated consequences of purposive social action. Am. Socio. Rev. 1 (No. 6), 894–904.
Ministry of Health, 2017. Healthcare in Denmark - an Overview. Ministry of Health, Denmark.
Morley, J., Machado, C.C.V., Burr, C., Cowls, J., Joshi, I., Taddeo, M., Floridi, L., 2020. The ethics of AI in health care: a mapping review. Soc. Sci. Med. 260, 113172 https://doi.org/10.1016/j.socscimed.2020.113172.
Neumark, T., 2023. Digital diagnostics from Tanzania: beyond mere technological fixing? Soc. Sci. Med. 319, 115306 https://doi.org/10.1016/j.socscimed.2022.115306.
Nightingale, P., Martin, P., 2004. The myth of the biotech revolution. Trends Biotechnol. 22 (11), 564–569. https://doi.org/10.1016/j.tibtech.2004.09.010.
Official Journal of the European Union, 2021. REGULATION (EU) 2021/522 of the EUROPEAN PARLIAMENT and of the COUNCIL of 24 March 2021: Establishing a Programme for the Union's Action in the Field of Health ('EU4Health Programme') for the Period 2021-2027, and Repealing Regulation (EU) No 282/2014. European Parliament, European Union.
Onno, J., Ahmad Khan, F., Daftary, A., David, P.M., 2023. Artificial intelligence-based computer aided detection (AI-CAD) in the fight against tuberculosis: effects of moving health technologies in global health. Soc. Sci. Med. 327, 115949 https://doi.org/10.1016/j.socscimed.2023.115949.
Pantanowitz, L., Sharma, A., Carter, A.B., Kurc, T., Sussman, A., Saltz, J., 2018. Twenty years of digital pathology: an overview of the road travelled, what is on the horizon, and the emergence of vendor-neutral archives. J. Pathol. Inf. 9 (1), 40. https://doi.org/10.4103/jpi.jpi_69_18, 40.
Petersen, A., 2018. Digital Health and Technological Promise : a Sociological Inquiry. Routledge, New York.
Syddanmark, Region, 2019. The Financial Framework for Implementing the Digitization Strategy. Region Syddanmark, Denmark.
Salto-Tellez, M., Maxwell, P., Hamilton, P., 2019. Artificial intelligence-the third revolution in pathology. Histopathology 74 (3), 372–376. https://doi.org/10.1111/his.13760.
Selanikio, J., 2022. The AI that Disrupts Radiology Won't Read X-Rays: Hinton Drops the AI-Bomb. Retrieved from. https://www.futurehealth.live/blog/2022/4/18/ai-that-disrupts-radiology-wont-read-xrays.
Siala, H., Wang, Y., 2022. SHIFTing artificial intelligence to be responsible in healthcare: a systematic review. Soc. Sci. Med. 296, 114782 https://doi.org/10.1016/j.socscimed.2022.114782.

Skeem, M., 2019. Sådan Digitaliserer Region Syddanmark Patologien. Retrieved from. https://diagnostisktidsskrift.dk/diagnoser/sadan-digitaliserer-region-syddanmark-patologien.html.
Smith, J., Johnsen, S., Zeuthen, M.C., Thomsen, L.K., Marcussen, N., Hansen, S., Jensen, C.L., 2022. On the road to digital pathology in Denmark-national survey and interviews. J. Digit. Imag. 35 (5), 1189–1206. https://doi.org/10.1007/s10278-022-00638-3.
Sundhedsministeriet, 2021. Status På Udmøntning Af Kræftplan IV - 2020 (Denmark).
Sundhedsudvalget Region Hovedstaden, 2018. Udviklingsorienteret analyse: De diagnostiske funktioner i Region Hovedstaden i et perspektiv mod 2020.
Sundhedsudvalget Region Hovedstaden, 2019. Handleplan for Forbedring Af Regionens Målopfyldelse Af Forløbstider I Kræftpakkerne (Retrieved from Denmark).
Sundhedsudvalget Region Syddanmark, 2020. Minutes of the Meeting in 24 February 2020 (Retrieved from Denmark).
Taussig, K.-S., Hoeyer, K., Helmreich, S., 2013. The anthropology of potentiality in biomedicine: an introduction to supplement 7. Curr. Anthropol. 54 (S7), S3–S14. https://doi.org/10.1086/671401.
Timmermans, S., Kaufman, R., 2020. Technologies and health inequities. Annu. Rev. Sociol. 46 (1), 583–602. https://doi.org/10.1146/annurev-soc-121919-054802.
Tucker, J., 2023. The future vision(s) of AI health in the Nordics: comparing the national AI strategies. Futures 149. https://doi.org/10.1016/j.futures.2023.103154.
Turrini, M., 2012. Continuous grey scales versus sharp contrasts: styles of representation in Italian clinical cytogenetics laboratories. Hum. Stud. 35 (1), 1–25.
Turrini, M., 2013. Computer versus microscope: visual activity fields of instruments in the information age. Spontaneous Generations: A Journal for the History and Philosophy of Science 7 (1). https://doi.org/10.4245/sponge.v7i1.16151.
Tybjerg, K., 2022. Scale in the history of medicine. Stud. Hist. Philos. Sci. 91, 221–233. https://doi.org/10.1016/j.shpsa.2021.09.005.
Ziebland, S., Hyde, E., Powell, J., 2021. Power, paradox and pessimism: on the unintended consequences of digital health technologies in primary care. Soc. Sci. Med. 289, 114419 https://doi.org/10.1016/j.socscimed.2021.114419.