



# Navigating uncertainties of introducing artificial intelligence (AI) in healthcare: The role of a Norwegian network of professionals

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## ABSTRACT

Artificial Intelligence (AI) technologies are expected to solve pressing challenges in healthcare services worldwide. However, the current state of introducing AI is characterised by several issues complicating and delaying their deployments. These issues concern topics such as ethics, regulations, data access, human trust, and limited evidence of AI technologies in real-world clinical settings. They further encompass uncertainties, for instance, whether AI technologies will ensure equal and safe patient treatment or whether the AI results will be accurate and transparent enough to establish user trust. Collective efforts by actors from different backgrounds and affiliations are required to navigate this complex landscape. This article explores the role of such collective efforts by investigating how an informally established network of professionals works to enable AI in the Norwegian public healthcare services. The study takes a qualitative longitudinal case study approach and is based on data from non-participant observations of digital meetings and interviews. The data are analysed by drawing on perspectives and concepts from Science and Technology Studies (STS) dealing with innovation and socio-technical change, where collective efforts are conceptualised as actor mobilisation. The study finds that in the case of the ambiguous sociotechnical phenomenon of AI, some of the uncertainties related to the introduction of AI in healthcare may be reduced as more and more deployments occur, while others will prevail or emerge. Mobilising spokespersons representing actors not yet a part of the discussions, such as AI users or researchers studying AI technologies in use, can enable a 'stronger' hybrid knowledge production. This hybrid knowledge is essential to identify, mitigate and monitor existing and emerging uncertainties, thereby ensuring sustainable AI deployments.

## 1. Introduction

Artificial Intelligence (AI) technologies are perceived as having a great potential for solving existing and future challenges within healthcare services, including rising costs, shortages in the healthcare workforce, and the exponential growth of digitalised health data necessary to process and manage [1–3]. Existing AI technologies are, however, not a clearly defined group of technologies but are developed for various use areas with different capabilities and outcomes [4,5]. AI technologies currently being developed for healthcare and slowly taken into use (as of 2023) are typically based on Machine Learning (ML) or Deep Learning (DL) approaches, with image analysis as one of the most promising areas of application ([6]; p. 722 [7]; p. 293; [8]).

The Norwegian Government's vision of AI in healthcare gives a typical example of the current expectations, stating that, in the future, AI

technologies will 'provide faster and more accurate diagnostics, better treatment and a more effective use of resources' ([9]; p. 26).<sup>1</sup> The vision further emphasises that mobilising and establishing collaborations between various actors from the public and private sectors is crucial to enable AI in healthcare (for similar arguments, see [10]; p. 7; [11]). According to research on AI implementation in healthcare, such constellations of actors will need to cover a 'last mile' or bridge a 'gap' to progress towards widespread deployment [12–14]. Problematic issues to address in this context relate to topics such as ethics, regulations, data access, human trust, and limited evidence of AI performance in real-world clinical settings [6,10,15,16]. Some of the key challenges involve uncertainties regarding whether AI technologies will secure equal and safe patient treatment or whether the machine learning decisions have the necessary transparency and explicability essential in diagnostic processes and to ensure user trust.

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<sup>1</sup> Similar expressions can be found in other governments' strategies and policies as well see, for example, the UK's work on the National Strategy for AI in Health and Social Care [41] or the Danish AI strategy [42]. See also [43] comparison of Nordic countries' future visions of AI in health.

In this article, I explore how a specific constellation of actors attempts to address and navigate the many issues and uncertainties characterising the current situation of introducing AI in the context of the Norwegian public healthcare services. Specifically, the research takes a qualitative case study approach to examine the so-called KIN network (Kunstig Intelligens i Norsk Helsetjeneste – Artificial Intelligence in the Norwegian Healthcare Services), an informally established network consisting of professionals with different backgrounds and affiliations with interests in AI and healthcare. The network aims to contribute to the ongoing work of enabling AI in real-world clinical settings by facilitating knowledge and experience sharing among its members and interacting with decision-makers, such as politicians, different authorities and hospital managers.

The article draws on concepts from Science and Technology Studies (STS) dealing with innovation and sociotechnical change as coming about through collective efforts of heterogeneous actors (see, for example, [17–20]). With the KIN network as an object of study, the article suggests that an entry point to understanding the challenges of introducing AI in healthcare is to look at the issues concerning AI deployment addressed by such actor constellations. The rationale behind this approach is inspired by Callon et al., who argue that exploring controversies ‘allows an inventory to be made of the different dimensions of what is at stake in a project’ ([21]; pp. 29–30). Similarly, in the case of this article, exploring how the KIN network addresses the challenges and uncertainties of AI deployment can provide an inventory of what is at stake in the current introduction process. Such an analysis may also render visible elements not taken into account by more overall and generic expectations of AI, like the one of the Norwegian Government. Exploring uncertainties related to emerging complex technologies is crucial to delineate what may be overlooked in innovation processes but nevertheless are essential to identify, mitigate and monitor in order to achieve sustainable solutions.

More specifically, the article addresses the following research questions: *how can an informally established network of professionals, like the KIN network, contribute to enabling AI in healthcare?* To discuss this topic, I seek answers to the following sub-questions: *How does the KIN network characterise its purpose and role, and how does it go about achieving its aims?*

The article starts with an outline of the theoretical framework, followed by a presentation of the research methodology, including a description of the case, the research process and the data analysis. Subsequently, the article presents the findings, followed by a discussion and final remarks.

## 2. Innovation processes as collective activities

Scholars within Science and Technology Studies (STS) have argued that innovation and sociotechnical change result from the interactions among actors with different characteristics (see, for example, [17,18,20,22]). Through the KIN network, human actors from different backgrounds and affiliations come together to share their knowledge and experience. Such heterogeneously organised knowledge production, happening across otherwise typically distinct boundaries between disciplines, sectors, and organisations, is what Gibbons et al. [23] refer to as a ‘hybridisation’. This hybridity may have an effect leading to the establishment of actor constellations called ‘hybrid forums’, which again ‘reflects the need of different communities to speak in more than one language in order to communicate at the boundaries and in the spaces between systems and subsystems’ ([23]; p. 38). Similarly, Callon et al. [21] describe hybrid forums as ‘open spaces where groups can come together to discuss technical options involving the collective’ and where ‘the groups involved and the spokespersons claiming to represent them are heterogeneous, including experts, politicians, technicians, and laypersons who consider themselves involved’ (p. 18). Callon et al. emphasise further that the aspect of hybridisation also relates to the type of questions and problems discussed in such forums, which are related to a variety of domains and addressed at different levels. Moreover, a

common trait of these hybrid forums is that they often emerge due to unpredictable and messy advancements in science and technology, and they are suitable ways to manage or accommodate the uncertainties generated by such advancements ([21]; p. 18). In this context, uncertainties may be seen not only as the reasons for certain group constellations being established but also as a great motivation for seeking and gaining more knowledge ([24]; p. vi).

Aiming for heterogeneity in group constellations established for influencing societal transition processes is not uncommon in Nordic countries. It aligns well with ‘consensus-building’ being one of the key pillars of their political systems ([25]; p. 18). This consensus orientation places the Nordic countries as reformers somewhere in between the slower-moving systems of, for instance, Germany and systems which are able to keep a higher speed, such as in the UK. Even though the Nordic system of ensuring consensus takes time, and the result is not necessarily radical, the chances of implementing more sustainable solutions are often higher [26]. Aiming for consensus and sustainability corresponds, furthermore, well with the Nordic countries’ AI strategies, which have a particular focus on AI for sustainable societies [27,28].

Within political science, another type of group formation is described as ‘interest groups’ [29]. These are, like hybrid forums, positioned between systems and subsystems. However, such constellations are typically not open spaces, nor do they include the same variety of member types. The members of interest groups are mainly spokespersons for the members of the organisations they represent; they do not necessarily represent themselves or their like. The kind of ‘in the middle’ position taken by interest groups reminds us how they are intermediaries, acting between ‘networks’ in the political science understanding of the term (see, for example [30], and the subgroups that have specific interests within the particular policy area. Thus, interest groups are typically associated with advocacy organisations (e.g., Doctors without Borders) or professional associations and/or trade unions (e.g., country-specific medical associations). Hence, interest groups aim not to create knowledge across, for instance, institutional boundaries, such as in hybrid forums, but help to ‘facilitate relationships between actors that would otherwise have difficulty relating to one another’ [29]; p. 433).

Scholars associated with one of the most well-known STS frameworks, Actor-Network Theory (ANT), offer another perspective on collective activities. Akrich et al. [17] argue that innovation processes and their outcome are shaped by the number of actors that the project at hand is able to mobilise and by the character of the interactions between these actors. In this context, the actors can be both human and non-human (e.g., AI technologies). Thus, an essential element for mobilising the necessary actors and gaining enough power to proceed with innovation is to make and keep relevant actors interested in the project ([17]; p. 205). If the project, exemplified by the KIN network in the present study, succeeds in keeping the actors interested and establishing the necessary alliances, this confirms the validity of the project’s aim or foundational principle.

Callon’s [18] influential depiction of the domestication of scallops and fishermen of St Brieuc Bay gives several examples of how alliances between actors are established but also threatened and how this affects an innovation process. An essential point in Callon’s story is how non-human actors (e.g., AI technologies) are entities important to involve in the ongoing processes and keep as allies, in the same way as human actors (e.g., physicians as AI users). However, as non-human actors like AI technologies cannot speak for themselves, they are given a voice through other actors who bring them into the conversations (e.g., AI researchers, vendors, users or researchers studying AI in use). Thus, considering who speaks in the name of whom is essential, which also includes paying attention to the distinction between spokespersons and representatives ([18,31]; p. 216). For instance, in the case of this study, AI researchers or AI vendors, who are currently the most knowledgeable regarding the capabilities of AI technologies, may appear as the AI technologies’ main spokespersons. As these spokespersons have their own interests or agencies, such as promoting their research or selling

their products, they will most likely represent AI in a certain (optimistic) way. These interests influence, furthermore, which kind of information is shared and circulated within the project at hand—the KIN network and beyond. This distribution of power raises questions about which versions of AI the existing alliances that collectively aim to enable AI in healthcare are built upon and how this assemblage of AI versions and their beholders affects the outcome of the ongoing introduction process.

The KIN network's aim of facilitating the sharing of knowledge and experience among professionals with a focus on the issues and uncertainties complicating the introduction of AI in healthcare does not only underscore the network's *raison d'être* but also that AI, as a sociotechnical phenomenon, is comprehensive and challenging to grasp, or worse still, to master. One significant consequence of an ambiguous concept such as AI [5] is that it complicates the ongoing conversations as people talk about AI from various perspectives and perceptions without knowing whether they are 'on the same page'. For instance, questions such as whether AI will make healthcare services more efficient will give several different answers, depending on whose opinion is asked and in what context ([5]; p. 28). Another outcome of the vast AI concept is that the flexibility of the term enables multiple actors to form their own expectations and develop their expertise accordingly. If this expertise, building on certain expectations, is broadly and convincingly shared, this could set an agenda other stakeholders will follow ([32]; p. 139).

These examples of potential consequences of the vague and flexible AI term show that there are rhetorical aspects of importance to be aware of while studying AI conversations. As an *apropos*, and perhaps slightly ironic, as AI is a broadly defined concept and treated accordingly in the conversations observed and the interviews conducted during this study, the generic and overall terms 'AI' and 'AI technologies' are used interchangeably in this article. These terms cover AI in both a broad and narrow sense and simultaneously reflect how it is used within the network studied and by the informants.

### 3. Research methodology

This article is based on a qualitative longitudinal case study approach, including data from non-participant observations of the KIN network's meetings, conferences and seminars, and semi-structured interviews with the network's secretariat.

#### 3.1. Case description

In late 2020, the KIN network was established in Norway as a nationwide initiative to increase AI deployments in real-world clinical settings. The initiative came about through informal conversations among peers in relation to the first national conference on AI in healthcare for managers and clinicians in the Norwegian healthcare services, organised in Bodø in 2019. A year later, some of the initiators became a part of a secretariat of eight people, managing the network and facilitating its activities. The secretariat consisted of:

- a researcher from a research department at a private limited company
- a department manager from a public agency
- two managers from a national research centre
- a senior adviser from one of the four Norwegian regional health authorities
- a department manager from one of the four Norwegian regional health authorities

The activities carried out by the network are quarterly meetings organised by the secretariat and three to four yearly seminars or conferences organised by network members representing different geographical areas and institutions. The secretariat sets the meeting agendas inspired by input from the network members, while the local organisers develop the conference programmes.

The KIN network has no limitation regarding the number of members. As such, everyone interested can join the network, including, but not limited to, professionals with backgrounds in medicine, mathematics/statistics/physics, machine learning, health economics, healthcare research, pharmacy, and social sciences [33]. The members are typically recruited through colleagues, other acquaintances or a sign-up option on the network's website. During the two years this study was carried out, the member list grew from approximately 20 participants at the first official meeting to 160 members at the end of 2022. The largest group of members are researchers from fields within the hard sciences (e.g., informatics, machine learning in particular and medical physics) from universities, research centres or hospitals. Other groups are hospital employees and bureaucrats with backgrounds in medicine or technology, working at the intersection between technology and healthcare. Finally, some of the smaller groups are people from the industry, mainly from software companies, interest organisations, and municipalities. Additionally, in February 2023, the network had 32 observers, including the author of this article and project managers or senior advisers from affiliations such as the Norwegian Directorate of Health, the Directorate of E-health, the Board of Health Supervision, and the Board of Technology which supports political decision-making processes.

#### 3.2. Research process

I was enrolled as an observer of the KIN network just in time to participate in the second official meeting in February 2021. For two years, until December 2022 and with a short revisit at a meeting in May 2023, I observed their quarterly digital meetings (eight altogether) and three of six conferences/seminars (two in-person). As I attended these activities, I especially paid attention to the people participating in the discussions and giving presentations, who they were and what they talked about. During these observations, I mainly observed the ongoing verbal communication unfolding and the visual presentations. As I did not know beforehand who would attend the meetings, getting consent from all participants to record the discussions was impossible. Therefore, the primary source of documentation was fieldnotes taken during the meetings. At two of the conferences I attended in person, I also conversed with participants during coffee breaks and meals, writing fieldnotes afterwards when by myself.

Furthermore, in Autumn 2022, I interviewed six of the eight secretariat members who had been part of the secretariat from the very beginning. The interviews lasted between 30 and 60 min and revolved around topics such as how the network was established, the aim and role of the network, who the members were, whom the network collaborated with, how the two years with the network had been, which kind of AI they saw as mediated through the network, and what they perceived as current achievements, challenges, and relevant work to carry out in the future. These interviews were recorded and fully transcribed.<sup>2</sup>

As secondary material, I examined the PowerPoint presentations from the presentations given during the meetings. These also acted as the network's meeting minutes, as the secretariat added a few comments to the presentations after the meetings. I also studied the conference programs and the information and documents published on the website (for website URL see, [34]). The website provided information about the network, the secretariat, the members and the membership policy. It also included a list of ongoing AI projects in Norway (primarily research and development projects at hospitals) and an overview of the network's activities.

<sup>2</sup> The research project and its data management practice, including anonymisation procedures and data storage, was approved by the Norwegian Centre for Research Data (now called SIKT – the Norwegian Agency for Shared Services in Education and Research). The interview informants were informed about the procedures and signed a consent form.

### 3.3. Data analysis

The transcribed interviews were analysed in three phases. First, they were subject to explorative open coding, where they were read line-by-line and different themes were highlighted. Subsequently, the text was reread and coded with more specific codes ([35]; p. 172). As similar codes were grouped, overall categories emerged, such as ‘the network’s purpose’, ‘role of network’, ‘members’, ‘AI in healthcare challenges’, ‘topics discussed’, ‘agendas’, ‘challenges for network’, ‘interaction with other stakeholders’ and ‘influence in the field’. Lastly, a more abductive process was conducted as the categorised data were considered and refined based on the issues foregrounded by the research questions, which took shape after the first two analysis phases. This process resulted in two main categories: ‘the network according to the network’ and ‘the network’s activities, agendas and influence’. The fieldnotes, meeting minutes, conference programmes and website information were further conferred for elements supporting or supplementing the findings from the interviews. An example of such elements is the description of the network from the website included below.

## 4. Findings

The findings presented in this section are organised after the two categories resulting from the data analysis, which also reflects the topics of the research sub-questions.

### 4.1. The network according to the network

On the KIN network’s website, the network is described as follows:

*KIN is a national network for artificial intelligence in the healthcare service, which consists of various professional communities from all over the country. The network takes a bottom-up approach and aims to share experiences and put important issues concerning the clinical implementation of artificial intelligence on the agenda. We connect professional communities by establishing meeting places for joint discussion and exchanging knowledge about implementing artificial intelligence in the healthcare sector. The network is open to anyone who wants to participate and share their work* (excerpt from the KIN network’s website, my translation)

This quote describes the network’s intentions as three-folded: to share experience and knowledge, set central issues on the agenda and connect people from different fields, all based on a ‘bottom-up’ approach.

Apart from being open to those who want to participate, the network’s membership policy underscores that membership is personal, meaning that the participants represent themselves and not their affiliated organisations [33]. During the interviews, it was argued that being a personal member made the work and discussions easier as the members did not need permission from their managers to participate in the network or have a particular opinion on the topics discussed. The conversations unfolding during the meetings could thereby proceed more freely, without too many restrictions and reservations. It was further argued that this made the membership and the network more informal and, at the same time, aligned with the ‘bottom-up’ approach the network wished to take.

The use of the ‘bottom-up’ term to describe the approach was repeatedly emphasised during the introduction of the meetings. The logic behind the approach was explained by an informant as follows:

*It’s quite simple: keeping the focus on what the people with knowledge of AI in healthcare perceive as difficult or useful, what the solutions to the problems are, and so on, will result in a more professional-oriented agenda than a political one. If we [the network] find different potential [in AI], which the top management either doesn’t see, doesn’t include in strategies or doesn’t make decisions about ... then you have to do what*

*you normally do: try to let it [the knowledge] trickle upwards in the system, talk to your bosses and so on* (a secretariat member, my translation)

This statement shows not only that individualised expert knowledge is essential to the network but also that the knowledge and expertise should be channelled (or trickle) further ‘up’ the system, letting the knowledge of the professionals inform the agenda in these circles, too. The informant argued moreover that this way of sharing information is the best way to establish proper foundations for important and strategic decisions in the case of AI:

*To the extent that we stumble upon gold, right, we must tell our managers what it is so that they can act on it. In the boardrooms and in top management positions, you don’t automatically know everything that happens at the grassroots level* (a secretariat member, my translation)

Through these two latter quotes, we find examples of perceptions of how decision-makers need help from the knowledge of experts to act and make decisions related to the introduction of AI in healthcare. Similarly, another informant remarked that ‘the bureaucracy’, which the informant claimed was too distant from the dynamics in the professional communities, needed knowledge from the professionals to develop proper policies: ‘It is hard to imagine knowledge-based policy in this area, without the professional communities being very actively mobilised’. Furthermore, this quote underscores that the network perceives the mobilisation of several actors as an essential factor in the early phases of introducing novel technologies.

There was also another reason why a network like the KIN network was perceived as necessary. As an informant argued, no healthcare organisation had come very far in deploying AI, which again made it important that the professionals had the ability to discuss and share knowledge in ‘informal grassroots networks’. The use of the term ‘grassroots’ in this context can also be seen as a way of positioning the network as a counterpart to the more ‘top-down’ initiatives in the healthcare sector and, again, aligning with their ‘bottom-up’ approach. The characteristic of being an informal network was further stressed by referring to the fact that they did not have a budget or mandate from elsewhere: ‘We don’t have a budget or anything, right ... people do it almost on a voluntary basis’ (a secretariat member).

Prompted by a question of what the KIN network had achieved in the two years it had existed, an informant stated that it had become a sort of ‘gravity centre’ for many of the ongoing processes introducing AI in the healthcare services. Another informant remarked that: ‘it has become a way of having a dialogue with the authorities, it has become a channel where people can give input [to the authorities], and it is easier for them [the authorities] to ask the KIN network [for input or feedback on certain topics]’. Thus, the network was described as a ‘dialogue partner’ but also as an ‘expert group’ or ‘catalyst’. All of these descriptive terms, ranging from ‘grassroots’ to ‘gravity centre’ and ‘catalyst’, give quite different interpretations of the network’s role: from being something that covers the ground, ensuring a solid fundament for knowledge to grow, to a centre from where different projects are created, start evolving and accelerating.

### 4.2. The network’s activities, agendas and influence

The means to achieve the network’s goals of knowledge and experience sharing were mainly the organisation of ‘a series of focused seminars/conferences where professionals from relevant communities meet to share experiences through presentations and discussions’ (excerpt from meeting minutes, 27. November 2020, my translation). On these occasions, both network members, observers and invited non-members contributed as presenters or participants in panel discussions. These contributors were typically from the research and hospital environments but also from the industry, legal experts, the cancer registry, the four regional health authorities, the data protection authority, the

Directorate of Health, the Directorate of e-health, and the Ministry of Health and Care services.

An informant explained that the meetings should reflect what most members agreed upon as necessary topics to discuss, adding the question: ‘What are the most important and difficult topics that must be resolved in this area?’. Thus, to a certain degree, the meeting agendas were informed by the result of digital polls conducted at the end of each meeting. Through these polls, called ‘temperature checks’, the members could vote for topics they perceived necessary to address or crucial to discuss in future meetings. The polls consisted primarily of pre-defined topics for which the meeting participants could vote. However, at some meetings, suggesting other issues through a free-text option was also possible. A third way for the members to influence the meeting agendas was to contact the secretariat directly with ideas or wishes. Incoming suggestions were typically transformed into pre-defined topics, which were added to the polls for the upcoming meetings. Thus, the list of categories could change slightly from meeting to meeting.

The predefined topics of the polls typically included categories such as:

- ‘Validation and adjustment of AI solutions to local conditions (incl. Norwegian patient groups)’
- ‘Ethics and legislations regarding AI (bias in data, black box, responsibility)’
- ‘Clinic and users – decision support and communication of uncertainties [the system’s output provided for the clinicians, informing them about the accuracy or quality of the AI result]’
- ‘How to make AI solutions as beneficial for the clinics as possible’
- ‘Make or buy [develop AI in-house or buy commercially available products]’
- ‘Competence development within the sector’
- ‘Cloud solutions for data sharing’
- ‘Harmonization/data quality’
- ‘Policy and financial incentives’
- ‘Validation of continuous learning technologies’
- ‘Infrastructure and cyber security’
- ‘Consequences of new rules for certification and approval of AI solutions [how to obtain CE-marking following the updated Medical Device Regulations, 2021]’. (a synthesis of categories from the different meeting presentations, my translation and additional explanations in brackets)

The upper three categories of this list were rated as the top three of the most desired topics for discussion during the two years the meetings were observed. As I attended a meeting five months after I completed the data collection, this ranking was still the case. Although the topic of this particular meeting was ‘Quality assurance and validation of AI’, the same topic was voted for as the number one topic for future discussion at the end of the meeting. Based on this ranking, it can be argued that areas perceived by the network members as involving most uncertainties are all related to the deployment of AI in real-world clinical settings and key issues particular to AI technologies for healthcare. The uncertainties included questions such as: how can or should healthcare providers validate or test AI technologies before deployment in clinical practices,<sup>3</sup> will it be possible to adjust the technologies according to local conditions such as particular clinical workflows, procedures and patient data, will the outcome of use be fair and safe for all patients, who is responsible if errors occur and how can the clinicians be sure of the accuracy and quality of the AI result?

Apart from the meetings and conferences, the network members and

<sup>3</sup> For insights on what a validation of AI for use in healthcare might imply, see [44]; which includes an overview of the British standard for a validation framework, informed by multiple and various experts and public consultations.

especially the secretariat attended or carried out additional activities to influence politicians, authorities and other decision-makers. These were activities organised outside the borders of the defined network (the regular meetings and conferences), such as workshops on AI adoption organised by a national coordination project also aiming to enable AI in healthcare initiated by a policy plan of the Norwegian Government [9] (cf., [36]). The secretariat also wrote a letter to the Ministry of Health and Care Services stressing the need for a continued focus on enabling AI adoption, and they organised an event at the largest and most important yearly political gathering in Norway, Arendalsuka, in 2022. At this event, they reached out to politicians and health authorities as they argued for a need for a national ‘roadmap’ to overcome many of the current issues of introducing AI in healthcare services.

Another type of interaction between the network and the authorities happened as representatives from the authorities gave presentations at several of the network meetings about topics such as access to data for AI use in healthcare or about activities carried out on a national level to ease the introduction of AI in clinical practices, including guidance on juridical issues. Based on the authorities’ presence at various meetings either as presenters or observers, an informant claimed that the network had become valuable for the authorities as they could both ‘inform and obtain knowledge for their own part’.

However, some of the informants also questioned the actual influence of the KIN network. For instance, regarding the final decision-making, one informant remarked that no matter what knowledge or recommendations the network shared with the health authorities, ‘the government will do as it pleases’. Another informant questioned whether the knowledge shared and accumulated through the network would reach the clinical practices and further benefit the patient treatment. The informant elaborated on this issue by relating it to the Norwegian tradition of organising hospitals into what the informant called ‘silos’; one silo for research and another for patient care, between which few bridges exist for knowledge transactions. The informant explained this as follows:

*... one of the great weaknesses of the Norwegian public hospital sector is that it is rigged, as in the 1970s. It’s rigged for streamlining patient care on the one hand and research on the other, separately. The latter produces knowledge, preferably by studying patient care. When such knowledge is established, to a sufficient extent, there are fragile mechanisms for deploying it into the clinic and further changing the clinic (a secretariat member, my translation).*

The informant continued to elaborate on how these silos also challenge the introduction of AI. As the informant stated, AI is a kind of information technology which is even farther away from patient care than the research carried out in the research silo. The research is at least related to specific patient groups and, therefore, has a connection to the hospitals’ clinical practices. In the case of AI, however, the informant perceived this distance or lack of access to clinical settings as a reason why it is hard to find out whether or how AI technologies can benefit clinical work.

## 5. Discussion

### 5.1. Hybrid knowledge production to enable AI in healthcare

As the KIN network is open and aims to mobilise different actors interested in AI and healthcare from across disciplines, sectors and organisations, conditions are established for enabling hybrid knowledge production, as described by Gibbons et al. [23]. However, despite the network’s attempts to mobilise members representing diverse expertise and affiliations, most of them were AI researchers from the research and university sectors and hospitals’ research units, with a background in fields like informatics, machine learning and medical physics. This group was followed by smaller groups of bureaucrats working within areas of healthcare and technology, hospital employees working on

technology-related projects and representatives from the AI or software industry. This distribution of members raises questions about whether the actors mobilised through the network are heterogeneous enough; are they able to produce the hybrid knowledge necessary to gain a better understanding of the many uncertainties concerning the introduction of AI in healthcare and, subsequently, contribute to ensuring sustainable AI deployments? It also raises questions about who speaks in the name of whom [18,31] and what the current selection of spokespersons might imply for the knowledge shared within the network and the network's contribution to the introduction of AI in the Norwegian public healthcare services.

From the current member list, it can be argued that the majority of the members who speak on behalf of AI technologies have interests in promoting such technologies in certain positive ways; they are AI enthusiasts. Thus, it can also be argued that these actors' expertise, grounded in their expectations of AI and communicated within the network, set the agenda for other members and associated stakeholders to follow [32]; p. 139). As of now, what seems to be missing in the network, and therefore not influencing the agenda nor the knowledge production, are members representative of actors such as AI users and specific AI technologies in use in real-world clinical settings (e.g., actual users or researchers studying AI in use). Such spokespersons could potentially provide more knowledge of the uncertainties identified by the network members as crucial to discuss in order to proceed with the introduction of AI in healthcare.

However, as new and more actors emerge, new uncertainties will surface, too [21]. Consequently, as the missing actors become mobile and become a part of existing actor constellations, previously overlooked, deemed unimportant or unknown issues can be identified and explored. That the lack of representative spokespersons may result in crucial issues being overlooked underscores the importance of continuous work to mobilise new actors as they appear to enable a more hybrid knowledge production.

The issue of crucial actors not yet properly mobilised within the KIN network questions further the network's self-declared 'bottom-up' approach. Rather than representing the 'bottom', it can be argued that the majority of the current members are positioned in the middle, between the system (the government and health authorities) and the subsystems or the actual 'bottom' (including actors such as AI users, patients, and specific AI technologies in use). The network may also be seen as taking a middle position in the tension between industry advocates pushing for a market approach and more top-down governmental processes focusing on developing national frameworks and regulations to avoid or mitigate potential harms (cf., [36]). This position is underscored by the variation in members representing both poles who collectively, through the network, seek to contribute to enabling AI in healthcare. This perspective, positioning the network in the middle, suggests that the role of the KIN network resembles more the intermediary role of interest groups rather than the hybrid knowledge-producing role of hybrid forums.

Conversely, it can be argued that as long as the discussion of AI stays on an overall, mostly theoretical level where AI is treated in general terms and not as specific technologies with evidence of real-world performances, the current network members are the 'bottom'. Thus, paradoxically, this is also where the network differs from interest groups. The present network members mainly represent themselves and their interests; they are the 'grassroots' from which knowledge grows and 'trickles upwards' in the system. Moreover, as they have no budget or formal mandate, the term 'informal grassroots network' may not be as farfetched after all, positioning them as a counterpart to the more 'top-down' initiatives.

As long as the number of AI deployments in healthcare continues to be limited, the number of users and AI technologies in use will be limited, too. However, as soon as the number of deployments increases, the new 'bottom', including spokespersons representative for actors such as AI users and specific AI technologies in use, can be mobilised

into the network. Eventually, with more knowledge of AI technologies' actual performance and evidence of immediate impact, new uncertainties can be identified and explored, and new knowledge can be shared within the network and beyond. Furthermore, as the new 'bottom' is mobilised, it can be argued that a broader consensus can be built within the network. However, such consensus-building will take time as the number of network members has increased and become more heterogeneous. This broader participation and heterogeneity may also require that the secretariat work actively to avoid the establishment of fractions within the network as a result of the network becoming more distributed in character. However, if a broader consensus is achieved and the hybrid knowledge produced as a result is shared with decision-makers and other stakeholders, the chances of a more sustainable outcome might be enhanced. On the other hand, failing to mobilise the new set of actors emerging could mean that the network eventually dissolves; if the knowledge produced has no relevance to the new situation with AI in healthcare, the members' and other stakeholders' interest in the network will probably decline.

## 5.2 The KIN network as a hybrid forum

Introducing AI involves multiple uncertainties, many of which seem to be constitutive of the KIN network and their meeting agendas, similar to the hybrid forums of [21]; p. 18). The uncertainties related to AI deployment identified and prioritised by the network members as essential to achieve more knowledge about can furthermore be seen as incentives for continuing the meetings [24]; p. vi). Elements of answers to the current uncertainties will become visible as more and more AI technologies are deployed and taken into use. However, it will not be possible to predict or get a complete overview of either short-term or long-term outcomes of the various and widespread AI deployments that will take place in different local clinical practices, their particular workflows, procedures and patient data. Thus, as the introduction of AI enters new phases, a myriad of new uncertainties connected to the many variations of AI technologies and use contexts will appear.

The prospects of a continued landscape of known and unknown uncertainties call similarly for a continuation of exploring and addressing emerging uncertainties. Even though such explorations will never lead to exhaustive inventories of all possible uncertainties, they will make visible some 'means to take measure' as AI technologies are introduced, taken into use and used over time. Subsequently, the inventories will enable the involved actors to anticipate and monitor critical issues and uncertainties and discover new ones as others are reduced ([21]; p. 22). Arguably, in cases concerning the introduction and use of ambiguous and unpredictable technologies like those based on AI, such continuous work seems more relevant than ever.

As Callon et al.'s hybrid forums, constellations like the KIN network can serve as an 'apparatus of elucidation' ([21]; p. 35). Today, such elucidation of the inventory of the present uncertainties can be exemplified by the list of topics identified through the 'temperature checks' as important to the network members to discuss. The meetings addressing topics such as AI validation and data access for AI use are further examples. As the members share their knowledge and this knowledge 'trickles upwards' to decision-makers in the system, it can be argued that they affect the current state of introducing AI after all. As such, they may even contribute to reducing some of the present uncertainties and, thus, to a certain extent, contribute to enabling AI in healthcare. This could, for instance, be as the KIN network draws the authorities' attention to the healthcare services' need for a national 'roadmap' or hospitals' need for support to start validating AI in their local clinical settings, despite the organisational silos between research activities and patient care.

As the discussion above indicates, the ongoing 'elucidation' and contribution to reducing the present uncertainties are mainly based on knowledge produced by a 'weak' hybrid or heterogeneous actor constellation. Actors such as AI users, patients and AI technologies in use are not represented by spokespersons who can speak of how AI

technologies actually perform in real-world clinical settings or how they affect the lives of those inhabiting this world. As touched upon, the network's existence depends on the constellation of spokespersons it is able to mobilise ([31]; p. 218). If spokespersons representative for the now missing actors become a part of the network, the network can also better ensure that what is spoken for is not later refuted by the actors they speak in the name of [18,37]. Phrased differently, if a constellation of actors, like the KIN network, wants to continue bringing forth knowledge that contributes to a sustainable introduction and future with AI in healthcare, the new 'bottoms' of actors that emerge must be mobilised. If such mobilisations happen, a broader consensus-building and 'stronger' hybrid knowledge production can also be ensured within the network.

However, if wider participation and heterogeneity are achieved, it will introduce a new layer of complexity to the network constellation, which at the same time emphasises the problematic nature of AI as an umbrella term for different types of technologies. With the diversity of AI technologies and the many users and patients affected by these technologies, all of whom may be represented by a variety of spokespersons (no longer just the AI enthusiasts), the complexity of the network seems limitless. Consequently, as the network becomes increasingly heterogenous, securing consensus among the members and preventing the formation of factions or 'silos' within the network, where members gather based on shared interests and expertise, becomes more challenging.

Hence, as various AI technologies are deployed, and new sets of actors are made mobile, it may become necessary to define some boundaries for the network. This may include making decisions concerning which specific type of AI technologies or medical area the network should focus on, as well as which users and patient groups should be included and represented by whom. Ultimately, who should be a part of the network's new 'bottom' will have to be negotiated.

## 6. Summary and final remarks

Through this study, the characteristics of a network of professionals aiming to contribute to enabling AI in the Norwegian public healthcare services have been explored. So has their ability to lessen the issues and uncertainties currently complicating and delaying the deployment of AI in healthcare.

Through the KIN network, knowledge production and sharing between actors not necessarily previously linked happens. However, the heterogeneity of the network can be questioned and problematised. As of now, certain actors cannot be sufficiently mobilised and are therefore not yet spoken for within the network. These actors, lacking representative spokespersons, include human actors, such as physicians as users of AI and patients as recipients of services supported by AI, as well as non-human actors, such as different but specific AI technologies in use, spoken for by, for instance, researchers studying AI use. In the current network, AI users, patients and AI technologies are mainly spoken for by actors who can be characterised as AI enthusiasts. This representativity, or the lack thereof, affects the knowledge produced and shared within and beyond the network. Thus, based on the network's characteristics, it can be argued that its contribution to enabling AI in healthcare has its natural limitations. The network cannot produce the hybrid knowledge necessary to reduce currently known uncertainties regarding AI deployments in real-world clinical settings.

As more and more AI deployments occur and the actors not yet properly mobilised start interacting, more concrete issues and uncertainties will emerge. Thus, as introducing AI progresses into more widespread deployment, such actors can better be mobilised. Subsequently, a stronger hybrid knowledge that contributes to a more sustainable introduction of AI can be produced. For now, in the early phases of introducing AI in healthcare, this study shows that the KIN network is an 'apparatus of elucidation', bringing forth uncertainties necessary to explore and address in order to progress in deploying AI. These

uncertainties are made visible through the votes given by the network members concerning the topics they deem most important to discuss and the further activities carried out within the network. As the current members interact and share their knowledge with other stakeholders, they draw decision-makers' attention to these elements of importance for enabling AI in healthcare. Which role informally established networks, like the KIN network, will play as AI becomes more widely deployed will depend on whether the spokespersons representative for the new actors that emerge are mobilised. It also depends on whether they are able to stay as a united constellation. Only then can a strong hybrid knowledge of existing and arising uncertainties be produced.

Finally, although this study is limited to a single case within a Norwegian context, it highlights a global trend. Numerous initiatives worldwide are working towards enabling widespread deployment of AI in healthcare, exemplified by the Alliance for Artificial Intelligence in Healthcare [38], the Canadian Association of Radiologists Artificial Intelligence Working Group [39] and the Australian Alliance for Artificial Intelligence in Healthcare [40]. Thus, to enhance our understanding of the role played by different constellations of actors in contexts of emerging complex technologies, this study calls for further investigations of such mobilisations. Moreover, the study calls for investigations of what occurs as AI technologies are increasingly deployed in healthcare and new actors and uncertainties appear. Further research in these areas will contribute to a more comprehensive understanding of the introduction and future of AI in healthcare.

## Author statement

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

## Data availability

The data that has been used is confidential.

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