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Artificial intelligence as a mode of ordering. Automated-decision making in primary care

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ABSTRACT

This paper examines the process of organizing primary care from the increasing production of digital data and algorithms, leading to decision-making being delegated to automated processes. Based on a case study of primary care in Catalonia (Spain), we develop an interpretative framework to analyze the effects and controversies of the introduction of AI in primary care, stressing the need to understand these technologies as historically situated trends, as part of a growing automation process of ordering frontline clinical care. To foster a nuanced discussion on the mode of ordering of automation, we replace the notion of AI with Automated Decision-Making (ADM) and use the conceptual distinction between striated and smooth spaces, as developed by Deleuze & Guattari. With the analysis we identify four dynamics that order and organize health, illness, and public health systems: (1) The capacity of Electronic Health Records and associated software to shape the daily routines of primary care; (2) The dual role of healthcare professionals, who serve as both data users and data collectors; (3) The system of values and priorities configured by the network of classification systems in use and; (4) The emerging tensions during the progressive automation processes. These dynamics configure a mode of ordering characterized by diminishing the importance of experiential knowledge, the reduction of patient negotiation capacity, the professionals' discomfort with being constantly monitored and controlled, as well as the gradual neglect of factors related to socio-economic determinants of health.

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1. Introduction

Based on an empirical study conducted on primary care in Catalonia, using the approach of science and technology studies (STS), our aim with this research is to explicitly approach artificial intelligence (AI) in healthcare as a sociotechnical system: AI as

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more than an isolated technology, but as part of an assemblage or a system composed by economic, symbolic, social or cultural elements that configure a 'mode of ordering' health, illness, and healthcare systems. John Law's 1994 book, *Organizing Modernity*, introduced the concept of 'modes of ordering'. Modes of ordering are recurring patterns embodied within, witnessed by, generated in, and reproduced as part of the ordering of human and non-human relations, prescribing how actors could and should act, as well as making sense of and account for their actions, as well as the actions of colleagues (Law, 1994). Modes of order are not referred to a particular technology, but to a sociotechnical assemblage, allowing us to move beyond dual notions of agency and structure (Jørgensen & Schou, 2020). Indeed, we use the idea of modes of ordering – and its underlying relational approach – to analyze patterns that resonate across automation in primary care. Using an STS approach and Law's proposal (1994), modes of ordering refer to the narratives of talking about health, illness, and care, but they are more than narratives. They are performed and materialized in a concrete, non-verbal manner in the network of relations in primary healthcare, including procedures, methods, protocols, and artifacts. The modes of ordering talk about how health relations should properly be ordered and how machines should be in that network of relations. They include explicit strategies enacted or formulated by participants; however, they also include less explicit strategies, recursive logics, or patterns that don't have a necessary subject, that order or constitute, the network of primary healthcare.

Since the twentieth century, health promotion strategies have become widespread, accompanied by the growth of the private health insurance industry, pharmaceutical companies, food retailers, and biomedicine start-ups (Rose, 2001). Amidst this development and considering the perceived urgency of the current healthcare crisis (Maibaum et al., 2022; Vallès-Peris & Domènech, 2023), a growing consensus among policymakers, politicians, clinical entrepreneurs, and experts in computer and data sciences asserts that digitalization, i.e., artificial intelligence (AI), will play a pivotal role in resolving issues within healthcare systems (Morley et al., 2020), among them in primary care. Although the application of AI systems in this domain is currently in its infancy, it is assumed that their use may be useful for predicting pre-specified outcomes, exploring and describing data, and providing recommendations or decision support (Terry et al., 2022); as well as streamline workloads, utilizing healthcare staff and resources in the most efficient manner (Kerasidou, 2020; Mayer, 2023). Although the implementation of AI within primary care is currently low, it is advocated widely as one of the future strategic solutions expected to be widely implemented across healthcare systems over the next decade (D'Elia et al., 2022). In response to this situation scholars from various disciplines emphasize the urgent necessity of establishing and adopting ethical and social frameworks to regulate and oversee the integration of AI (Morley et al., 2020; Volovici et al., 2022). Some argue that there is still time to act, as AI's impact on frontline clinical care remains relatively modest (Panch et al., 2019).

The narrative that situates AI as an isolated and disruptive technology with promising benefits and terrible risks takes us away from the tensions and controversies of the modes of ordering and organization on which such technologies rely, associated with the growing automation of various domains of our lives. In this landscape, we take as our starting point an alternative conceptualization to the framework that understands AI as a technological innovation that comes out of nowhere as something completely disruptive

with great risks or great benefits. On the contrary, we approach AI as part of a historical neoliberal process that intensifies a series of existing dynamics fueled by ever-growing amounts of (digital) data and advances in computer science in which decision-making in contemporary societies is increasingly delegated to automated processes (Araujo et al., 2020). AI thus, is part of a broader process of ordering and organizing society. To operationalize the analysis of such a mode of ordering in frontline clinical care, we analyze the process of automation in primary care using two notions: Automated Decision-Making (ADM) and the abstract distinction between 'smooth' and 'striated' space of Deleuze and Guattari (1998).

The use of the notion of ADM, in line with the sociotechnical logic of STS, allows us to approach the changes and controversies in primary care not by focusing on an isolated technology, but rather on a series of strategies or patterns that order the relationships in which various technologies participate. In this way, we want to underline the need to situate the debate on the controversies and effects around AI in health beyond AI. Thus, we approach AI and the narrative around it as part of a mode of ordering characterized by a growing process of automating decisions. This process of automating requires constant data collection, data infrastructure technologies, and ways of organizing health systems that enable the relationship between the data and their infrastructures.

The distinction between 'smooth' and 'striated' space is used for analyzing the relationship between global and local dynamics, looking at the conflicts, tensions, or misunderstandings that surface in practices locally configured, which are regarded as sources of issues and controversies that warrant inclusion in a more global ADM debate. Attempts at ordering are never complete and create new and unintended forms of order, as well as are replete of tensions and resistance (Law, 1994). The relationship between modes of ordering encompassed by ADM and their effects are not homogeneous nor general, at the same time they have a global dimension, global neoliberal logics coexist with local practices, converging within specific situations and institutions (Ong, 2007). Particularly, we focus the analysis on the conflicts and tensions in primary care in Catalonia (Spain), as the Catalan health care model is one of the most paradigmatic cases to explain the commodification -and later privatization- of public health care systems in Europe, in which coexistence and public-private collaboration, as well as the elements of commercialization, have been very present in its origin and evolution (Martínez et al., 2016).

1.1. Automated decision-making in healthcare

There is a noticeable absence of discussion on the effects of AI within the domains of public and population health (Murphy et al., 2021), and often there have been disregarded the everyday practices that underpin and sustain AI, which, in turn, give rise to a series of ramifications and contradictions within frontline clinical care (D'Elia et al., 2022). This underscores the need for caution in the rhetoric that extols AI's immense potential to enhance healthcare and health systems, as AI's impact on public health – an essential cornerstone for assessing values of equity and justice in healthcare – remains largely unexamined (Murphy et al., 2021). The obscurity shrouding practices, human labor, and interactions involved in AI's creation and upkeep are palpable within the debates surrounding AI in the realm of health (Vallès-Peris & Domènech, 2023).

These debates appear to transcend geographical boundaries and localized practices, positioning the conversation within a global landscape that is difficult to situate in our everyday life.

In front of this situation, the non-profit research and advocacy organization AlgorithmWatch (AlgorithmWatch, 2020), prefers the use of the notion of 'Automated Decision-Making' (ADM) instead of thus of AI (with all hypes and technological solutionism that it encompasses). This replacement is not only an issue of nomenclatures, but a political and conceptual shift that allows for alternative analysis and research priorities. ADM is understood as processes through which the ever-growing amount of data is being processed by algorithms, which are then used to make (data-driven) decisions. From this broader perspective, ADM is a way of thinking about technologies as systems in place of individual technologies, thus involving a range of processes, from aids for human decision-makers to a checklist for conducting triage at the desk of a primary health care center, or complex ADM processes that include systems of AI for diagnostics (Araujo et al., 2020). ADM systems as 'ways in which a certain technology – which may be far less sophisticated or "intelligent" than deep learning algorithms – is inserted within a decision-making process' (AlgorithmWatch, 2020). From the conception of ADM as systems rather than technologies, it is underlined the need to consider the socio-technological framework that encompasses a decision-making model beyond a particular artifact or software. It involves approaching ADM as an assemblage that englobes the algorithm that translates a model of decision into computable code, the data this code uses as an input, the entire political and economic environment surrounding its use, as well as the interactions of various agents and the organizational culture in which it is used.

Given the political and economic impetus and priority given to the digitization of health, ADM has a fundamental role in imaginaries, collective meanings, and the organization of processes, being associated with an anticipated future of inclusivity, if they follow the principles of the medical practice and responsibly and that its implementation will increase the efficiency of health systems and health and quality of life of citizens. In this way, we situate the priority of the study of progressive datafication and algorithmicizing in primary care beyond the hype of AI and its utopian/dystopian futures (De Togni et al., 2024), but rather as a continuum historically situated, in which different technologies, work processes, forms of data classification, ways of understanding health and illness, political agendas or economic priorities participate simultaneously, forming a broader scenario that tends toward an increased standardization (Lampland & Leigh Star, 2009).

1.2. Smooth and striated in local context and daily practices

The empirical study we present on primary care aims to situate the debates and controversies surrounding ADM in local contexts and particular settings. With this purpose, we use the conceptual differentiation between two theoretical or abstract spaces, the 'smooth' and the 'striated', of Deleuze and Guattari (1998). Smooth space is open space, what Deleuze & Guattari call 'nomadic', in opposition to the striated which is a space of closure – a 'sedentary', bordered 'State' space (Bayne, 2004). In the striated space, the lines tend to be subordinate to the dots, one goes from one point to another.

In smooth space the opposite is true: the dots are subordinate to the path (Deleuze & Guattari, 1998).

The development of ADM in public health is believed to have the potential to bring about significant benefits in two key dimensions: enhancing the speed and accuracy of patient diagnosis and treatment, and, where possible, aiding in early prevention. It also aims to streamline workloads, utilizing healthcare staff and resources in the most efficient manner (Kerasidou, 2020). As ADM relies on data, achieving these objectives requires the ability to measure, enumerate, classify, and rank various elements related to diseases, treatments, medications, the organization of healthcare centers, resource utilization, or doctor-patient relationships. In essence, ADM necessitates an intensive process of structuring healthcare information.

For Deleuze and Guattari (1998), the smooth and striated spaces only exist thanks to the combinations between them. The simple opposition between smooth-striated is not easy, places are always populated by complexities and superimpositions. So, the mode of order encompassed by ADM in primary care centers is interpreted as a place of confrontation. The striated is what orders and makes different forms follow one another, what organizes the diagnosis of a disease, the prediction of the evolution of an affliction, the treatment plans according to the symptomatology, or the management of human resources with a limited budget. However, in this striated space, the smooth emerges. The smooth is the continuous variation, the continuous development of the form, the symptoms that do not fit with the diagnoses, the medical visits that exceed the expected time, the discomfort of the professionals with their use of the software, or the patients who come to the center without having asked for a visit. Therefore, we position the debate around ADM within these movements of transition (from smooth to striated, from striated to smooth) that occur within primary care. This involves recognizing the spaces and relations in the in-between the smooth and the striated, which entails identifying and discussing the tensions, conflicts, and complexities that arise during the process of 'becoming' between the two spaces. In this way, instead of focusing solely on artifacts or applications, we analyze the network of daily practices and relationships with data and algorithms in a local territory, i.e., primary care centers in Catalonia (Spain). This involves analyzing the striation process within primary care and how, simultaneously, spaces characterized by smoothness emerge within this process.

2. Case and methods

The analysis presented is based on a case study conducted from 2021 to 2022 concerning the use of ADMs in primary healthcare in Catalonia (Spain). Since 1981 Spain has had a decentralized healthcare system in which governance of sanitary issues (in terms of operational planning, resource allocation, acquisition, and service provision) is a direct competence of each of the 17 autonomous communities, such as Catalonia. To have an idea of the volume that this means, in the case of primary care, the primary care system in Catalonia recorded 66,608,263 visits and provided care to 6,592,634 patients in a single year (Salut, Servei Català de la Salut, 2022).

There are substantial differences in the healthcare systems of each autonomous community of Spain, among which Catalonia is characterized by having a mixed healthcare system with complex partnerships and interactions between the public and private

healthcare sectors. Public-private collaboration ranges from managing and increasing tenders and agreements to creating and diversifying a healthcare market involving both public and private (profit and non-profit) companies. This model is characterized by minimal accountability and a gradual transfer of decision-making power to the providers themselves (Benach et al., 2019). All this in a healthcare system in which the paradigm is fundamentally biomedical, an adjuvant element of commodification, where the hospital level of care is favored and the areas of primary, social, community, prevention, and health promotion are underdeveloped (Martínez et al., 2016). In addition, public health spending in Catalonia is the second lowest in Spain (5.5% of GDP compared to the Spanish average of 6.3%) (Ministerio de Sanidad, 2023). Moreover, Spain is already 30% below the EU average in per capita health spending, with a percentage of public funding in health spending below the EU average (70.6% compared to the EU average of 79.7%) (European Commission, 2021).

The case study comprises the analysis of publicly available information about primary healthcare in Catalonia and a series of interviews with various professionals who are involved in primary healthcare and digitalization. The documents and information analyzed, including general practitioners' blogs, websites of healthcare professional associations, tutorials from the Department of Health, public reports, and news related to the primary care system's operations, were selected using the snowball technique. This technique involved iterative exploration based on the documents themselves and the insights gained from interviews.

We conducted a total of 20 interviews, chosen with the criteria of ensuring a diverse group of healthcare professionals from primary care centers. Consequently, our interviewees included general practitioners, primary care physicians & researchers, and managers. Among the interviewees, 14 were women and 6 were men, with ages ranging from 30 to 60. All participants signed an informed consent form and, after a few months, received a document with the main results of the study.

We conducted semi-structured face-to-face interviews. This type of interview takes the form of a conversation, in which the dialogue shifts between topics, following the interviewee's answers to questions such as: *Could you describe a typical day in your primary care center? What are your relevant activities? How is AI being used in your work? What benefits and problems do you find? Independently of AI, are you using other technologies or are you involved in other health digitalization processes? What would you like primary care to be like in the medium to long term? What are the main impediments in this direction?*

To analyze and interpret the collected data, we use an approach inspired by the symbiotic empirical ethics of Lucy Frith (2012), who proposes an ethical theory in which practice informs theory just as theory informs practice. This commitment to the symbiosis between theory and practice is particularly useful for our work since although we do not focus on ethical theory, our analysis relies on an ethical-political approach to the growing automatization of healthcare. For this, the paper we present is a kind of exercise of symbiotic empirical philosophy that has involved an iterative process between theory and empirical work, that could be systematized in four stages:

In the first stage, we employ Thematic Analysis to identify patterns within the collected data (Clarke & Braun, 2014). We used an inductive method for data analysis, without establishing predetermined categories or coding schemes. From the thematic

analysis, we identified several themes and sub-themes (see Annex, Table A1). The second stage consists of specifying concepts and theories that we will use for interpreting such data. As part of this process, we use some theoretical resources of philosophy and STS to tackle the challenge of understanding the effects of AI technologies in primary healthcare. In the third stage, we use theory as a tool to interpret empirical work. We interpret the themes and sub-themes identified with the thematic analysis considering the concepts and theories specified. In this process, theory is adapted and reinterpreted to the research data. Finally, in the fourth stage, we return to primary empirical data, with the lens of the reinterpreted theory. Within this process, some concepts and theories are discarded, as well as identified new themes in the empirically collected data.

From this circular process, we have developed an interpretative theoretical framework that is organized into four sections (from sections 3–6), each of them opened with an (anecdotal) quote from the interviews, to illustrate the relationship we want to maintain between the theoretical interpretation and the local daily practices.

3. Infrastructure capacity of electronic health records and interfaces

> One day, the power went out. Emergency generators are reserved for refrigerators and other critical equipment, and we couldn't conduct the scheduled medical visits because we didn't even have a list of patients. We couldn't even perform blood extractions because we needed the barcode sticker to send it to the laboratory. Sending a vial of blood with just the name to the laboratory is not possible because each analysis must have its own barcode. Interview with a nurse

What is most powerful in the approach to the smoothness of the striated is the diverse ways in which the two spaces are related and interact with each other (Bayne, 2004). One of the forms or variations of such relation is what Deleuze and Guattari (1998) call the technological model. This model is characterized by its constitution of two kinds of parallel elements that intertwine, and these two elements have different functions, ones are fixed, and the others are mobile, with the mobile elements passing above and below the fixed ones. In the simplest case, some elements are vertical, and the others are horizontal, and the two intersect. Deleuze and Guattari (1998) use for illustrating this idea the image of the warp and the weft of a textile production.

In the assemblage of ADM in primary care, the fixed element of such a model of intertwining elements is what in the Catalan Primary Healthcare System is called 'Clinical Station of Primary Care' (CSPC). The quote that opens this section pertains to an interview in which was explained a day when a power outage occurred in a primary care center, bringing all activities to a halt due to the non-functioning of CSPC. CSPC stands for the software that allows access and data entry in primary care. This software is designed to organize four types of relations: (1) Doctors, nurses, and administrative staff can access patient data; (2) healthcare professionals can communicate and share patient information among themselves; (3) the public health system can monitor all healthcare professionals and patient data and; (4) although patients do not have access direct access to the software, their online consultations are viewed by doctors, nurses, and administrative staff through CSPC. It is not an exaggeration to state that CSPC plays a pivotal role in the daily routines of a primary care center. The first task for physicians, administrative staff, nurses, and social workers upon arriving at their workplace is to open the computer and

activate CSPC. In the interview cited in the opening quote of this section, a nurse recounts a day when a power outage caused significant issues, among them that scheduled medical visits could not be conducted because nobody can have the list of patients. Neither could be performing blood extractions because there is a needed barcode sticker to send them to the laboratory, because it is not possible to send a vial of blood with just the name to the laboratory, each analysis must have its barcode. Although the power outage may appear anecdotal it underscores that without CSPC the patients and the blood couldn't be associated with data and, essentially, they cease to exist for the health system. A medical visit is not merely an interaction between a patient and a healthcare professional. There must be, at the very least, a third element: in addition to the patient and the healthcare professional, the interaction must be recorded in the computer system, and data must be introduced and/or produced by the system. The organization system provided by CSPC is not an optional addition to clinical practice; it is the fundamental prerequisite for it, the main fixed element that organizes the relations for communicating with data and establishing the health and illness records of patients. Next to CSPC the main mobile element of our technological model is Electronic Health Records (EHR).

Every pertinent detail must be entered into it, generating data, this is EHR. When general practitioners conduct home visits and need to leave the center to see patients at their homes, they may take notes of their examinations, diagnoses, and prescriptions on paper, a mobile phone, or a tablet. Subsequently, all this information must be entered into the CSPC system, adding such data to patients' EHR. Physical pains and concerns about the body, interactions with other healthcare or social services, fluctuating laboratory test results, and the words and glances that shape the doctor-patient relationship are somehow entered into the system and recorded in the EHR, which contains the full patient's clinical history.

In Catalonia, all EHRs available within the public healthcare system throw the CSPC are stored in a centralized repository. Primary care professionals find the information contained in the shared clinical history repository particularly valuable. They can find out the results of diagnostic tests ordered by other physicians, track their health history, find out about emergency visits, etc., and all this, independently of the patient, is accessible through a few clicks in the CSPC. These valuable data are what algorithms will use to identify patterns, make predictions, or automate processes related to primary patient care. The software for accessing and entering data in primary care, the CSPC in our case, is the fixed element in the network of relationships that make up the striation of space, while the EHR is the mobile element of such network. The map defined within these elements allows us to situate each point in its quadrant. The information infrastructure created among both elements agglutinates indicators and calculations, which interweaves different classification systems: of disease diagnosis; risk identification and prediction; and medication prescription.

4. Human elements in ADM and the double role of professionals

> We're overwhelmed, you're talking and entering data at the same time. Alerts and prompts [in the screen] interfere with the relationship with the patient. We have to do everything at once. Interview with a general practitioner and data analyst

ADM are produced in an assembly that is not only infrastructure by non-human technological actors (the CSPC and the EHR) but also by humans: by healthcare professionals. ADMs are produced through a combination of software, data, and human labor, in assemblies in which professionals operate as both fixed and variable elements of the technological model configured by the ADM. Practices with ADM in primary care centers are organized throw two different and complementary dynamics: the dimension of data collection and the dimension of data use. Both of them organize and maintain CSPC, which functions as a clinical tool (data is used as a tool to support clinical practice) and as a system for monitoring patients' health and professionals' work. These two dimensions cannot be separated or considered independently, as each is a condition for the possibility of the other.

It is common to hear policymakers, politicians, and some researchers say that digitizing health information will help solve inefficient health systems and reduce costs while facilitating the development of better-coordinated models for managing and organizing care (Murphy et al., 2021). This rhetoric has intensified since the COVID-19 pandemic. EHRs have shown promise in improving clinical outcomes when accompanied by complementary management factors and skills (Bronsoler et al., 2022). Using ADM with these data will allow for monitoring risks personalizing diagnoses and using more efficient resources, also helping to address the problem of the shortage of specialist doctors in primary care (Khedkar et al., 2020).

The striation of the space with ADM allows a more efficient use of resources and improves diagnostics accomplishing different functionalities: (a) to support the prescription of medication; (b) to facilitate the monitoring of chronic diseases and; (c) to provide information on symptomatology, diagnoses, and treatments. The CSPC offers information on standardized health programs, protocols, clinical warnings, and pending activities that could be applied to the patient. When medical professionals use these functionalities, they essentially relate to the dimension of data use. In the mid-to-long term, the development of ADM that enhances and improves these functionalities is seen as a positive development. In our case study, all interviewees believe that the use of algorithms to establish patterns and risk predictions based on these data can strengthen primary care.

However, these functionalities are often interpreted in isolation, without considering the context in which massive amounts of data are produced and used, and the resulting transformations in clinical practice (Agniel et al., 2018). To use the data, they must first be generated and entered into the system. In a primary care center, the functionalities offered by CSPC occur simultaneously as the general practitioner or nurse is collecting and introducing into the system information about the patient. As reported in the interviews, a general practitioner in a primary healthcare center in Catalonia, typically with a full quota, has an average of 12 min per patient visit. They may have up to 30 visits scheduled per day, and on some days, this number may increase to 40 or 50, especially when emergency visits and e-consultations are added. During these 12 min of the visit, they must listen to the patient, perform an examination, record symptomatology and diagnosis using coded options, explain the pharmacological prescription to the patient, and code and type the prescriptions. All these activities configure the data collection dimension of ADM, in which professionals become a pivotal element of the model.

As shown in the opening quote of this section and as could be seen from the list of tasks that a healthcare professional has to perform during the 12-minute medical visit, the increasing automation and codification of clinical practice, both for doctors and nurses, result in the emergence of several undesirable effects and discomforts. Studies have shown that these dynamics are associated with lower job satisfaction, clinician burnout, disruptions in clinician-patient relationships, and a higher volume of desktop medicine that extends to after-hours work (Holmgren et al., 2021). Physicians have also been found to experience EHR-related fatigue during short periods of continuous EHR use, which may be linked to less efficient utilization of technological systems, requiring more time, clicks, and screens (Khairat et al., 2020).

Care professionals become a pivotal element in the technological model that encompasses ADM. However, because of their double role as data users and collectors, they are neither a fixed element nor a mobile one, but an element in movement. Taking the metaphor used by Deleuze and Guattari (1998) about weaving, the care professionals would be like the needles that weave the wool, which go from one side to the other. On the one hand, they are the mediators of the clinical and administrative management dimension of the infrastructure that facilitates the tracking of patient clinical data with a comprehensive view, supports clinical decision-making, and enables the sharing of clinical history information among various professionals and specialists who interact with the patient. On the other hand, they are also the mediators that enable public administration to monitor the diagnostic and prescription activities carried out by the sanitary system, incorporating a set of surveillance mechanisms for their daily professional activities based on standardized criteria of effectiveness and efficiency. This collection dimension is only possible by the role of healthcare professionals as data collectors. Thus, ADM in primary healthcare is characterized by a third element, neither fixed nor mobile, but in transition: healthcare professionals. Like the needles that weave the wool, healthcare professionals are elements in constant movement that mediate the relationship with patients, the healthcare system, and their professional activity.

5. The network of standardized systems

> The standardization of treatments is a criterion for quality. Everyone, whether they live in the country or the city, regardless of the CAP [the name of primary healthcare centers in Catalonia] they are in, must be treated the same way. General practitioners feel challenged by standardization because they are not using the most appropriate drug as the first-line treatment in the healthcare system. Interview with a manager of the Healthcare Department

Data included and used by healthcare professionals through CSPC software, which defines patients' EHRs, is structured among different classification systems. In this process, data are standardized and transformed into a coherent and common format. The classification and standardization systems establish the criteria for the relationship between the data entered, making it possible to automate the relationship between inputs and outputs.

There are multiple and diverse classification systems nested in the CSPC, to cite a few examples: Symptoms and diagnoses are coded based on the International Statistical Classification of Diseases and Related Health Problems (ICD) -currently being used in Catalonia the10th Revision- elaborated by the World Health Organization Family of

International Classifications (WHO FIC). Regarding the prescription of medication, the Catalan healthcare system uses the Pharmaceutical Prescription Quality Index (PQI), designed annually by the Catalan Healthcare Department and containing a set of indicators and sub-indicators with specific objectives for enhancing each of them, as well as its ponderation according to its contribution to the global enhancement of pharmaceutical prescription. For managing visits and patients assigned to professionals a series of quotas are defined (with a certain margin for modification by the administration of each center), which makes it possible to organize the agendas of professionals, the medical care team assigned to new patients or to organize how to deal with emergencies that come to the center. Similarly, the Catalan health system also establishes a series of objectives to be met by professionals, about the number of visits attended, patient follow-up or medication prescription, combining general, area, and center criteria, which are collected from the data entered in the system and which are recognized in a system of economic bonuses for professionals.

Such standardized systems interact with one another in a striated space ordered by CSPC, EHRs, and professionals, configuring a network that articulates primary healthcare centers and front-line clinical practice, a network in which the action is located and allocated (Latour, 2011). Elements do not have effects by themselves but rather are constituted from the webs of which they are part. 'Objects, entities, actors, processes – all are semiotic effects: nodes in a network that are nothing more than sets of relations; or sets of relations between relations' (Law & Mol, 1995, p. 277), in which the actions and the effects of the actions are redistributed in the network.

A notable example for illustrating the redistribution of the action through the network is referenced in the quote that opens this section, about medication prescriptions. When a physician enters a new prescription for a patient via CSPC, the tool cross-references the new treatment with previously prescribed medications, the patient's age and medical history, and a pharmaceutical prescription guideline. This guideline is updated annually by the Healthcare Department and contains recommended drug prescriptions for each treatment, based on a series of cost-benefit criteria and analysis of clinical trials providing scientific evidence of their efficacy. When physicians prescribe medication through the computer system (which is the only way to issue a medication prescription), CSPC instantly alerts them to possible prescription errors or suggests better drug alternatives. For instance, if a patient has renal insufficiency and the physician prescribes a diabetes medication, the alert warns about the risk of lactic acidosis in cases of severe renal insufficiency. Additionally, if, for any reason, that drug is not included in the pharmaceutical prescription guideline, CSPC recommends alternative treatment options.

In the quote introducing this section a health department manager explains why the standardization of medication prescription criteria is necessary for ensuring the quality of health assistance, and why physicians do not like it (according to the manager's criteria). However, the effects and values of the network are not visible when focusing on an isolated element of such network (i.e., the criteria used to standardize treatments) but are linked to areas that are not explicitly related to health, such as commercial or financial domains (Ruckenstein & Schüll, 2017). It is possible that, for various reasons, the physician does not follow the recommendation that appears in the computer system. For example, the patient may have already tried the medication and developed resistance to most treatments or may be intolerant to certain components. The patient takes the

prescription (that doesn't follow the CSPC's recommendation) to the pharmacy, which contains the code of the doctor who issued the prescription. This data is cross-referenced with the information received by the Department of Health from pharmacy billing, which is associated with the prescribing doctor's code. This data is compared against the list of drugs and indicators contained in PQI. Simultaneously, the PQI is part of the metrics used to compute annual salary bonuses for primary healthcare practitioners. This implies that there is a system of financial incentives that reward professionals for adhering to the guidelines and recommendations of the health department. If healthcare professionals repeatedly disregard the recommendations and alerts provided by CSPC regarding medication prescription or patient monitoring, it directly impacts their annual remuneration.

Within this process of space striation through CSPC, EHR, healthcare professionals, and standardized classification systems a set of values and behavioral norms mediate the practices and relationships within a primary care center, structuring and shaping possibilities for action . Decisions and choices are mediated by such networks, that decide how care, primary health assistance, and illness should be interpreted and what actions should be taken as a result. Following the example of medication prescription, the action is mediated by the PQI, which makes a series of recommendations based on the patient's EHRs, the system of bonuses for professionals calculated based on CSPC data, compared with the data obtained from the pharmacies, etc. A mediation network that establishes a form of action based on standardization and homogenization criteria on a cost-efficiency basis.

6. Tensions and resistances

> To decide a case, you need context. The home provides that context, and it can be overwhelming. Understanding each case requires a great deal of intuition. Just the other day, for example, I visited an elderly woman who was bedridden and nearing the end of her life, thankfully without any pain. The living conditions in the house were far from hygienic, and the primary caregiver was her daughter, who had an intellectual disability. When I lifted the sheet for examination, to my surprise, I found three or four small kittens underneath. If I were to strictly follow the protocol and consider the situation, the woman would need to be hospitalized. However, as I discussed it with her daughter, I could sense the discomfort it caused, and it seemed like hospitalization might lead to a less-than-dignified end. While the protocol suggested hospitalization, my intuition told me otherwise. Interview with a general practitioner

The introduction of new clinical protocols related to health information technology does not merely impose new structures, roles, and processes on healthcare; it also leaves existing systems altered (Timmerman et al., 2019). Standards assimilate prevailing practices, power dynamics, and cultural traditions while also reshaping them, resulting in a form of 'local universality' (Petrakaki & Klecun, 2015). As we've explained in the introduction, the differences between smooth and striated spaces are complex, and both logics constantly intertwine (Deleuze & Guattari, 1998). The quote that opens this section has been selected from a general practitioner's account of a home visit. In this visit, the general practitioner encounters a rather complex situation within the home of a modest family, giving rise to a set of logic that cannot be integrated into the system explained in the previous sections. We've chosen this quote because it highlights two dimensions

that consistently appeared throughout the case study as non-standardized and non-standardizable: the socio-economic context and experiential knowledge (referred to as 'intuition' by the doctor in the quote).

Like any mode or ordering, it contains an assemblage of values and prescriptions of actions that tend to a process of space striation, but it opens potential spaces for the smooth, often giving rise to hesitation and resistance (Deleuze & Guattari, 1998). The information infrastructure of ADM also entails the selection of information that will be omitted for classification. Part of the discarded information comprises entries that healthcare professionals input into a free-text box within CSPC. This free-text box is used by doctors and nurses to record anything they deem relevant about the patient's visit but cannot be encoded or analyzed by the public health system. It may include inquiries about the patient's family situation, financial hardships, personal anecdotes for future reference, or their own observations and patient concerns. In this manner, healthcare professionals' criteria for selecting non-standardized information also reflect a set of values and priorities that aren't inscribed in the network of actors and processes participating in the process of space striation. These annotations in the free-text box underscore the significance of understanding the context of patients' lives and the doctor-patient relationship on a personal level.

Another example of how the smooth and the striated collide is when a physician intentionally does not enter the values of a patient's diagnostic test correctly in the CSPC, as explained in an interview. Instead of including the values in the drop-down form provided for that purpose, for example, they write them in the free-text box. If the physician were to enter them in the standardized form, the diagnosis would not be nuanced, and the physician would not be able to order additional diagnostic tests or might be penalized in the final annual calculation of salary bonuses if they decide to apply a less invasive treatment or a treatment negotiated with the patient. A similar mechanism relates to the decision of some health professionals to forgo a higher annual salary bonus because they do not agree with certain criteria of the patients' health monitoring system. One nurse shared an example related to breastfeeding. The Catalan health system adheres to WHO recommendations that emphasize the benefits of breastfeeding during the first six months of a baby's life. When a patient is in postpartum follow-up, the nurse provides information on this topic and encourages breastfeeding. Recording this information and indicating whether the patient is breastfeeding (by entering it into the CSPC) is part of the patient follow-up and monitoring process, which positively affects the nurse's salary bonus calculations. In one of the interviews, a nurse explained her dilemma with this issue. Although she fully supported the WHO recommendation and provided patients with all the relevant information, she faced the possibility of a lower salary bonus when a woman, despite having all the information available, chose not to breastfeed. The nurse expressed discomfort with trying to persuade patients on this matter solely to improve her bonus indicators because, in her words, as a nurse, 'I have to support patients in their decisions.'

The management of an increasing volume of data and the growing application of algorithms that enable greater automation and prediction intensify existing dynamics in the medical field, as evidenced by numerous studies on the widespread use of EHR in healthcare (Rose, 2007). The values of efficiency, innovation discourse, and cost/benefit logic crystallize in the context of ADMs but are common processes in the

realm of healthcare and, more broadly, in the organization of public services influenced by neoliberal principles (Lave et al., 2010; Numerato et al., 2021). The same applies to the prioritization of biomedical approach or professional oversight (Donia & Shaw, 2021).

In our local analysis, we demonstrate how the network of practices, relationships, and artifacts involved in ADM amplifies these values and priorities. But we also observe a reverse process or a set of resistances and tensions within that process. In these realms of resistance come to the forefront relevant controversies and debates related to ADM, which include instances of complicity and negotiation in patient care, the significance of socio-economic factors in healthcare, and the value of experiential knowledge.

7. Conclusions

Based on a case study of primary care in Catalonia, in this paper we have developed an interpretative framework to analyze the effects and controversies of the introduction of AI in primary care, stressing the need to understand these technologies as historically situated frameworks. We have elaborated an interpretative framework from STS integrating the idea of modes of ordering, ADM, and the distinction between smooth and striated space, allowing us to approach controversies in primary care not by focusing on an isolated technology, but rather on a series of strategies or patterns that order the relationships in primary care, in which various technologies and processes participate.

The implementation of technologies that use complex processes of machine learning or deep learning is only possible with a growing process of datafication and the introduction of ADM in various domains of our lives, among them in healthcare. There are no data to standardize and correlate in public health without a series of structured practices and relationships that allow the selection among multiple items from various classification systems. Thus, since this framework ADM goes beyond particular and individual technological systems (i.e., AI). ADM become a mode of ordering configured by a collection of mobile practices that participate in a process of healthcare striation, wherein historical trends of standardization, efficiency, and neoliberalism in healthcare converge. The effects of ADM emerge as a result of an intricate web of relations and interactions among different technological and human elements. Thus, debates around ethical and social controversies around AI can no longer be focused on particular algorithms or applications, as well as humans can no longer be seen as external elements of such a mode of ordering, nor the grants of ethical or responsible values. This mode of ordering is imbued with a set of values and criteria that influence the relationships and perceptions within primary care. Such values notably emphasize prediction, cost-effectiveness, surveillance of professionals, and a biomedical approach to healthcare.

However, in this process could be identified a set of resistances: healthcare in primary care centers is not reduced to its biomedical component, decisions are not only influenced by cost-benefit ratios, knowledge grounded in scientific evidence is one of the forms of knowledge recognized in primary healthcare, and choices are tied but not slaved to salary bonuses. Relationships involve negotiating treatments with patients, considering socio-economic determinants of health, using more time than stipulated for medical visits, or using knowledge rooted in experience. These forms of resistance should not be understood as forms of individual response or contestation to global dynamics nor as human resistance to the technological. The values and behaviors that guide these

actions also emerge in the assemblage of relationships with ADM, slowing the progress of space striation and performing alternatives to ADM's mode of ordering. These alternatives are also organized and configured in a network of relations in frontline clinical care in which healthcare professionals, patients, CSPC, EHRs, and values of care or community primary health participate.

These resistances (or the network of relations of resistance) performed in primary care open new discussions (or refresh old ones) on the effects of the growing tendency to health digitalization through complex 'intelligent' technological systems. These resistances alert us of the controversies of a mode of ordering that diminishes the value of experiential knowledge and patient negotiation; that uses healthcare professionals as data users and data collectors, thus affecting occupational well-being and professional identity; as well as the need to evaluate the dangers for social justice and public health of the gradual omission of factors related to the socio-economic determinants of health in primary care. In sum, approaching intelligent data systems, i.e., AI, as part of a socio-technical process of ADM intensification in healthcare opens new political and public debates on the desirability of its embedded mode of ordering and its implications for democracy and health equality.

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Author contributions

All authors contributed to the study conception, design, and fieldwork. The first draft of the manuscript was written by NV-P and JP commented on and edited previous versions. All authors read and approved the final manuscript.

Compliance with ethical standards

The research was approved by the 2021 Bioethics Grant research jury of the Victor Grifols i Lucas Foundation. All the interviewees participating in the research signed an Informed Consent.

Disclosure statement

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Annex

Table A1. Thematic analysis.

Sub-themes		Themes
Clicks	Dailylife	Infrastructuring capacity of EHRs and interfaces
Electronic Health Records		
Shared offices		
List of patients		
Barcodes		
Plugs-on the screen		
Derivations		
Pump-up alerts		
Stress		
Relation with patients and other professional		
Screen		
Data access according to professional category	Organization-Network of relations	
Shared medical history		
E-visits		
Telephonic visits		
CIE-10	Criteria of prioritization	Network of standardization systems
Z Code		
Guide to priority drugs		
Triage protocols		
Direction by objectives	Direct economic consequences-efficiency	
Standards of assistive quality		
Pharmaceutical quality index		
Pharmacy invoicing		
Annual salary bonuses		
Double and triple clicks	Non-rational relations	
Different itineraries to access the same items		
Accumulation of different versions		
Active intelligence	Sanitary professional as data user	Double dimension of practices and double role of professionals
Pharmacological prescription		
Monitoring chronic patients		
System of alerts		
Positive evaluation		
Medicine of the future		
Short time for visits	Sanitary professional as data collector	
Visits in the cloud		
Constant clicking		
Codification		
Discomfort		
Overwhelming		
Experience and clinical eye not considered		
Devaluation of work		
Non-coding practices		

Note: Themes and sub-themes.