Towards a Sociology of Healthcare Robots

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Abstract

We propose a sociological approach to healthcare robots that emphasises the heterogeneous ethics of mutual labour and the complex definitions of care that emerge through robot design/deployment. This argument is the product of a narrative literature review that examined assistive robots deployed in care settings. We found that although the deployment of healthcare robots has redefined the concept of care, as featured in geography, legal studies, and philosophy, it rarely appears in sociological inquiry. There are three fields that this approach to a sociology of health and illness complements. These are (1) phenomenology and the new approaches to touch and recognition in embodied relations with robots; (2) biopolitics, where the governance of life is conceptualised as a conjunction between the biological and artificial; and (3) the reconfiguration of healthcare labour around mutuality, where robots both maintain, and are maintained by, the human. We end by suggesting that the increased implementation of robotics into care work provides a broader sociological opportunity for addressing how boundaries of 'human' can be rethought alongside new healthcare technologies.

Keywords: Artificial Intelligence, Biopolitics, Data, Labour, Robots

Introduction

It's 1985 and the PUMA 560 robot arm previously used for industrial tasks is being trialled by surgeons to aid with a biopsy cannula. As medical professionals use computed tomography to insert the needle into the brain, the aim is to lower risk from hand tremors (Hockstein et al, 2007). Since this trial, healthcare robots have been variably implemented across hospitals, residential care facilities, and domestic spaces to aid in patient care. The category of 'healthcare robot' is wide, with such robots taking a diverse range of mechanical forms. Healthcare robots are distinguished between being social

and non-social. Non-social robots include teleoperated surgical machines that aid with precision (Abrishami et al, 2014), while social healthcare robots are dialogical, including social and affective dimensions, as seen in arms that assist patients with feeding (Nickelsen and Simonsen Abildgaard, 2022) and automated companions that are intended to emotionally assist older and vulnerable patients (Pfadenhauer and Dukat, 2015). The focus of this review is on social healthcare robots since these offer new sociological dynamics in care. Robotics are a locus of hands-on-care, which include a type of embodiment as they materially interact with patients and healthcare staff, while also incorporating the algorithms that underpin these material processes (Maalsen, 2023). There is a significant body of literature that this review will contend with, which includes the social, affective dimensions (Jones, 2017) of robots as well as their materiality (Paterson, 2023), with each shifting our understandings of care since the trial of the PUMA.

Research on the inclusion of robots in healthcare settings has been led by philosophers, legal studies scholars, and geographers (Del Casino, 2016). These works provide a strong account of human computer interaction (HCI), but little of this is concerned with the sociology of health and illness. Despite this, there is value for sociologists of health and illness to consider the social, cultural, political, and ethical questions that these robots pose for healthcare. We conducted a narrative literature review to further explore this because of its value for investigating fields where there is no comprehensive sociological account in the literature (Smith, 2025). We shaped our literature review by asking (1) how the existent research approaches and conceptualises healthcare robots; (2) what the present gaps are; and (3) how sociologists can make use of this literature and address these gaps. Literature was gathered from Google Scholar, Web of Science, and SCOPUS, and focused on the ways that healthcare robotics takes the social world as an assemblage of knotted, entangled relationalities between humans, materials, and machines. This reflected the interdisciplinary accounting of robotics, which enrichened our outlining of a 'sociology' of healthcare robots, where sociology is viewed as adding a fresh perspective that layers this interdisciplinary investigation. This informed our search terms of 'biopolitics', 'robotics', 'robotics + healthcare', 'phenomenology' through medical sociology, social science and medicine, human computer interaction, science and technology studies, and phenomenology journals. Literature was assembled into a Zotero folder and was summarised on a large reading list document. The five authors then met to discuss themes emerging from the literature, which were focused on how sociologists of health and illness can contribute to healthcare robotics literature through existing perspectives.

We found that the inclusion of robots in healthcare settings has prompted a re-examination of human-nonhuman relationalities of care (DeFalco, 2016), where categories of human and machine entangle with one another. To capture these crumbling boundaries between human/machine, we propose a sociological approach to healthcare robots that emphasises the heterogeneous ethics of mutual labour and the complex definitions of care that emerge through robot design/deployment. The human is implicated within the machine and the machine is implicated within the human as robot designs mirror humans in appearance, speech, and gesture. After outlining how robot design/deployment disrupts existing relationalities in care, we turn to the contributions of this approach by exploring three significant fields relevant to a sociology of health and illness. These broadly structure the paper. Firstly, the approach contributes to the phenomenology of health technologies by complimenting existing work concerning the ways that boundaries between human and machine are transgressed through embodied interactions (Shildrick, 2023). Namely, the porousness of the biological body is enmeshed with new designs of soft robotics that generate feelings of care among patients (Paterson, 2023). Secondly, we draw on Lipp and Maasen's (2022) work on techno-biopolitics to further the conversation. The implementation of healthcare robotics reflects a governance of life, less biologically deterministic, but

instead more reliant on technologies that increase the surveillance, datafication, and commodification of the patient body. Third, our arguments pose new dimensions for thinking about healthcare labour as something that is mutually maintained alongside robots, where care staff keep robots operational and robots keep care staff working through the alleviation of health risks, such as back pain and more generally, compensate for possible labour shortages (Sumartojo and Lugli, 2022; Wright, 2018).

Our approach is located in the broader field of a materialities of care, where sociologists have argued that materialities come to stand in for caring relations (Buse et al, 2018). This perspective is used to map the impact that the robot has through embodied interaction. However, we expand on this to make the argument that sociologists should develop this perspective to capture the embodied data relations emergent in robotic interaction. The value of healthcare robots is that any interaction with these robots as things is a means through which agency is attributed to them (Alač, 2016). The human has never been more implicated in things both through embodied interaction and the data generated through those interactions. We end by suggesting that the increased implementation of robotics into care work provides a broader sociological opportunity for addressing how boundaries of 'human' can be rethought alongside new healthcare technologies.

Robot Imaginaries

The imagination of healthcare robots have informed assumptions of patient need, government policy on robotics, media representation, and public sentiments towards the use of robots in care. Approaching the imaginaries associated with healthcare robotics demonstrates the care relations underpinning robot design, but also the care robots are expected to deliver. Robots have long been imagined in fiction (see: the 1927 film 'Metropolis') before the technology to integrate them into healthcare settings was made possible. What robots can do and how they are modelled have regularly been based on these fictional imaginaries of the early and mid-20th century. For example, robots are often designed to have human characteristics, providing recognition that frames social interactions with them. DeFalco (2020) suggests that media and literary based representations of social robots in healthcare settings challenge our preconceived notions of care as a private exchange of mechanical processes and behaviours that take place through devalued labour. These imaginaries of robots act as a representation that asks us to think of care as a core feature of posthumanism where robots provide a means for reconsidering the nonhuman networks at play inside of relations of care.

Much of the research conducted into robot imaginaries have been undertaken with older people (Aronsson and Holm, 2021). Neven's (2010) research examines the ways that robots are adapted to those around them through the imaginaries of prospective users of care robots. He found that age based assumptions are regularly threaded into the design of technologies and their implementation, but that these assumptions emerge from both the prospective users and the designers of the robot. These design based imaginaries are problematised as prospective users are imagined as being old, frail, and lonely, which was an image of a particular type of care that designers and potential users distanced themselves from. Similarly, in a study concerning the perceptions of the need for robot assistance, Wu et al (2014) state that their older adult participants felt robots were not useful for them, but that they would be valuable to assist the particularly frail and vulnerable. Through these imaginaries, there is an element of distancing whereby the socio-technical components of the imaginary become a way of projecting an identity onto others. As in both of these papers, the findings reveal that those imagining the robots counter-define themselves against who they perceive as an ideal user in need of such services.

While significant attention has been placed on the imaginaries of potential everyday users, Lipp (2022) has placed more emphasis on the role of both the roboticist and the robot at the centre of these imaginaries. To reflect this, he introduces the concept of the 'robot drama', where roboticists stage the robot on a literal testing ground that brings together what we expect from robots and what they can do in practice. These dramas are in many ways testing grounds for the imaginaries of care that users expect from robots, whereby the roboticist has the opportunity to suspend this imaginary of possibility in favour of making repairs to the fragility of the machine. Lipp's work speaks to the broader sociological perspective of dramaturgy, refiguring the discussions in this. The robot takes the place of the actor at the social nexus of interactions, performing for the roboticist and informing new imaginaries. Vallès-Peris & Domènech (2020) have also focused on the translation of imaginaries of industry designed robots into the 'wildness' of the healthcare setting. They suggest that the design of the healthcare robot is based on the particular conceptions of care held by the roboticist. These conceptions of care speak to different elements of healthcare delivery, such as being task based, tedious, and/or physical. Studying roboticist imaginaries, they argue, are a means of tracing the fragmentation of the care relations underpinning design. These imaginaries embedded in the design of the robot are in tension with the ethics of care that prioritise common good and interconnectivity.

Refining the Relationalities of Care

The introduction of social robots into healthcare settings has impacted the relationalities present within care. This turn draws from the broader work on posthuman analyses of the relationalities between humans and nonhumans in care. Care is relational. As De La Bellacasa (2012) argues, to care about something is to create a relation. Literature on healthcare robots has further distributed and developed on the relationality present between the human and nonhuman in care. For example, Coghlan (2021) suggests that care robots capture a critical account of the conceptual limits of the robot and the human as they seemingly overlap within the assemblage of care work. The role of digital technologies has growing relevance to these 'more-than-human' relationalities of care. This is evident in Lupton's (2023) work on the internet of animals, where she argues that digital technologies bring with them new and constantly changing assemblages that challenge how we think about categories of 'human' and 'animal'. There have been many deployments of zoomorphic robots, such as PARO, the robot seal. Lupton identifies the importance of zoomorphic robots as representations of animals, with the treatment of these technologies mirroring our treatment of 'real' animals. The zoomorphic robots inspire similar relations between patient and animal carer, reflecting how the benefits of robot animals can mirror those of 'real' animals in care settings (Shoesmith et al, 2024). Digital technologies in essence offer new opportunities in the relationalities of care between people and animal counterparts.

There are differing approaches to the impact of digital technologies on more-than-human theories of care. DeFalco (2016) similarly draws on these crumbling boundaries between human and non-human in portrayals of robotics. However, she turns attention to the ways that the human is already implicated in the non-human through the design/deployment of digital technologies. The interconnectedness between the biological human body and the artificial steers us towards a conception of care as non-species specific. Boundaries between human and nonhuman that we have previously imagined as being closed are just that, imaginary. As robots show a greater humanity and lifelikeness in care settings, DeFalco notes that the human is always already implicated in the nonhuman, particularly when the nonhuman is performing a traditionally human function, such as speaking. A growing dependency on the humanity of technology facilitates a splicing of the categories of human and machine into one posthuman subject, which acts as an expanded relational self. The design of the robot increasingly

reflects human characteristics. They walk, talk, and wave. These human features underpin recognition that leads to users attributing a form of human agency to the robot, blurring the boundaries between life and object, human and non-human (Alač, 2016).

DeFalco's (2016) arguing for a posthuman subject that is already figured in robot technologies has roots in the broader critical engagement with intelligence as a mediator between these categories of human and machine. DeFalco follows from Hayles' (2014) earlier discussions of the cognitive nonconscious. Here, Hayles argues for a broader term of cognition that reflects an intention towards something. This type of cognition is found in all nonhuman life, but also in computational models. As Hayles (2014: 216) writes, "An object need not be alive or conscious in order to function as a cognitive agent." These ideas of automated thinking have been a developing trend in critical data studies (Parisi, 2019). There has been a growing significance placed on the similarities between human modes of thought and developing algorithmic assemblages of which automated healthcare robots are a part (Pasquinelli, 2023). Human thinking is therefore figured in data infrastructures, but healthcare robots too have been designed in the image of the human creator, with automated thinking models growing from an expanded concept of cognition. This poses the question of whether robots in healthcare are designed from the anthropocentric standpoint, reflecting human constraints in the design. Certain gender-based biases, for example, are often reproduced and exacerbated through the automated thinking of robots in healthcare (Fosch-Villaronga et al, 2022).

This expanded relational self is further articulated in the literature on the interactions between humans and robots in healthcare settings. De Togni et al (2021) have reflected on the changing relationship of care between human and machine by taking the concept of intelligence as a focal point. They note that the inclusion of robots in healthcare asks us to approach intelligence as something relational and affective to better capture this expanded relationality between human and machine. For example, machine learning algorithms underpinning robots in healthcare settings can be used to identify patterns and correlations of disease, generating new categories of illness. These can alter how medical professionals understand certain illnesses. Moreover, certain emotional components underlie these conceptions of intelligence. In a scoping review of the scientific literature on artificial intelligence and healthcare, Morrow et al (2023) place compassion at the centre of a psychological notion of the human-artificial intelligence conception of caring. They further state that, in this literature, artificial intelligence technologies are being used to enhance empathetic responses within these relationalities between human and machine.

Underpinning robots as intelligent actors in care is their sense of liveliness. This liveliness emerges through the mutuality of caring. Sumartojo and Lugli (2022) have reflected on the status of these healthcare robots as unfinished and contingent. Drawing on robots in the home during COVID-19, they argue that their status as unfinished gives them a liveliness whereby they can be redesigned on the go and improvised to meet an unplanned situation. There is a sense from Sumartojo and Lugli that these redefinitions of care are constituted through a sense of mutual caring between human and machine. Maalsen (2023) builds on these ideas by focusing on the software underpinning these robots. Through asking "What does caring for and with an algorithm look like?" (Maalsen, 2023: 198), they argue that care is not solely a human matter as care concerns the interactions between patients and technologies. Algorithms that shape robot intelligence are relational, they must be cared for as much as they are used in caring.

Healthcare robots are therefore dialogical (Jones, 2017) as they open up communications between receiving and providing care. Lipp (2023) contributes to this notion of mutual caring by reflecting on the way that roboticists and others render interaction between robots and people possible. He reflects on robots as being in need of care as much as humans need robots to care. Social robots are fragile and in constant need of maintenance by the humans around them. In caring for robots, Lipp argues that we come to confront the inherent anthropocentric notions of care, where caring for a robot causes a rethinking of the labour inscribed within the manufacture of the robot. This is specifically reflected in rethinking the anthropocentric interactions made with robots as agents of care, where interfacing becomes as much about providing care to robots as receiving care from them. This expanded relationality between human and nonhuman expressed through a growing mutuality of care poses significant implications for sociological studies of the phenomenological, biopolitical, and labour relations inside of healthcare.

The Phenomenology of Healthcare Robots

These assemblages of mutual caring between humans and robots have a significant implication on the approach of phenomenology. This is specifically present in the implications that these new relationalities of care have for the sensory engagement with machines. DeFalco and Dolezal (2023) highlight the importance of 'affective technotouch' to refer to the embodied encounters humans have with robot technologies. This sense of an affective technotouch is used to stress the vulnerability, porousness, and emotionality of the human body. These reflect embodiment as a core site in which the boundaries between human and machine cease to exist. This is evident through the sensory mode of touching where the machine seeps through the pores of skin. Touch is no longer a dividing line between human and nonhuman categories, but rather the vulnerability of the body implicates the human in the nonhuman. From this, the authors note that affective technotouch is a means through which scholars can question the powers and vulnerabilities that shape the way robot technologies are developed.

Touch is therefore a vital feature of the new relationalities of care prompted by healthcare. Paterson (2023) develops these ideas of touch by focusing on 'soft robotics', which are robots that invite more affective forms of interaction. Materially dissimilar to the 'hard', metal robot skin, soft robots are 'soft' and 'fleshy'. Soft robots like the HuggieBot invite new types of interpersonal interaction that lower perceptions of pain and increase comfort. For Paterson, these soft social robots provide a new means for investigating the futures of touching in interactions between humans and robots in care. Shildrick (2023) also reflects on the notion of techno-touch as part of an irreducible interconnectedness in dementia care. For Shildrick, touch is both physical, but also a metaphor for emotion. Touching brings human and machine into conjunction, grounding their vulnerability in a willingness to be open to a mode of living alongside robots and other nonhuman life. Touch is therefore a significant component for thinking through these new relationalities of care that robot applications in health settings open up. Touches between robots and people open up the porousness of the human body where posthuman sensibilities seep beyond the boundaries of the fleshy person, formulating a sensibility where the human lives in conjunction with nonhuman life.

These relationalities of care that close the binary between human-machine have also been found in the recognition that patients sense when engaging with robots. Parviainen et al (2019) have rooted this recognition within the sense of biography tied to the robot. This biography is reflected through the hybrid body of the robot, showing how it has features of the human body, such as a human smile, or blinking eyes. Yet, at the same time, the robot body is distinctly robotic and nonhuman, with plastic casings and grippers as hands. They present the notion of the double body, referencing the morphologies

of the robot design that are entangled with the features of living. Biography is recognised through the design of the robot body, whereby they are an embodiment of the assemblage of a human/nonhuman relational care. Zora, the robot studied, encouraged interactions with members of elderly residential homes. Here, these residents found the robot to resemble living beings, whereby they attempted to give Zora a personal history, tried to categorise its nature, and understood its actions through their own notions of bodily need.

While many create meaningful relations through empathy with robots, there is also an eeriness that accompanies robots in some patient responses. Kim et al (2022) suggest that these feelings of unease emerge not only from robots that have a high resemblance to humans, but also in those robots that had fewer similarities to humans. The authors found that eeriness came from the instances where facial manipulations did not correlate to bodily movement. This eeriness of robots was reduced when robots displayed emotions, which reflects that patients may find robots less eerie when they are able to empathise through shared emotions. However, age was an important mediator of this as Brink et al (2019) have suggested that the eeriness of robots develops as one ages. Specifically, these feelings of unease were found in children over nine years old and were located in the perceived mental capacities of the robot. This reflects the work above concerning intelligence as a relational concept, which in this case generates unease in the empathy and recognition children have in the thinking power of these robots.

Aronsson and Holm (2021) further discuss the significance of recognition and empathy in the relationalities between humans and robots. They suggest that as robots become more complex and their functions more sophisticated, the distinction between human and nonhuman agency will become meaningless. Drawing on the social robot, Pepper, and its interactions with older people, the authors argue that older people are able to form meaningful emotional connections with robots like Pepper by attributing agency to them. Kerruish (2021) has built on these notions of empathy and recognition by developing the concept of affective arrangement to examine human empathy towards robots. Like Aronsson and Holm (2021), Kerruish (2021) suggests that empathy is not an expectation that robots feel as humans do. Rather, these empathetic relations draw attention to the entanglements between humans and machines. These relations are sustained by human labour and Kerruish argues that designers should understand such robots as relational devices capable of forming meaningful affective relations with humans.

The Biopolitics of Healthcare Robots

The redefinition of care as one dependent on mutual caring between humans and robots has presented implications for well-established and utilised conceptual frameworks in the sociology of health and illness. Lipp and Maasen (2022) discuss the implications that these assemblages of mutual caring have for biopolitics. They argue that interpretations of Foucault's (2008) biopolitics understate the voice of nonhuman agency and are limited in capturing the governance of technology over life. That is, Foucault's biopolitics has been taken to be technologically deterministic, rather than centred on the relationalities between the biological and the technological.

To better capture these biopolitical entanglements of the biological and the artificial, Lemke (2015: 3) has refigured biopolitics to be one aligned with a 'government of things'. Lemke's argument for a government of things is intended to include the material realities that contemporary humans live within. That is, one interfacing utterly with technology. Though Lemke's argument is intriguing, he admits that serious theoretical challenges remain in expanding Foucault's (2008) concept to these new material

realities. Lindner (2020) has also argued for a shift in the concept of biopolitics not as a politics of life itself, but rather as a politics of life as it is lived. Drawing on wearable technologies, Lindner suggests that humans in contemporary digital life have never been more entangled with technologies. Wearable sensors discipline our behaviours, moderating heart rates and in some cases sending that data directly to government and commercial institutions. Focus, Lindner argues, must be placed on the behavioural modifications that socio-technical entanglements place on the (more than) human body.

Lipp and Maasen (2022) offer the term 'techno-biopolitics' to better capture the impacts on biopolitics from the nonbiological nonhuman. In a techno-biopolitics, life as it is lived is manufactured through the interconnections humans make with technologies. This occurs through interfacing, which the authors describe as a set of interactions that make biological life and technology compatible with one another. Life, as it has been known as distinctively biological and human, has become increasingly manufactured through these interactions with technologies that hold an increasing stake in the governance of life. As humans intermingle with machines, such as healthcare robots, life has become decentred from the purely biological. The concept of biopolitics therefore needs to contend further with the artificial components that impact on the governance of life.

This techno-biopolitics captures the ways that the capillaries of discipline are extended through robot technologies. For example, Lindner (2020) warns that analytical focus should be placed on the behavioural modifications that socio-technical entanglements place on the body. These ideas of behavioural modification are comprehensively expanded on by Zuboff (2019) in her account of 'surveillance capitalism'. For Zuboff, the collection of data and use of this data to modify behaviour is a significant model for capitalism. Value is generated from the ability of technologies to modify one's behaviour. The ability for healthcare robots to collect new forms of patient data provide them with a form of commercial value. Data is a commodity that is able to be used in the surveillance of patient care, and then exchanged based on that use (Lupton, 2014). The techno-biopolitics of robot deployment in healthcare settings draws attention to the commercial applications of data collection, arguably pushing the boundaries of established ethics and consent by increasingly 'interfacing' them through a digitised care. The care of the human body is reshaped through the digital mechanisms of the robot, where the biological body is abstracted into data that is then inputted into diagnostic systems, which are subject to being traded among different bodies in the pursuit of best care practice.

New forms of bodily surveillance interfaced through the biological and digital therefore ask sociologists and policy makers to pursue new lines of enquiry in patient care and consent, as well as a closer observation of institutional responses to these new techno-biopolitics that adapt patient care. These observations reflect Koopman's (2019) work on 'infopower', which is exercised through formatting and fastening. Formatting is where the categories used to gather the data on the individual are embodied in the individual and used to mould them. For example, formatting may occur where the categories of data used to shape individual care from the robot is embedded in their understanding of themselves as a patient. This is to say that the deployment of the robot into healthcare settings creates new digitised categories of patient care derived from data collection. Koopman's (2019) work shows how human agency is often formatted and then fastened into these new digitised, data driven institutional structures with little way out. Data is, as Lupton (2020) argues, made through people's actions and also used to make people. In this case, this reflects particular patient interactions with the deployed robot and the ways that this data is then used to create a patient in line with the care that they receive. While patient care is profoundly changed through mass data collection and offers new forms of power over individual patients, changes must come from the institutional level to recognise that the data collected and provided to patients, such as in the form of diagnostics, is used to benefit the patient rather than commercial gain.

Healthcare Robots & The Reconfiguration of Labour

These relationalities of care that healthcare robots introduce are therefore dependent on the labour of care workers (Kerruish, 2021). As established above, a significant change in labour has emerged from the unfinished state of robots (Sumartojo and Lugli, 2022). Where robots are included, care work is not one directional with robots giving and patients taking. Rather, as Lipp (2023) highlights, just like the humans they care for, robots are also in need of care. That is, the introduction of robots into healthcare settings changes how care is defined as one of mutuality but also asks the patients to perform labour in working with and maintaining those robots. Furthermore, this dialogue has been captured by Nickelsen and Simonsen Abildgaard (2022) who have shown that feeding robots reconfigure these human centred notions of care by providing new choices, which in turn impact the design of these robots. That is, the ways that feeding robots create new choices for patients in eating (or not eating) reveals some of the possibilities of what feeding robots can do in the care of vulnerable people.

These discussions of mutual care have also asked precisely what a robot can practically do in a healthcare setting. Lehoux and Grimard (2018) have outlined the work that assistive robots can do in healthcare settings. The authors found that their participants did not outright reject care from assistance robots. Rather, robots operated as potential mediators of social activities and were able to perform tasks to reinforce the independence of older people receiving care, such as cleaning the house, prevention of falls, and health monitoring. Though, their participants were sceptical about the ability of these robots to perform emotional work, underscoring their ability to perform as humans. However, these questions of practicality must also be considered around the cultural meanings of different tasks, which inspire diverse responses from care staff and patients. Wright (2018) provides the example of the lifting robot to make this argument. Lifting can cause backpain, leading to labour shortages. As such, the lifting robot is seen as a possible alternative. Yet, lifting in Japanese care cultures is situated in ‘peace of mind’ and the use of a robot to deliver this was viewed as disrespectful as it contradicted the ability of the care staff to treat each patient as an individual with their own personality and specific lifting needs.

There is a strong emphasis on ethics in care robot labour, with privacy being another significant component of this. Niemelä et al (2021) who highlight the concerns that telepresence healthcare robots pose to privacy, arguing that guidelines should be produced that outline where and how robots can be used in residential care settings. The privacy concerns emerged from the perceived lack of ethics concerning presence. When is the robot off? The authors argue that patient choice should be at the heart of the use of telepresence healthcare robots as the residential care facility is their home. Certainly, the same choices pertain to the use of semi-automated social robots in healthcare settings, too. This notion of privacy can also be extended to Bedaf et al’s (2014) work on robot labour. They argue that some forms of labour are too delicate for robots to undertake, such as assistance with showering. Smarr et al (2014) have also found that older American adults prefer human assistance for private, personal care matters, while they accept the use of the robot for assistance with more mundane chores. Santoni De Sio and Van Wynsberghe (2016) have argued that a stronger sense of ethics concerning what robots can and should do would rectify more than privacy, but rather would draw attention to the values that are at stake in healthcare settings. As such, they suggest that new policy ethics opportunities emerge from robot healthcare applications that could provide new insights into power and interest in these care settings.

These ethics expand into questions of racialised and gendered aspects of care robots. Sparrow (2019; 2020) challenges the politics of race present in this rethinking of relationalities of care when the healthcare robot is integrated as a labour force. Whether robots have a ‘race’ challenges roboticists to

navigate the racialised politics of care work that are embedded in the design of the robot. The sanitised design of a healthcare robot is white as it is easy to clean and reflects the medical aesthetic, but this faces the problem that robots are perceived as white, and viewed as replacing a racially diverse workforce of care workers. The further implication is that the default body is a white body, which correlates to the traces of racial and gendered biases in artificially intelligent diagnostics (Fosch-Villaronga et al, 2022). The contention of whether robots have a 'race' challenges roboticists to navigate the racialised politics of care work that are embedded in the design of the robot. Sparrow (2020) argues that an awareness of this racial politics will assist roboticists in realising the potential and social power of robots in care work.

Gendered notions of robot design ethics are highlighted by Strengers and Kennedy (2021) who reflect on the 'smart wife', the increasingly feminised character of AI assistants, such as Alexa, or Siri. These AI exhibit the tendency to frame designs around idealised 1950s US vision of the housewife. These technologies are used to carry out forms of labour that were traditionally seen as part of the housewife role. Docile but efficient; compliant but entirely in control, Strengers and Kennedy note that the smart wife reflects outdated female stereotypes and also reinforce conservative political narratives concerning the role of women in the home and childrearing. This is a global phenomenon as *Kawaii* (cuteness) in Japanese culture has influence over the design of such robotics. This air of cuteness factored into the gendered design and development of 'actroids' in Japan whereby the robot makes the consumer feel at home (Knox and Watanabe, 2017). Thus, we must take care to see the gendered dimensions inherent to the caring work that these healthcare robots do and what this means for the political narratives concerning the places and expectations of women in society.

Healthcare labour through robotics does not solely take place in the hospital, but also happens in the broader assemblage of those robots, such as in the manufacture of the parts that take place in the Global South. We have discussed extensively how the integration of healthcare robots has spliced the biological human with the artificial machine, but this occurs at the point of the user. Bissel and Del Casino (2017) note this and direct geographers to the etchings of power within situations and events. They highlight that robotics are changing workplaces from resource work to healthcare. At the heart of this, however, is a lack of recognition concerning the power of the consumer labour indicative of mutual caring and the production labour on the manufacturing line. Indeed, on an environmental level, Carr (2023) has discussed the entanglement between repair and care within the context of global climate crisis. Robotics provide a way to look within the moments of disruption posed to the planet. That is, the development of robots can cause harm to the planet, such as through deep drill mining operations. Yet, care through repair is also inherent in the mutual caring practices in the embedding of robots into healthcare settings.

Towards a Sociology of Healthcare Robots

The issue for sociologists of health and illness is that the deployment of robots into healthcare settings has profoundly altered care through a splicing between the biological and the machine (DeFalco, 2016; Hayles, 2014). Care is heterogeneous. This is seen in 'humanlike' robots integrated into healthcare settings, as well as the increasing abstraction of the biological body into configurations of data that are subject to surveillance and trade. Both of these have encouraged further questions of the biopolitics, phenomenology, and labour of care. These discourses of mutuality between human and machine could inform how sociologists approach care between people and things. As Pickering (1993) notes, the science that underpins these healthcare robots can be thought of as a discipline of performative material devices which enact forms of agency. The similarities between human agency and material agency lies not in intentionality, but rather in the ways that they are productive of one another. Consequently, when

we discuss the materialities of care it is important to reflect on the practice of the science that oversees the design and imagination of healthcare robots. This notion of a material agency that helps to inform the agency of human designers and public imagination reflects the co-production of agency, a mangling of practice between material development and human thinking. It may be here in the mangling of agency between the digitally material and the human where a sociology of healthcare robots is rooted, particularly in recognising that new institutional care structures are required to contend with the techno-biopolitics of such robots.

This draws attention to the materialities of care (Buse et al, 2018). Latimer (2018) adds that the use of materials constitutes the relations of care in which they are a part. Certainly, the prior work on the affective relations between human and machine through the porousness of the body reflects new ways to approach these materialities of care as splices of biological and machine categories (DeFalco and Dolezal, 2023). The expectations tied to the maintenance of robots in care settings (Sumartojo and Lugli, 2022) also presents sociological questions for the way that things are cared for in the political economy of care work. Buse et al (2018: 6) chart a materialities of care that they argue draws attention to the ordinary and non-verbal aspects of care practices. Materialities play an active part of care and the authors argue that "Materials are shared between people as part of practices of care, they sometimes 'stand in' for caring relations, and may shape, enable or constrain practices of caring." At the forefront of these materialities of care are the technologies that shape experience and feel of care in practice. These materialities of care capture the experiences one has on a sensory level with the things around them.

There are two ways that a sociology of healthcare robots may chart these entanglements between the human and the material, as materials stand in for caring relations that inform practices of care. The first is to place more emphasis on the imaginaries that inform the design of the materials that come to stand in for caring relations. For example, Nevan's (2010) work has shown that perceptions towards healthcare robots are often shaped by the imaginaries that users have of those technologies. Moreover, the deep learning algorithms that underpin the operation of semi-autonomous robots are also subject to imaginaries. Hoff (2023) has reflected on the socio-technical imaginaries of healthcare robots, addressing the impacts that they have on the regulation overseeing the labour of healthcare professionals in governmental policy work. As such, imaginaries are significant for informing the ways that materials stand in for care relations in the everyday by highlighting the expectations attached to them. However, imaginaries also inform how these materials stand in for care relations as they are deployed between the healthcare setting and government policy.

Second, healthcare robots offer a way into conceptualising the caring relations that their materiality stands in for. As the literature has revealed, these relationalities embed the human and the machine into one, emphasising the role of mutual care. While many attempt to attribute human emotions to these robots and scholars have argued that robots are able to make affective social connections with patients (Kerruish, 2021), there is a growing question of how emotional labour is refigured through healthcare robots. That is, robots have previously been expected to do emotional forms of labour in patient care, but patients have been sceptical about the capacity of said robot in doing emotional labour (Lehoux and Grimard, 2018). The position of the human care worker in this emotional labour is still uncertain and a mutuality of labour is undertaken by patients, robots, and care professionals to establish the emotional rules underpinning care work. This might be termed *emotional maintenance*, where human emotionality that is attributed to robots is a part of a mutual labour in not only humans attributing the emotions, but also in the robot performing actions that embody those emotional connections. These ideas of mutuality in emotional maintenance tie into the broader point that healthcare robots are never quite finished and

always looking to be developed. For example, Aronsson and Holm (2021) warn us that, as robots become more complex, this mangling of emotion in the material and the human will only become more contentious. Sociologists of health and illness may therefore consider how healthcare robots profoundly impact the emotional components of care labour, which will become a more fruitful area as robots further develop alongside advancements in AI. This reflects the broader aspect of mutual labour where care professionals will be amending, redesigning, and reapplying healthcare robots to new settings, particularly in the event of a public health crisis. That is, the state of a robot as unfinished provides it with flexibility that will inform its maintenance to a social setting that organisational care structures will need to be amended to support.

Conclusion: An Agenda for Sociologists of Health and Illness

This review has shown that sociologists of health and illness will need to take account of the role that assistive semi/autonomous robot systems play in increasingly digitised health service contexts including care, treatment and diagnosis. These will have profound questions for the organisational structures at play as the patient body becomes increasingly datafied through these digital services. Here we have examined the notion of embodied affective care changes and datafied care changes in isolation, but bringing them together, sociologists may ask; how do organisational care changes spurred by robotics recognise the politics of embodied data relations? To better capture the overlaps between phenomenological and biopolitical foci, we must view robots as both hardware bodies that have impacts on relationalities inside of care settings and also as complex arrays of algorithms that shape the parameters for how those bodies operate. The organisational structures of care are being changed on the level of embodied interaction (Paterson, 2023), but sociologists should also be questioning the data politics of these embodied interactions, and the organisational consequences these have for care.

To provide a better account of this, sociologists of health and illness could demonstrate greater interaction with the emergent work in critical data studies. At stake here is how care operates on an organisational level, as well as the definitions of patienthood that are understood by the patients receiving care. Robot data capturing devices arguably recreate their status and experience as 'patient' (Lupton, 2020), in which there is tension between care and surveillance. Koopman's (2019) account of power shows promise in better understanding how patients are *fastened* into a particular idea of being a patient when datafied by robot systems, whereby the role they inhabit is remade by the data collected about them. These data fasten what could be a limited picture of the patient into the imaginaries that inform robot design. As such, we recognise that new embodied relations impact patient experience of care, but so too do the arrays of data harvested about patients. Sociologists could therefore build from both the phenomenological and techno-biopolitical questions to ask; how does data collection from care robots impact the experience of being a patient? And, furthermore, to what extent may this challenge traditional ideas of care? The datafication from robots is, as Maibaum et al (2022) have reflected, a potential extension of the neoliberalisation of care across global economies by becoming an extending commodification of health services. Surveillance medicine has been a core concept in the sociology of health and illness, but what we are proposing here is that the scale of data harvesting, the form it takes, and its valorisation have all shifted through the design/deployment of the robot.

Through the literature review, we propose a sociology of healthcare robots that emphasises the heterogeneous ethics of mutual labour and the complex definitions of care that emerge through robot design/deployment. The robot care of the human body is a site where boundaries between human/non-human crumble. Humans are, as Buse et al (2018) argue, implicated in material things, and these

materialities in the case of robots come to stand in for and expand the relations present in caring. We reflected on this in the sensorial engagement of embodied interactions that are driven by the porousness of the biological body and designed softness of the robot body. Alongside this, boundaries collapse in the techno-biopolitical sense, in the site of governance through the datafication, surveillance, and commodification of the patient body. Taken together, these crumbling boundaries reinforce that the labour of human care staff and their robot counterparts have become increasingly entangled. With categories of 'human' and 'machine' both in need of maintenance, they come to maintain one another. Sociologists of health and illness should examine these shared needs, where we recognise that robots are unfinished, but so too are people. The fuzziness of boundaries between human, animal, and machine is only growing with the advent of new technologies that pose more nuanced questions of these boundaries, providing an ongoing and unfinished debate that has profound implications for how we think of the human (Osborne and Rose, 2024), particularly in healthcare. As the field develops, we should be mindful that increased implementation of robotics into care work provides a broader sociological opportunity for addressing how boundaries of 'human' can be rethought alongside new healthcare technologies.

References

Abrishami, P., Boer, A., Horstman, K., (2014). Understanding the adoption dynamics of medical innovations: Affordances of the da Vinci robot in the Netherlands. *Social Science & Medicine,* 117, 125–133.

Alač, M., (2016). Social robots: Things or agents?. *AI & society*, 31, pp.519-535.

Aronsson, A., Holm, F., (2021). Conceptualizing Robotic Agency. Social Robots in Elder Care in Contemporary Japan. Relations. *Beyond Anthropocentrism,* 8, 1.

Bedaf, S., Gelderblom, G.J., Syrdal, D.S., Lehmann, H., Michel, H., Hewson, D., et al., 2014. Which activities threaten independent living of elderly when becoming problematic: inspiration for meaningful service robot functionality. *Disabil. Rehabil. Assist. Technol,* 9, 445–452.

Bissell, D. and Del Casino, V.J., (2017). Whither labor geography and the rise of the robots?. *Social & Cultural Geography*, 18(3), pp.435-442.

Brink, K.A., Gray, K., Wellman, H.M., (2019). Creepiness Creeps In: Uncanny Valley Feelings Are Acquired in Childhood. *Child Development,* 90, 1202–1214.

Buse, C., Martin, D. and Nettleton, S., (Eds). (2018). Conceptualising 'materialities of care': making visible mundane material culture in health and social care contexts. In *Materialities of Care: Encountering Health and Illness Through Artefacts and Architecture*. John Wiley and Sons. pp.1-13.

Carr, C., (2023). Repair and care: Locating the work of climate crisis. *Dialogues in Human Geography*, 13(2), pp.221-239.

Coghlan, S., (2022). Robots and the Possibility of Humanistic Care. *Int J of Soc Robotics,* 14, 2095–2108.

Del Casino, V.J., (2016). Social geographies II: Robots. *Progress in Human Geography,* 40, 846–855.

DeFalco, A.I., (2016). Beyond prosthetic memory: posthumanism, embodiment, and caregiving robots. *Age, Culture, Humanities: An Interdisciplinary Journal*, 2016(3).

DeFalco, A., (2020). Towards a Theory of Posthuman Care: Real Humans and Caring Robots. *Body & Society,* 26, 31–60.

DeFalco, A., Dolezal, L., (2023). What is affective technotouch (and why does it matter)? *The Senses and Society,* 18, 85–91.

De La Bellacasa, M.P., (2012). 'Nothing comes without its world': thinking with care. *The sociological review*, 60(2), pp.197-216.

De Togni, G., Erikainen, S., Chan, S., Cunningham-Burley, S., (2021). What makes AI 'intelligent' and 'caring'? Exploring affect and relationality across three sites of intelligence and care. *Social Science & Medicine,* 277, 113874.

Fosch-Villaronga, E., Drukarch, H., Khanna, P., Verhoef, T., Custers, B., (2022). Accounting for diversity in AI for medicine. *Computer Law & Security Review*, 47, 105735.

Foucault, M., (2008) *The Birth of Biopolitics: Lectures at the College de France, 1978–79*. Basingstoke: Palgrave.

Hayles, N.K., (2014). Cognition everywhere: The rise of the cognitive nonconscious and the costs of consciousness. *New Literary History*, 45(2), pp.199-220.

Hockstein, N.G., Gourin, C.G., Faust, R.A. and Terris, D.J., (2007). A history of robots: from science fiction to surgical robotics. *Journal of robotic surgery*, 1, pp.113-118.

Hoff, J.L., (2023). Unavoidable futures? How governments articulate sociotechnical imaginaries of AI and healthcare services. *Futures*, 148, p.103131.

Jones, R.A., (2017). What makes a robot 'social'? *Social Studies of Science,* 47, 556–579.

Kerruish, E., (2021). Assembling human empathy towards care robots: The human labor of robot sociality. *Emotion, Space and Society,* 41.

Kim, B., De Visser, E., Phillips, E., (2022). Two uncanny valleys: Re-evaluating the uncanny valley across the full spectrum of real-world human-like robots. *Computers in Human Behavior*, 135.

Knox, E., Watanabe, K., (2017). Ethical considerations of gendering very humanlike androids from an interdisciplinary perspective, in: 2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN*). Presented at the 2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, IEEE, Lisbon, pp. 539–546.

Koopman, C., (2019). *How We Became Our Data: A Genealogy of the Informational Person*. Chicago, IL: University of Chicago Press.

Latimer, J., (2018). Afterword: materialities, care, 'ordinary affects', power and politics. In Buse, C., Martin, D., Nettleton, N., (Eds). *Materialities of Care: Encountering Health and Illness Through Artefacts and Architecture*. John Wiley & Sons, pp.136-147.

Lehoux, P., Grimard, D., (2018). When robots care: Public deliberations on how technology and humans may support independent living for older adults. *Social Science & Medicine,* 211, 330–337.

Lemke, T., (2015). New materialisms: Foucault and the 'government of things.' *Theory Culture Society,* 32(4):3–25.

Lindner, P., (2020). Molecular politics, wearables, and the aretaic shift in biopolitical governance. *Theory Culture Society,* 37(3):71–96.

Lipp, B., (2022). Robot Drama: Investigating Frictions between Vision and Demonstration in Care Robotics. *Science, Technology, & Human Values*. 1-26.

Lipp, B., (2023). Caring for robots: How care comes to matter in human-machine interfacing. *Social Studies of Science*, 53, 660–685.

Lipp, B., Maasen, S., (2022). Techno-bio-politics. On Interfacing Life with and Through Technology. *Nanoethics,* 16, 133–150.

Lupton, D., (2014). The commodification of patient opinion: the digital patient experience economy in the age of big data. *Sociology of health & illness*, 36(6), pp.856-869.

Lupton, D., (2020). *Data selves: More-than-human perspectives*. Cambridge: Polity.

Lupton, D., (2023). *The Internet of Animals: Human-Animal Relationships in the Digital Age*. John Wiley & Sons.

Maalsen, S., (2023). Algorithmic epistemologies and methodologies: Algorithmic harm, algorithmic care and situated algorithmic knowledges. *Progress in Human Geography,* 47, 197–214.

Maibaum, A., Bischof, A., Hergesell, J., Lipp, B., (2022). A critique of robotics in health care. *AI & Society*, 37, 467–477.

Morrow, E., Zidaru, T., Ross, F., Mason, C., Patel, K.D., Ream, M., Stockley, R., (2023). Artificial intelligence technologies and compassion in healthcare: A systematic scoping review. *Frontiers in Psychology*, 13, p.971044.

Neven, L., (2010). 'But obviously not for me': robots, laboratories and the defiant identity of elder test users. *Sociology Health & Illness,* 32, 335–347.

Nickelsen, N.C.M., Simonsen Abildgaard, J., (2022). The entwinement of policy, design and care scripts: Providing alternative choice-dependency situations with care robots. *Sociology Health & Illness,* 44, 451–468.

Niemelä, M., Van Aerschot, L., Tammela, A., Aaltonen, I., Lammi, H., (2021). Towards Ethical Guidelines of Using Telepresence Robots in Residential Care. *Int J of Soc Robotics,* 13, 431–439.

Osborne, T. and Rose, N., (2024). *Questioning Humanity: Being Human in a Posthuman Age*. Edward Elgar Publishing.

Parisi, L., (2019). Critical Computation: Digital Automata and General Artificial Thinking. *Theory, Culture & Society,* 36, 89–121.

Parviainen, J., Van Aerschot, L., Särkikoski, T., Pekkarinen, S., Melkas, H., Hennala, L., (2019). Motions with Emotions?: A Phenomenological Approach to Understanding the Simulated Aliveness of a Robot Body. *Techné: Research in Philosophy and Technology*, 23, 318–341.

Pasquinelli, M., (2023). *The Eye of the Master: A Social History of Artificial Intelligence*. Verso Books.

Paterson, M., (2023). Social robots and the futures of affective touch. *The Senses and Society,* 18, 110–125.

Pfadenhauer, M., Dukat, C., (2015). Robot Caregiver or Robot-Supported Caregiving?: The Performative Deployment of the Social Robot PARO in Dementia Care. *Int J of Soc Robotics,* 7, 393–406.

Pickering, A., (1993). The mangle of practice: Agency and emergence in the sociology of science. *American journal of sociology*, 99(3), pp.559-589.

Santoni De Sio, F., Van Wynsberghe, A., (2016). When Should We Use Care Robots? The Nature-of-Activities Approach. *Sci Eng Ethics,* 22, 1745–1760.

Shildrick, M., (2023). Robotic technologies, touch and posthuman embodiment in queer dementia care. *The Senses and Society,* 18, 126–138.

Shoesmith, EK, Clarke, C, McPherson, G & Ratschen, E., (2024). 'Using PARO, a robotic seal, to support people living with dementia: 'what works' in inpatient dementia care settings?', Human-Animal Interactions, vol. 12(1), 1-13.

Sparrow, R., (2019). Do robots have race?: Race, social construction, and HRI. *IEEE Robotics & Automation Magazine*, 27(3), 144-150.

Sparrow, R., (2020). Robotics has a race problem. *Science, Technology, & Human Values*, 45(3), pp.538-560.

Smarr, C., Mitzner, T.L., Beer, J.M., Prakash, A., Chen, T.L., Kemp, C.C., (2014). Domestic robots for older adults: attitudes, preferences, and potential. *Int. J. Soc. Robot*. 6, 229–247.

Smith, A.K.J., (2025) The sociology of prescribing: A narrative review and agenda. *Social Science & Medicine*, 117830.

Strengers, Y. and Kennedy, J., (2021). *The smart wife: Why Siri, Alexa, and other smart home devices need a feminist reboot.* MIT Press.

Sumartojo, S., Lugli, D., (2022). Lively robots: robotic technologies in COVID-19. *Social & Cultural Geography*, 23, 1220–1237.

Vallès-Peris, N., & Domènech, M. (2020) Roboticists' imaginaries of robots for care: the radical imaginary as a tool for an ethical discussion. Engineering Studies, 12(3), 157-176.

Wright, J., (2018). Tactile care, mechanical Hugs: Japanese caregivers and robotic lifting devices. *Asian Anthropology*, 17, 24–39.

Wu, Y.H., Cristancho-Lacroix, V., Fassert, C., Faucounau, V., de Rotrou, J., Rigaud, A.S., (2016). The attitudes and perceptions of older adults with mild cognitive impairment toward an assistive robot. *J. Appl. Gerontology*, 35, 3–17.

Zuboff, S., (2019). *The age of surveillance capitalism: The fight for a human future at the new frontier of power.* New York, NY: Public Affairs (e-book).

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