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RESEARCH ARTICLE

Wearables, the Marketplace and Efficiency in Healthcare: How Will I Know That You're Thinking of Me?

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Abstract

Technology corporations and the emerging digital health market are exerting increasing influence over the public healthcare agendas forming around the application of mobile medical devices (wearables). By promising quick and cost-effective technological solutions to complex healthcare problems, they are attracting the interest of funders, researchers, and policymakers. They are also shaping the public facing discourse, advancing an overwhelmingly positive narrative predicting the benefits of wearable medical devices to include personalised medicine, improved efficiency and quality of care, the empowering of under-resourced communities, and delivery of health services previously unavailable to the citizens of developing countries. Typically techno-optimist in their description, the key barriers to this impending inflection point in healthcare are identified as technical issues such as short battery life and a lack of data protection. However, this tech innovation narrative is consistent with problematic ethical, social, and political assumptions that have practical and normative effects, and risk, one, undermining the real clinical potential of wearable devices and, two, designing social inequality and injustice into our mobile health interventions in global healthcare. I argue that the foundational assumptions dealing with the just distribution of healthcare 'goods' (efficiency), the individual as part of society (autonomous and independent), and the political framing (neoliberal) of future healthcare policy devalue equity and despite what they promise cannot meet the distinctive needs of individuals and groups that do not conform to a standardised concept of care-receiver.

Keywords Wearables · Efficiency · Solutionism · mHealth · Healthcare

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1 Introduction

> If Silicon Valley had a designated futurist, her bright vision of the near future — say, around 2020 or so — would itself be easy to predict. It would go something like this: Humanity, equipped with powerful self-tracking devices, finally conquers obesity, insomnia, and global warming as everyone eats less, sleeps better, and emits more appropriately. (Morozov, 2013)

In 2021, the emerging digital health market is attempting, with significant success, to influence public healthcare agendas and shape public opinion regarding mobile health (mHealth). The tech corporations and boosters associated with this marketplace portray self-surveillance through wearable health technologies as *empowering*, mHealth as a means to improve equity of access to health services, and interventions at the scale of populations as an essential component of our individual flourishing and self-management/care.[1] Contrarily, I argue that such techno-optimism, attendant to a dominant solutionist paradigm, is consistent with problematic ethical, social, and political assumptions and is detrimental to more nuanced and human-centred approaches to mHealth. The assumptions of the market-led and technology-focused approach deal with how to justly distribute healthcare 'goods'; how to consider the individual as part of society; and which political framework should provide the scaffolding to future healthcare policy. While I focus on the first of these issues in this article, the predominant assumptions (respectively: efficiently; as autonomous and independent; and neoliberal) are intimately linked. In combination, they risk undermining the real clinical potential of medical technologies (in this instance, wearable devices) and may result in the designing of social inequality and injustice into our interventions in domestic and global healthcare. Technologies, such as mHealth apps, are a product of human design that can multiply advantage or disadvantage through the influence of bias, indifference, or ambivalence present in the society (Friedman & Nissenbaum, 1996; Lupton, 2013). Accordingly, any innovative approach to healthcare centred on technology — is technocentric — requires critical oversight, which is often missing from the overly enthusiastic accounts of mHealth and wearable health devices in contemporary medical, industry, and science literature.

My attempt to rebalance the discourse on wearable health devices and healthcare delivery starts with a brief overview of the status of mHealth, focusing on wearables. Section 2 includes a brief description of the emerging digital health marketplace, the reach of its influence, and some of the key barriers technology corporations consider impediments to the widespread implementation of wearable health interventions. Then, in Section 3, I discuss the public facing discourse on mHealth, explaining that the current focus of private enterprise, funders, policy, and regulatory bodies on technological innovation in healthcare is part of a contemporary global trend that enthuses over disruptive innovation and seeks market-based

[1] This vision requires even healthy people to accept extensive surveillance and can demand persons trade their privacy for public services and well-being (Prainsack, 2019).

technological solutions — solutionism — to complex political and social problems (see Hanlon, 2018; McGinnis & Movsesian, 2000; Morozov, 2013). Then, in Section 4, I argue that the tech innovation narrative associated with the burgeoning digital health marketplace is consistent with problematic ethical, social, and political assumptions that have normative and practical effects. In particular, the moral repertoire underpinning solutionism and techno-optimism — efficiency (and productivity) and utility — is aligned with economic rationalism and neoliberalism and risk devaluing equity if inadequate attention is given to broader civic obligations such as giving priority to the worse-off.[2] Moreover, despite what is being promised by the marketplace and boosters, an efficiency ethic may not fulfil the *distinctive* needs of individuals and groups that do not conform to the standardised concept of care-receiver and may even cause harm if the research and development of these interventions are not socially embedded. To support my argument, Section 5 discusses the influence of socio-economic inequalities on individual and population health, and presents two brief case examples (diabetes, and women's health in developing countries). The case examples highlight the potential harm that a wearable-led revolution in healthcare might cause, and the benefit that might be lost, if isolated from consideration of complex social environments and civic values such as inclusivity, solidarity, and democratic participation. This draws me to conclude that we must avoid being seduced by mHealth mediations of traditional healthcare delivery that promise quick and cost-effective technological solutions and appeal to a moral repertoire more familiar to public policy than medical ethics.

2 Wearable Health and the Emerging Digital Health Marketplace

mHealth is experiencing rapid growth[3] and is shaping healthcare systems as part of a larger digital health project (eHealth) that leverages information and communication technologies that capture, analyse, and share health data to support/provide health goods and services. As its name implies, mHealth uses wireless technologies, for example smartphones and wearable devices like wristbands and watches, to facilitate healthcare interventions across health categories such as disease management, monitoring of physical function and disability, and lifestyle mediations (see Dunn et al., 2018; Latif et al., 2017; Lucivero & Jongsma, 2018; Lupton, 2013; Sharon, 2018). Wearable health devices and their attendant big data platforms and machine learning applications enable *nonstop* data collection about an individual, have some capacity to sample biomarkers, and facilitate *real-time* analysis of this data. Applications of wearable technologies are diverse, and include monitoring of blood glucose concentrations, cardiovascular and metabolic observation, tracking medication use,

[2] See Crisp's (2003) outline of distributional justice and explanation of why ethically it is vital that we consider how welfare is shared within and across communities and not simply to focus on aggregate well-being.

[3] Some market forecasts predict that by 2026 wearable health will be worth $139 US billion and in 2021, up to 1 billion devices could be in use (ANDHealth, 2020).

observation of mental health and movement disorders, assisting with pre/neo-natal care, and fitness and nutrition (Ariani et al., 2017; Dunn et al., 2018; Hogle, 2016).[4]

The grade (or quality of sensor) of wearable devices varies widely, typically in association with their intended application, and includes research and clinical grade through to the familiar watch-styled consumer sensor (e.g. Fitbits) (Dunn et al., 2018). While the distinction between grades of wearables is important for understanding their limitations (e.g. consumer grade devices do not presently take reliable biomarker samples, and the data captured is sometimes unreliable), the boundary between consumer health products and medical devices is becoming permeable (Hogle, 2016). Wearable technology of all grades is being actively promoted in clinical care environments by technology corporations and their boosters within healthcare institutions. For example, recent clinical trials used the *Fitbit Charge* (a consumer device) to monitor convalescence in post-ICU patients (Dunn et al., 2018) and since their inception consumer wearable devices have been designed, deployed, used, and marketed as a form of 'health technology'. This has seen them rapidly become a mass market product as part of the emerging digital health marketplace (see Dunn et al., 2018; Lucivero & Jongsma, 2018; Montgomery et al., 2018).

Furthermore, partnerships between hospitals, national health services (e.g. Britain's NHS and the US HHS), and technology corporations (e.g. Apple, Amazon, and Google) are becoming more common.[5] This is likely to accelerate wherever commercial software architecture is used to integrate wearable data into eHealth records, a recent focus of collaboration (e.g. Apple HealthKit and Epic) (Dunn et al., 2018). This convergence between public health institutions and the digital health marketplace is unsurprising, for as Sharon and Lucivero (2019) report, '… "datafication" is contributing to a re-configuration of health and medicine, prompting its expansion to include new spaces, new practices, new techniques and new actors'. With increased datafication of health comes an increased reliance on technology corporations to provide expertise in data management.

The health and biomedical sector has also witnessed a decisive move into the field by all of the major commercial technology companies during the past few years (Sharon, 2018). Corporations such as Amazon and Microsoft are becoming 'obligatory passage points for data intensive … medicine' (Sharon & Lucivero, 2019), enabling them to transform certain operations within healthcare, including the direction of research. Moreover, technology companies such as Apple are investigating how they might access biochemical information to facilitate a move into the field of clinical care (Beam & Kohane, 2016; Glennon et al., 2016; Schwamm, 2014). This shift might be accelerated by decisions that give companies such Amazon and Google access to public health records (e.g. their agreements with the NHS). Along with Facebook and others, these corporations trade primarily on their expertise in data

[4] Lupton (2013) notes that often this is facilitated through 'lay people' self-monitoring and seeking information on illness, treatment, and health, and by enabling remote consultation.

[5] Public-private partnerships add another layer of complexity that I do not have scope to address in this article. Ballantyne and Stewart (2019) offer an interesting case study of big data, the NHS and public-private partnerships.

capture, analysis, and application, and access to public health records enhances their already voluminous data sets, which are beyond the existing capacities of most, if not all, health institutions. Consequently, these companies are 'becoming important facilitators, if not initiators, of data-driven health *research* and healthcare' (Sharon, 2018) and their specialists are being elevated to the position of 'expert' within the health sector (Bot et al., 2019; Sharon, 2018; Sharon & Lucivero, 2019).

Technology companies moving beyond markets in consumer devices into medical and research domains increase their capacity to influence health research programs (academic, medical, and industry) (see Glennon et al., 2016). This also improves the chance of consumer technology corporations influencing future healthcare agendas, if they are not already (Sharon, 2018), either through direct participation in decision-making or through technological design choices. This is demonstrated by the enthusiasm of public health institutions to implement mHealth programs as domestic and international health interventions even where evidence of the benefits is lacking, or modest.[6] To date, the results in wearable health are chequered.[7] The success of wearable devices delivering healthcare services has been hampered by high rates of rejection under certain circumstances (e.g. 'poor cultural fit') (Møller & Kettley, 2017; Tomlinson et al., 2013) and examples of the use of mHealth delivering limited improvements in disease management (e.g. blood glucose monitoring) (Graffigna et al., 2016; Piwek et al., 2016). Yet, technology boosters proclaim 'mHealth… offers [an] unprecedented opportunity to transform the health services available to people across the globe (Latif et al., 2017)', with digital health promoted as a 'panacea' for the health deficit experienced by people in the worst-off communities (Winters et al., 2020). To deliver on these commitments, technological solutions are being sought for issues like unreliable connectivity and data security/privacy, and poor wearability, power consumption, and availability/affordability (Ariani et al., 2017; Latif et al., 2017). This focus on technological innovation dominates the public discourse on the potential for digital health to transform healthcare systems and, in part, is a result of healthcare agendas prioritising the 'scaling-up' of mHealth interventions, and partly because it receives most of the public and private funding interest (Tomlinson et al., 2013; Winters et al., 2020).

mHealth initiates, driven by the digital health marketplace, are clustering around problems thought to have technological answers resulting in 'leap-frog solutions' — solutions that rapidly and cheaply overcome long-standing barriers to the large-scale delivery of digital health programs (see Winters et al., 2020). While there is gradual recognition that the success of mHealth also depends on acknowledging that social factors accumulate alongside technical concerns, the latter still leads the research and development agenda in the literature on wearables, and typically delays considering the complexities of social context and distributive justice (Tomlinson et al., 2013; Winters et al., 2020). This emphasis on technological solutions transfers directly into the public facing discourse on wearable health and is influencing the design of wearable health programs. It is specifically this discourse and its

[6] See the review conducted by Rowland et al. (2020).

[7] On the poor performance of scaling-up mHealth interventions, see Tomlinson et al. (2013)

influence that I attempt to push-back against through a criticism of techno-optimism and solutionism.

3 Wearable Health and the Public Facing Discourse Shaping Healthcare Delivery

> In the future, people will spend less time trying to get technology to work. because it will just be seamless. The Web will be everything … If we get this right, I believe we can fix all the world's problems. — Eric Schmidt (former Google CEO)[8]

The public facing discourse and promissory claims promoting the benefits of wearable health devices are, predictably, strategic and optimistic and employ the language of altruism (Lupton, 2014b; Sharon, 2018), albeit a utilitarian vocabulary more familiar to public policy than medical ethics.[9] Vitally, we should not dismiss this discourse as a 'harmless framing' of healthcare as it exerts influence in public institutions and indicates an acceptance of technological thinking ahead of other forms of critical thought (see Sadowski, 2020, p.67), and can divert attention away from other competing mHealth research programs and agendas.[10] It also advances the technological imperative in healthcare, indicating that not using innovative technologies such as mHealth devices provides substandard care (see Burger-Lux & Heaney, 1986).

Some promoters of the mHealth technology already endorse wearables as capable of 'revolutionising' the global healthcare landscape,[11] and faith is placed in the innovative technologies of digital health to provide immediate and cost-effective *solutions* to the following:

- 'Global drivers' such as consumerism and 'downward pressure on costs' (Montgomery et al., 2018)
- Complex health and social issues including equitable and accessible healthcare (domestic and global); growing numbers of people experiencing chronic disease; and increased pressure on healthcare systems, institutions, and budgets from an ageing population (Lucivero & Jongsma, 2018; Montgomery et al., 2018; see also Ariani et al., 2017).

In part, this confidence is stimulated by large-scale investment, both public and private, in technological innovation, committing healthcare institutions to a

[8] Cited in Morozov (2013), p. 1

[9] See Cookson and Dolan (2000); Richardson et al. (2012). In defence of a utilitarian approach to public policy, see Goodin (1995).

[10] Sadowski provides a broader and more detailed discussion of this issue throughout his book, *Too Smart*.

[11] See, for example Dunn et al. (2018)

technocentric approach to problems that are social, not technical (e.g. an ageing population) (see Blythe et al., 2016).

Predictions of improved medical futures and quality of life founded on a technocentric healthcare system are not limited to technology corporations and medical futurists and digital health advocates such as Eric Topol (see, for example (Topol, 2012)). Some medical researchers, academics, regulatory bodies, and policymakers assert that the delivery of healthcare is about to be fundamentally changed, for the better, by mHealth and its key constitutive component, wearable health devices (Morley & Floridi, 2019; Bravo et al., 2015; see also Rich & Miah, 2014). When talk turns to the mHealth promise of increased efficiency, technology corporations and policymakers/regulatory bodies are particularly enthusiastic about the potential of wearables. This focus on efficiency, common to the industrialist worldview, 'serves the promise of technology' by promoting convenience and 'disburdenment' and suggests efficiency is paramount to human flourishing (Anthony, 2017; Borgmann, 1987). This narrative is shaping the market for these devices (Montgomery et al., 2018).

Market reports and health policy alike promote digital health as the pathway to an improved healthcare system, and this is evidenced, for example, by the strategic health agenda of Britain's National Health Service (NHS) and the US Department of Health and Human Service (HHS).[12] Both the NHS and HHS endorse patient self-management through mHealth and improved information management infrastructures as a means to address healthcare inefficiencies (Hogle, 2016; Montgomery et al., 2018; Rich & Miah, 2014). Moreover, their advocacy extends to proclaim mHealth can transform the delivery of health services, offering personalised medicine and better disease control; the empowering of under-resourced groups;[13] and improved domestic and global accessibility to health services (see Lucivero & Jongsma, 2018; Morley & Floridi, 2019; Rich & Miah, 2014); whilst also promising to disrupt public health systems experiencing systemic dysfunction, especially those in developing countries (Latif et al., 2017).[14] The presumption that complex social and healthcare issues are solvable through the deployment of an 'appropriately designed technological intervention' has, as Gardner and Warren (Gardner,

[12] In the US context, see *The Affordable Care Act* and the *Health Information Technology for Economic and Clinical Health Act*. For Britain, *Personalised Health and Care 2020,* the *NHS Long Term Plan*, and the *Empower the Person* program. (see Montgomery et al., 2018; Morley & Floridi, 2019)

[13] A search conducted by Morley and Floridi (2019) of the social sciences citation index in 2018 pairing 'empower' and 'health' returned 6651 articles. It is also noted that the narrative of empowerment coincides with the rise of neoliberal health policy.

[14] mHealth may have a legitimate role in achieving these outcomes and shows promise in improving access to health services in low- and middle-income countries; however, success appears less likely if healthcare programs are shaped by solutionist rhetoric, are technocentric, and focus on efficiency at the expense of egalitarian forms of distributive justice, such as giving priority to the worst-off. Appropriately designed mHealth interventions that involve socially embedded research and are subject to rigorous health technology assessments show potential to improve quality of life (although there is presently little clinical evidence), especially where traditional healthcare support and infrastructure is unavailable (see Agarwal & Labrique, 2014; Mechael, 2009). I discuss this further in Section 5.

2014; Gardner & Warren, 2019) highlight, become 'a defining feature' of western medical practice.

3.1 Disruptive Innovation

The market-based narrative on wearable medical devices is overwhelmingly positive, and such representations can result in, as Gilbert et al. (2018) argue, misunderstanding and oversight regarding the ethical and social issues associated with the implementation of technology.[15] Moreover, the narrative is techno-optimist, asserting that technological development will overcome the final impediments — technical issues such as short battery life — to the impending inflection point in healthcare, delivering on the promise of eHealth (see, for example Lucivero & Jongsma, 2018; Lupton, 2013), despite evidence to the contrary (Rowland et al., 2020; Tomlinson et al., 2013).

This optimism associated with digital technologies in the medical domain is concomitant with their perceived status as a 'disruptive innovation', and a shift toward neoliberalism. The ambition that mHealth will transform the delivery of healthcare imagines innovative medical technologies as the foundation for a new health economy that couples public healthcare institutions to technology corporations and digital health markets. This involves directing public funding toward medical technology companies that are tasked with 'reconfiguring' and 'streamlining' traditional health systems (Montgomery et al., 2018), *fundamentally* altering how healthcare operates (Schwamm, 2014). mHealth is thought to offer a way to re-conceptualise, re-organise, and re-structure healthcare in a manner that provides greater efficiency and (cost)-effective distribution of healthcare goods, lessening the burden on healthcare institutions and systems (see Baxendale, 2016; Lucivero & Jongsma, 2018; Rich & Miah, 2014). This is thought achievable, for example, by utilising wearable technology to engage with patients remotely, reducing the strain — burden[16] — on healthcare infrastructure (and the State responsible for the provision of this infrastructure). Some predict it may even facilitate the forwarding of medical goods (e.g. medication, advice) without the need for human intervention (Montgomery et al., 2018), providing a potentially cheap and easy answer to the burden of travel associated with delivering care in remote environments (Tomlinson et al., 2013).

Key characteristics of disruptive technology are observable in the digital health marketplace and the discourse on wearables. Specifically, the developers of the new technology are exerting disproportionate influence over the market; they are shaping the operation of key institutions and introducing new attributes to the field that do not align with established processes; and they do not respond to the historical needs

[15] This issue is more pressing when considering an investigation by Vinkers et al. (2015), who analysed the wording in scientific journals over the past four decades and reported an increase in positive language of 880%. In relation to mHealth, see Lucivero and Jongsma (2018) and Sharon (2017).

[16] Patient care in clinical settings is, at times, portrayed as a 'burden' by those promoting eHealth alternatives. See, for example Baxendale (2016).

of consumers.[17] The discourse on wearables frames healthcare as a commodity (see Schwamm, 2014) and the patient as a consumer and their experience in terms of empowerment, participation, and self-management/care (Lupton, 2013). Wearables may indeed be disruptive to the traditional institution of healthcare, but not necessarily in the manner predicted. Considering the characteristics of disruptive innovation, and the ambitions associated with mHealth, there is the potential to undermine the relation of care formed through interpersonal exchanges; swap out public healthcare providers for technology corporations and a market-based solution; and shift a portion of the burden of healthcare from the State to the individual and free market. This indicates a further entangling of healthcare with commercial imperatives that threaten to press the public good of healthcare into the marketplace.

3.2 Optimism and Solutionism

Innovation that is driven by emerging technology is not unique to digital health. It is part of a contemporary global trend to seek technological solutions to complex political and social problems, recasting the latter, as Morozov (2013) notes, as discrete, neatly defined and with 'definite, computable solutions'. The label given to this aspiration by its critics — solutionism — is unashamedly pejorative, a term taken from urban planning and characterised by Michael Dobbins as 'reaching for the answer before the questions have been fully asked', a practice of 'dumbing down' problems 'to meet the solutions offered' (Blythe et al., 2016; Dobbins, 2009; Morozov, 2013). We should not be surprised that a market-led approach focuses on technical fixes. Technology corporations are very good at responding to technical problems; it is when the problems encompass complex social issues that they may struggle for the appropriate answer, and this can have real-world implications for people's health.

Vitally, solutionism, techno-optimism, and the narrative of technological innovation and disruption are not limited to the technology marketplace and developers, permeating throughout the institutions of healthcare, research, and academia,[18] becoming a shared framing of digital health that is indicative of the blurring of lines between research, medical, and consumer wearables. A threat posed by solutionism and techno-optimism is that public healthcare is progressively reimagined in terms of technical problems and solutions, and as Jathan Sadowski (2020) notes, this can shrink the 'space for philosophical reflection and political debate'. An indication of this is that increasingly some areas of academia, like industry, now try to sell its work as *the* solution and attempt to persuade policymakers, regulatory bodies, and perhaps most importantly funding institutions, and that they know how to solve

[17] On disruptive technology, see Bower and Christensen (1995). This, in part, is why it is important to rebalance the discourse on mHealth, promoting alternative approaches (including some lead by the private sector) that are socially embedded and are more closely aligned with a moral repertoire of civic responsibility than the industrial worldview. An example of the latter is the GSMA (2015) Connected Women project.

[18] As Sharon notes (Sharon, 2017, p. 94) the narrative of disruption and revolution '…saturates popular media and policy reports', and has become popular with '…public health officials, and funding agencies'.

complex problems *quickly* and *cheaply*. As Blythe et al. (2016) identify, the ideal of the marketplace growing around innovative technology is to 'sell solutions' and such framings do not necessarily take root within research and academia without cultivation.

> Funding for research is increasingly geared towards "impact" on the economy or society … Both the funding and evaluation mechanisms for research presume that we understand the problems we confront and that technological solutions are just around the corner, waiting to be discovered. (Blythe et al., 2016)

A similar scenario is unfolding within transnational regulatory institutions. For example, the European Commission is embracing the idea of a technology-driven solution, specifically mHealth, to issues such as expanding health budgets and ageing populations (Lucivero & Jongsma, 2018). A key assumption is that mHealth can enable individuals to improve their overall well-being and quality of life by giving them 'control' of their health by making them more independent and positioning them to adapt to emerging and changing health conditions (Montgomery et al., 2018; Morley & Floridi, 2019). Or, as Morley and Floridi (2019) state, the UK Health secretary imagines mHealth taking power away from doctors and giving it to patients, thus enabling the latter to guide 'their own healthcare destiny'. If it were only that simple! Moreover, an underlying assumption, as Gardner and Warren (2019) spotlight, is that 'technologies themselves can be bracketed as discrete interventions with predictable (and desirable) effects'. The case examples in Section 5 counter this assumption, and the history of technology tells us otherwise, with the issue of affordance and unforeseen uses a major concern for the design and deployment of new technologies (Ellul, 1990; Gaver, 1991).

Advocacy for wearable medical devices and mHealth shapes our understanding by speculating about ideal futures made possible by new health technologies (see Rich & Miah, 2014).[19] This narrative is often repeated in the media[20] and amplified by industry and, as Morley and Floridi (2019) and others have identified, underpins the discourse that is driving research, commercial investment, and policy decisions, presenting technological development in the medical domain as inevitable, and self-evidently good. Techno-optimism draws on various presumptions, such as technology being part of a human history that is naturally progressive, to give an account of technological development as good in itself (see Sparrow, 2007); however, whether a given technological innovation will increase or contract health disparities is fundamentally linked to the social and political environment (Chang & Lauderdale, 2009; Phelan et al., 2010). It is also a function of the underlying social and political

[19] Gilbert and Ovadia (2011) offer the historical example of lobotomy, acceptance of which benefitted from the media portrayal as a 'miracle cure'. Such enthusiasm created an environment where careful assessment of ethical and social impacts was typically absent.

[20] Gardner and Warren (2019) provide the example of deep brain stimulation (DBS), where the media reporting is highly optimistic, while clinicians involved in the application of this technology present a more conservative assessment, aware of the limitations and complexities associated with the use of DBS to treat neurological conditions. See also Racine et al. (2007, 2010).

assumptions and normative principles that guide the design, deployment, and use of the technology.

4 Wearables, Efficiency, and the Moral Repertoire of mHealth

Borne of the marketplace and history of technology, the innovation and solution narratives currently shaping the place of wearables in mHealth, and the latter within the broader frame of healthcare, is taking root in areas of academia and within policy and regulatory bodies who are strengthening their relationship with industry, leading toward the commercialisation of research, market-based solutions, and the responsibilisation of citizens (see Lucivero & Jongsma, 2018). This agenda limits the role of the State in providing social welfare and justice, instead favouring neoliberal individualism as key to personal welfare. Subsequently, the role of the State is to aid and protect institutions that promote a system of free markets, rights in private property, and individual liberty, even in domains such as healthcare (Harvey, 2007; also Waldram, 2019). Accordingly, as Rich and Miah (2014)[21] highlight, the digital health discourse incorporates a vision of care-receiver as independent and autonomous, bounded, digitally literate, capable of self-monitoring, and willing/able to adjust their lifestyles and bodies.[22] This, however, overlooks features of the technology (e.g. learning-intense), the complex social setting of its deployment (e.g. shared access), and the experience of chronic illness (e.g. interdependency), which can exacerbate inequalities for those experiencing marginalisation and disadvantage if not accounted for in the program design (see Lupton, 2014a; Winters et al., 2020).

To sustain a claim to justice, mHealth narratives must appeal to an 'order of worth' or moral vocabulary, outlining a particular notion of the common good and shared humanity.[23] As Morley and Floridi (2019) point out, to promote one type of 'healthy' behaviour (e.g. self-monitoring/care) over another requires a conception of the good life and how it can be attained (see also McLaughlin, 2016). The dominant public facing discourse on wearables shows us that digital health appeals to a moral vocabulary that conceptualises 'the good' as attainable through increased *efficiency*, an order of worth labelled as 'industrial' by Sharon (2018) that is broadly favoured by healthcare institutions, public policy, and regulatory bodies. Vitally, the potential for technological breakthroughs to revolutionise healthcare is thought to centre on the capacity for improved efficiency. This has led to a surge in research investigating how mobile technologies might 'empower' patients,[24] provide laypersons

[21] See also Lupton (2013)

[22] This article is staged as a response to the overwhelmingly positive account of mHealth commonly encountered in market reports and public health policy; however, it is appropriate to highlight that those users who meet this description and have an appropriate level of health literacy may benefit from the narrow conception of mHealth (see Wagner, 2019).

[23] On orders of worth, see Boltanski, L. and Thévenot, L. (2006); Hanrieder (2016); and Sharon (2018).

[24] The literature on empowerment is diverse and expansive, and consists of many competing discourses. For an excellent review in relation to healthcare, see Morley and Floridi (2019).

control of their health, and reduce the *burden* on healthcare infrastructure (Lucivero & Jongsma, 2018; Morley & Floridi, 2019).

4.1 Efficiency

Efficiency, fetishized by Silicon Valley and solutionism (Morozov, 2013), is itself being held up as a 'higher good', a normative guide for the implementation of mHealth and the scaling-up of wearable health interventions.

> The industrial repertoire is a dominant one in the context of healthcare today, where digital technologies promise to propel medicine forward through early diagnosis, the development of precision treatments and the rendering efficient of inefficient healthcare systems (see, e.g. Department for Business, Energy & Industrial Strategy, 2017). (Sharon, 2018, p. 6)

However, efficiency of the kind discussed[25] is essentially utilitarian in its aspirations and can overlook equity issues central to meeting the healthcare needs of minorities, marginalised groups, and those with an orphan disease or inequality in lifetime health expectancy. These categories are overrepresented in developing countries and communities experiencing socio-economic disadvantage in developed nations. As Richardson et al. (2012) note, economic efficiency tends to discriminate between patients based on how responsive their care needs are to current technologies to maximise health outcomes given existing budgetary constraints.[26]

Efficiency in healthcare is narrowly focused on principles that maximise population health based on the aggregate improvement to health and well-being and does not aspire to equality of health outcomes across the population (Cookson & Dolan, 2000; Hutchison et al., 2016).[27] Distributive justice, guided by the normative principles of efficiency, allots healthcare goods to provide benefit to the greatest number, and may result in unfair discrimination against some groups by making them worse-off. While principles of justice in healthcare can combine efficiency and egalitarianism, and typically do (Cookson & Dolan, 2000; Richardson et al., 2012), when efficiency is afforded authority in decision-making and program design for implementation,[28] it can be difficult to subsequently put a substantive egalitarian principle — for example prioritarianism — into effect, limiting opportunities for restorative justice.

The efficiency ethic broadly aligns with the now common portrayal of persons as being autonomous and atomistic — rather than relational and embedded within society — and strategically rational healthcare consumers (Gardner & Warren, 2019;

[25] Industrial: valorising technology and productivity (see Boltanski & Thévenot, 2006).

[26] See also Hutchison et al. (2016).

[27] Hutchison et al. (2016) and her colleagues provide a useful distinction between efficiency and equity in healthcare, with the former concerned with 'the aggregate number of health gains achievable under a given resource constraint', and the latter with the 'distribution of those gains across the population or, in other words, the characteristics of the people to whom the health gains accrue'.

[28] On how conflicting ethical approaches to the implementation of health technologies impacts outcomes, see Winters et al. (2020) and Tomlinson et al. (2013).

Møller & Kettley, 2017; Morley & Floridi, 2019). This can explain the coupling with solutionism, which is instrumentalist and outcome focused and advances the ideal of maximising population health. Moreover, both are amenable to a health economics agenda and neoliberalism. This is apparent in the popular narrative of 'empowerment', which is present in healthcare policy across all levels, and is driving research, commercial investment, and policy decisions intent upon making those requiring care more independent and adaptive, and promising improved life outcomes through technologically based solutions (Bravo et al., 2015; Morley & Floridi, 2019). This framing of healthcare generates an expectation that individuals should, and can, take control of their own health (Lupton, 2014b). It also subjects public space to the demands of efficiency and coerces those in need of care to accept a healthcare ecology shaped by technological infrastructure. This serves to lead public discourse and shape the direction of research, and the ideal of individual responsibility winds back the State's responsibility for providing public health services (see Fiske et al., 2019; Sharon, 2017).[29]

4.2 Techno-Optimism and Solutions

As these narratives take hold in healthcare institutions, their techno-optimist framing of digital health as capable of solving complex social health issues through technological innovation aligns ever more closely with that of corporate and consumer health ideals targeted in this article. A concern with this is that the underlying ethic of efficiency, which incorporates ideals of haste, might see us reach for solutions before we have a full grasp of the complex problems that we confront (see Morozov, 2013, p. 6). This has already occurred in mHealth as corporations, public health bodies, and funders rush to scale-up interventions at a national and global level without shifting their focus from the technology and innovation to the implementation within diverse communities (see Lemaire, 2013; Tomlinson et al., 2013). [30] This highlights a fundamental flaw in solutionist and technocentric approaches — the solution tends to become disconnected from the social aspect of the problem, as observed in the modernism of urban planning city design (see Dobbins, 2009, p. 182). This flaw is apparent in the dominant contemporary narratives of mHealth and wearables that are, at best, naive when considering the role that social structures and physical and technological infrastructure play in advancing or obstructing a person's ability to accept increased responsibility for their own health, overlooking distinctive care needs that can prevent certain individuals and groups from benefiting from mHealth tools.[31] As Morley and Floridi (2019) highlight, the perceived

[29] This approach also presents a compromised notion of 'empowerment' that requires individuals accept a normalised identity determined by public and private institutions. It has been argued that empowerment, at a minimum, should enable self-determination and support substantive forms of autonomy (see Morley & Floridi, 2019).

[30] Ahuja and Kumar (2021) have recently highlighted the larger problem of the trivialization of ethics by business stakeholders involved in technology industries.

[31] On the last point, see Morley and Floridi (2019). Sharon (2017, p. 102) highlights that 'responsibilisation' may result in health being imagined as a 'choice' with the potential for individuals to be 'blamed for [choosing] poor health'. See also Owens and Cribb (2019).

benefits of an mHealth revolution as popularly portrayed in industry and public policy documents rely on the assumption that people are capable and willing of accepting responsibility for their personal health and that digital health tools will 'release individuals from all the other constraints that limit their ability to [achieve] perfect health…'.

Solutionism, and its attendant presuppositions, appears to hamper wearable device interventions, contributing to high rates of rejection and delivering limited improvements in disease management. These problems have been attributed, by those outside the industry, to issues like failing to consider

- The lived experience of users and their individual needs (Lupton, 2013; Mol, 2009);
- The social, physical, and psychological effect of the device on the wearer, including making the disease more intrusive (Møller & Kettley, 2017; Piwek et al., 2016);
- The relational aspect of wearable devices, and not properly integrating the wearer within the traditional healthcare setting (Graffigna et al., 2016).

Confounding factors include shortfalls in the number of healthcare workers, poor access to public healthcare, inadequate healthcare infrastructure (Eze et al., 2016), and inadequate assessment of how clinical needs transfer to external care (e.g. the home) settings (Møller & Kettley, 2017; Weigl et al., 2012). The uptake and growth of mHealth in developing countries have also been significantly slower than in developed nations (Latif et al., 2017). This is attributable to a multitude of reasons, spread across technical, social, cultural, and political aspects, and includes things such as poor connectivity, short battery life, cost, poor levels of digital and health literacy, gender inequality, language and cultural barriers, poor access to healthcare workers, and political instability (Ariani et al., 2017; Eze et al., 2016; GSMA, 2015; Latif et al., 2017).

Despite obvious limitations, boosters of mHealth technologies exist across public and private institutions and share claims-making. Beam and Kohane (2016) of the Harvard Medical School 'cautiously' proclaim '…the time could now be right for artificial intelligence to transform the clinic into a much higher-capacity and lower-cost information processing care service'. Such assertions redouble the reductive nature of digital health, elevating ICT experts and technology corporations within the health ecosystem, placing great importance in the decisions and guidance of institutions, organisations, and personnel who do not have experience in a holistic approach to healthcare (Bot et al., 2019; Sharon, 2016), and whose decisions are guided by a utilitarian or maximising ethic held in tension with the egalitarian approach generally supported in medical ethics.[32]

The conceptual foundations of mHealth are shaped by an appeal to efficiency, techno-optimism and solutionism, neoliberalism, and the history of western thought. The latter is connected to individualism and strategic rationality, centred on an agent

[32] This tension is discussed by Barsdorf and Millum (2017)

who is political and public and whose social relations are contractual and impersonal (see Prainsack, 2018).[33] In combination, this approach appears ill-suited to the relational quality of persons and lacks the characteristics necessary to promote caring relations fundamental to institutions of care.[34]

An observation by Nordgren (2013) brings this disconnect into focus:

> An application of the principle of human dignity is to not use patients merely as instruments for reducing health care costs by cutting down the number of encounters with health care professionals. Another application is to not discriminate against older patients by denying them personal meetings with caregivers and replacing such meetings with remote monitoring.

A potential feminist corrective conceives of persons as *inter*dependent, forming a network of relationships with specific people, and 'living well' is to 'foster social bonds and cooperation' (Held, 2006).[35] I cannot possibly develop this point within the confines of this article, but I use it to prompt the following reflection. When considering how competing ethical, social, and political frames may shape our innovation around wearable devices, we would do well to remember, first, that living with chronic illness people, as Gardner and Warren (2019) observe, become immersed in relations of care that shape their lives, and second, people use technology while exposed to social, cultural, and political contexts that can noticeably influence outcomes (Morley & Floridi, 2019).

5 Potential Risks of a Wearable-Led 'Revolution'

There are many contemporary challenges facing the effective delivery of healthcare. Whether confronting problems such as an ageing population, dwindling health system resources, or poor access to healthcare infrastructure and support, the potential of mHealth is currently championed to justly distribute healthcare goods and services (Ariani et al., 2017; Lucivero & Jongsma, 2018). This commitment to a wearable-led 'revolution' in healthcare, based on efficiency and market solutions, speaks of personalised medicine and empowerment; however, the application of wearable health devices relies on a modelling of the patient and disease pattern that is generalizable, predictable, and quantifiable. This requires a normative construct of a care-receiver identity (patient-hood) (Lupton, 2014a) to effectively design and deploy app-based interventions and may alter the cultural understanding of healthcare and

[33] On the history of Western thought and the place of the autonomous individual, see, for example Taylor (1985); Siedentop (2014); and Douzinas (2000). On the effect this has had on the ethics of healthcare, see, for example Prainsack (2018) and Fox and Swazey (2008).

[34] On an ethics of care and its relationship to western thought, see Held (2006).

[35] Sullivan and Reiner (2019) have previously inquired as to how 'well-being' should be established when developing technologies with the intent to alter behaviour, and conclude that at a minimum individuals must be enabled to derive and pursue their own idea of living well.

the responsibility individuals must accept for their well-being.[36] This also increases the likelihood that mHealth interventions will target 'normalised populations', those that align closely with the care-receiver identity underpinning the design of the app, to improve efficiency.

The simplified image of the individual has built-in norms and expectations that allow for continuous and 'reliable' data collection — measurement — but minimal variation in circumstance (Lupton, 2014a; Morley & Floridi, 2019).[37] This contributes to high rates of rejection of wearable health devices (approximately 50%) amongst persons with needs that diverge from population norms (Møller & Kettley, 2017).[38] To maximise potential health benefits from the perspective of efficiency (utilitarianism), the patient must adopt an 'institutional identity' and associated behaviours stipulated by the technology and care providers, which can disrupt their lives and key care relationships and places greater responsibility on the individual for health outcomes (Lucivero & Jongsma, 2018; Mittelstadt et al., 2014). As a result, if the care-receiver is unable to meet the demands of the imposed identity, their well-being might diminish, and result in an intervention-generated harm.[39] Deborah Lupton (2014a) warns that mHealth apps, as products of existing assumptions and discourses, might influence the way we understand the body and visualise and treat health, and could reinforce negative norms of health.

A market-based approach to the distribution of mHealth resources might provide an economically efficient way to allot healthcare goods and services, and is not necessarily unjust, but arguably for this claim to be true it must also promote equality and patient-centred care.[40] When measuring the impact of wearable health devices on institutions of care, we must consider the effect on persons living in complex social, cultural, and political structures and relying on relations of care. As Link and Phelan et al. (2010) note, the powerful connection between health outcomes and social environment is a rare certitude in the sociology of health. Access to fundamental social resources, such as education, money, and social influence, shows a robust link to health outcomes even after intervention has occurred into a specific disease profile (Chang & Lauderdale, 2009; Maturo, 2014; Phelan et al., 2010).[41]

[36] Look-alike modelling arguably exacerbates this problem (see Montgomery et al., 2018), shaping the market in the image of the best commercial client.

[37] The interaction of mHealth and personal autonomy is complex and cannot be addressed within the constraints of this manuscript; however, the normalized notion of health and patient that typically founds mHealth programs is suggestive of what Morley and Floridi (2019) refer to as 'static autonomy', where we exchange the paternalism of the physician-patient relationship for 'freedom' within the confines of normative identities.

[38] This speaks to a 'second' problem for an efficiency ethic. Beyond potentially discriminating against sub-populations, the failure to socially embed research may undermine efficiency simply because the intervention is not as effective as hoped.

[39] See Paldan et al. (2018) who elaborate upon the notion of 'intervention-generated-inequalities'.

[40] While I am sceptical of the claim that markets can allocate resources justly, modern forms of capitalism are premised on this idea. See, for example Nozick (1974). Regarding patient-centred care, I am referring to the six domains of care outlined by the Institute of Medicine in the USA (Institute of Medicine, 2001).

[41] For a detailed discussion of mHealth and how an individual's social situation may impact the outcome of self-monitoring applications, see Paldan et al. (2018) who offer a helpful account of how 'intervention-generated-inequalities' might be redressed.

Improving equality in health outcomes is better served by targeting the sources of inequality directly, not the intervening mechanism, as disease profiles change over-time,[42] and it is the underlying social factors that maintain disparities in health (Phelan et al., 2010).

Health technologies designed, deployed, and used in a manner that is responsive to the fundamental causes of health disadvantage, and alert to factors in the social, political, and cultural environment that can modify the effect of health innovations, have greater potential to reduce inequalities in health outcomes (see Chang & Lauderdale, 2009; Paldan et al., 2018). This knowledge has resulted in a positive effort, albeit imperfect, by some within the commercial sector – GSMA is an example – to address the complexities of the environment in which they aim to introduce mHealth technologies. It has also inspired advocacy groups, such as the International Diabetes Foundation, to take an active role in the oversight of digital health interventions. This also reaffirms the problem with solutionism in healthcare, and highlights the need, as Hutchison et al. (2016) identify, for technological interventions to be supported throughout their lifecycle with planning and funding to redress entrenched injustice in health outcomes. This includes acknowledging factors such as geographical remoteness or gender inequalities that, for example, limit the capacity for patients to follow treatment recommendations. Unfortunately, these positive developments are still being overwhelmed by the techno-optimism of many of the major technology corporations.

Mobile health decision support systems, with algorithms designed to assist in the diagnosis, treatment, and management of communicable and non-communicable diseases, have shown positive results in improving outpatient care (Latif et al., 2017); however, there are examples where the expected advantage was not achieved, and in some instances produced worse outcomes for participants than more traditional approaches. This has been evidenced by case studies on diabetes (Graffigna et al., 2016; Jakicic et al., 2016) and is a concern for mHealth responses to women's health in developing countries.

5.1 Diabetes

The International Diabetes Foundation acknowledges a role for mHealth in the management of both type 1 and 2 diabetes, but sensibly with the caveat that it must be integrated with high-quality healthcare services delivered by health professionals (International Diabetes Federation, 2014). This position is supported by research into the use of wearable technologies to aid diabetics to self-monitor blood glucose concentrations to improve glycaemic control and modify lifestyles (Graffigna et al., 2016; Piwek et al., 2016). A number of studies reveal, under certain circumstances, no benefit in glycaemic control in type 2 diabetes. Some even report an increased frequency of depression, patients finding their diabetes more intrusive through constant self-surveillance, and diminished psychological and emotional well-being

[42] A primary example is the shift from infectious disease to non-communicable disease as a leading cause of death in the USA (see Chang & Lauderdale, 2009; Link & Phelan, 2010).

when patients, rather than healthcare professionals, were afforded the key role in disease interventions (Graffigna et al., 2016; Piwek et al., 2016). The latter undermines the empowerment narrative central to mHealth, and questions the appropriateness of disrupting traditional healthcare practices, especially the relations of care, with programmatic implementation of wearable health interventions. A technocentric — rather than human-centred — approach that causes a disconnect between the technological-based solution and the patients lived experiences of the disease is attributed significant blame for limited improvements in health, in these examples (Fu et al., 2017; Graffigna et al., 2016).[43]

Another concern for the use of wearables to improve the management of type 2 diabetes is the medicalising of what is, in some instances a social problem, resulting in simplifying complex issues to make them tractable for mHealth (see Maturo, 2014). Poor access to good nutrition and inadequate exercise are risk factors for diabetes; however, with wearable health devices facilitating measurement of blood glucose levels and monitoring of calorific intake and physical activity, the focus can become how to quantify the disease, to delimit the problem through a medical diagnosis, and produce metrics we can respond to through cleverly designed algorithms and apps. While not necessarily unhelpful, this approach can distract from addressing fundamental social and political issues contributing to the crisis in access to adequate nutrition, directing attention and funding away from more ambitious public health programs. And, as previously mentioned, mHealth tools cannot release individuals from the other structural limitations upon their health. Simply reminding someone to eat healthily is of little help if they cannot easily access a nutritional diet.[44]

5.2 Women's Health in Developing Countries

Improving health outcomes for women in developing countries is a pressing issue for developing world bioethics and requires a multifactorial approach. Limited opportunities for economic, social, and political participation contribute to health inequalities and while overcoming the digital exclusion of women is an important step in confronting inequality (see GSMA, 2015; Kuruvilla et al., 2016), it cannot be considered *the* critical step in improving women's health. Wearable health interventions in developing countries have potential to reduce disease burden and improve quality of life, especially where traditional healthcare support and infrastructure are unavailable, but are not sufficient to overcome systemic problems such as gender inequity and may also present risks such as loss of support networks and confidentiality (Kahn et al., 2010). Interventions often seek to reduce health disparities across national borders; however, the answer is not as simple as exporting a modified solution from the developed world or increasing access to ICT. In Pakistan,

[43] More broadly, this is symptomatic of overreliance on technological devices and artefacts, which can 'disengage us from a richer connection with our world' (Anthony, 2017; see Borgmann, 1987).

[44] On the larger issue of the relation of wearable devices, social determinants of health, and overall well-being, see Owens and Cribb (2019).

for example, many factors contribute to women's poor utilisation of healthcare services. These include complex elements such as a hierarchical family structure that subjugates women, entrenched gender discrimination including access to education, and cultural constraints on women's autonomy that potentially determine women's health outcomes more than whether they have physical access to healthcare services (Shaikh & Hatcher, 2005). Moreover, in Pakistan, and other African and Asian countries, women's health is often overseen by a male guardian who controls how and when they access healthcare (Shaikh & Hatcher, 2005), and few women have autonomous or meaningful access to mobile devices (Ariani et al., 2017; GSMA, 2015; OECD, 2018).

Gender inequality associated with access to, and use of, ICT is in addition to the experience of discrimination and exclusion traditionally experienced by women in their daily life. In the domain of wearable medical devices, inappropriately designed health interventions may present acute risks to the end-users, raising issues such as lack of privacy and the potential for increased surveillance and control of women's health and bodies by men, exacerbating disadvantage. This requires strategies for improving access to healthcare through wearable devices to be gender sensitive and culturally aware, and part of a larger more ambitious project that overcomes existing structural issues such as socio-economic disadvantage, gendered discrimination, inadequate healthcare infrastructure, and an absence of appropriately trained healthcare staff. My concern here has been that such programs of research and innovation risk being overwhelmed by the rhetoric of solutionism and techno-optimism.

6 Conclusion

The reductive nature of techno-optimism and solutionism is undermining traditional healthcare institutions and the status of their experts, instead elevating the place of technology corporations, technologists, and ICT specialists. The increasing role of tech companies in promoting large-scale mHealth interventions and wearable device initiatives warrants careful attention (see Tomlinson et al., 2013). Being receptive to market-based solutions and an efficiency ethic, mHealth mediations of traditional healthcare risk overlooking equity and diversity in favour of maximising benefit to the new health economy and justifying the distribution of health services and goods on overall population health. This, in part, is attributable to the allure of solutionism, which promises immediate and cost-effective results; but, as Morozov (2013) warns, it can also discourage support for 'more ambitious … but also more demanding reform projects'. This is observed where developers of mHealth systems, and some creators of digital health programs, interact inadequately with stakeholders, including care-receivers, during design and deployment of health interventions founded on wearables (Eze et al., 2016).

The effective and efficient design of app-based interventions often utilises a normative construct of a care-receiver identity and their context, and this poses a unique risk when innovation is driven by emerging and potentially disruptive technologies that can re-organise social interactions and institutions, for better or worse. Hoping for leap-frog solutions is also problematic. As Dobbins (2009) avers in relation to

solutionism, there is the risk we do not have time to respond critically: 'The big idea may be so seductive … that people are swept up in the process. This risk becomes an even bigger problem as sophistication in marketing … becomes ever more compelling'. Presently market solutions and technology corporations are exerting ever more influence over public healthcare agendas formed around mHealth, attracting the interest of funders and researchers, and shaping the public facing discourse through techno-optimism and a technology innovation narrative. We would do well to approach this field with caution, for as the history of technology unambiguously shows, (in)equity and (in)justice are built into things (see Fiske et al., 2019, 618).

As researchers, we must not fetishize wearables to the point that we harm their real potential to improve the delivery of healthcare, both locally and globally. We must be attentive to the variability in individual health needs; the social, political, and cultural conditions that make healthcare interventions complex; the prospect that these devices might make the experience of disease more intrusive and burdensome; and that they might rupture the care relation, introducing a new distance between care provider and receiver. Despite what they promise, the foundational assumptions driving the wearable revolution — efficiency, individualism, and neoliberalism — cannot meet the distinctive needs of individuals and groups that do not conform to a standardised concept of care-receiver. For this reason, at least, when assessing the potential of mHealth, we should appeal to a moral repertoire more familiar to medical ethics than the marketplace and public policy.

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