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mHealth Geographies: Mobile Technologies and Health in the Global South

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The rapid expansion of mobile networks has revolutionized communications worldwide, yet mobile telephony is also having wider, significant effects across a range of issues including education, politics, entertainment, and finance (Steinhubl et al., 2015). This chapter explores one of these effects, the use of mobile technologies in health. Mobility is a fundamentally geographic concept and thus mHealth is an area that health geographers have and continue to examine. Mobile health (mHealth) refers to the use of wireless and mobile technologies in health and health care and includes a diverse range of activities such as health information hotlines, telemediated patient care, personal mobile health apps, and mobile health surveillance. mHealth is undertaken actively, by people using all types of mobile phones (basic, feature, and smartphones), personal digital assistants (PDAs), and tablet computers, as well as passively, using automated mobile sensing technologies. Whether produced actively by people or passively by sensors, at the core of mHealth is the collection and transfer of digital data; this could be a patient's vital sign information, survey data pertaining to a disease outbreak, or simply digital voice or text message data transferred from a rural patient to a medical professional in an urban hospital. Modern digital mobile communication networks are thus central to mHealth, enabling the transfer of data in near real-time over vast distances, however, technologies enabling more local data transfer such as Wi-Fi, Bluetooth, and Near Field Communications (NFC) are also increasingly central to mHealth architectures.

Global interest in mHealth stems from the rapidly increasing availability of mobile technologies and networks, with estimates suggesting that 75% of the world's population will have a mobile phone by 2020 (5.7 billion unique subscribers, and 10 billion total mobile connections) (GSMA, 2017). The decreasing costs and increasing functionality of mobile technologies have captured the attention of the scientific community, governments, and health systems, resulting in significant investment of resources into mHealth solutions. Owing to its core characteristics of mobility and portability, mHealth can enable the expanded reach of health care services to previously underserved populations including those in rural and remote regions, representing an important step towards universal health coverage, a key goal of the global health agenda (Mehl and Labrique, 2014). Although the evidence is still thin, mHealth is also pursued to meet the objectives of reducing health care costs (Betjeman et al., 2013), influencing positive health behaviours (Gurman et al., 2012), and improving patient outcomes through more rapid diagnosis of illness and better adherence to treatment regimens (Hamine et al., 2015). Additionally, emerging reasons for attention to mHealth include its potential empowerment of health care providers, communities, and individuals, and the introduction of innovative health service delivery models which leverage underused resources, for instance, by engaging lay and non-professional health workers and patients (Thondoo et al., 2015).

Across all world regions, more people have mobile phones than basic necessities such as toilets and safe drinking water (World Bank, 2013). Growth in mobile phone ownership presents an important opportunity for the Global South given their ubiquity in many less-developed settings. Situated within the broader context of limited existing health care services, mHealth presents the potential to *leapfrog* entrenched health practices and opportunities to develop new ways of delivering health care, with less-developed markets recognized as the key drivers of mHealth (PwC, 2014). Although recent developments in mobile Internet and sensor technologies significantly increase the possibilities for mHealth, smartphones are still rare in many less-developed settings, a reality that is tempering some of the enthusiasm regarding mHealth in the Global South. In less-developed settings, many of the more advanced forms of mHealth are currently out of reach and so, as always, the development of mHealth as a global health agenda must be sensitive to local contexts.

This chapter aims at advancing a contextually sensitive perspective on mHealth in the Global South. Following a review of mHealth in health geography and a call for more empirical and conceptual attention to the field by geographers, the main section of the chapter explores the recent developments around using two-way SMS (short message service, text messaging) platforms in health research and practice in the Global South, as an increasingly ubiquitous and very low cost data transfer technology available on all mobile phones. The chapter then concludes with a brief discussion of the challenges and future prospects of mHealth, focusing specifically on the need for health geographers to contribute to this global discussion.

mHealth and health geography

mHealth consists of a broad and expanding range of activities and practices deployed for a variety of purposes. As part of the World Health Organization (WHO) Global Observatory for eHealth's (2011) second global survey on electronic health technologies, mHealth was explored for the first time as a sub-focus of eHealth. The resulting report identified 14 types of mHealth *services* within six broader categories of *activities* being undertaken: communication between individuals and health services, communication between health services and individuals, consultation between health care professionals, intersectoral communication in emergencies, health monitoring and surveillance, and access to information for health care professionals at point of care. Based on a meta-analysis of mHealth literature, Olla and Shimskey (2015) developed a taxonomy to specify the overarching *purpose* of various mHealth applications, based on eight categories of *end-uses*: point of care diagnostics, patient monitoring, wellness, compliance, education and reference, behaviour modification, efficiency and productivity, and environmental monitoring. Given the disparate collection of mHealth practices to date, classification activities represent an attempt to bring clarity, recognizing that further conceptual attention is needed to understand the complexities of mHealth technologies and applications. However, such attempts at discrete classifications may be of limited utility; the continual advancement of mobile technology and the diverse ways it is intervening in a wide range of health and wellbeing practices make clear that mHealth represents an ever-moving and constantly shifting target.

Taxonomic impulses of medical science notwithstanding, mHealth as a field remains under-developed theoretically and conceptually and it can benefit considerably by a more thoroughgoing engagement with the social sciences. Geographic concepts are often invoked in mHealth, often with little explanation, and perhaps as an assumed normative aim. For instance, *overcoming geographical distance and barriers* is a central trope (e.g. Steinhubl et al., 2015); indeed it was deployed as an organizing concept in the WHO's (2011) path-breaking report on mHealth, subtitled *New Horizons for Health through Mobile Technologies*. Health geographers are well placed to conceptualize the dimensions and concerns of mHealth given the decades of attention in geography to interrogating concepts such as distance and its social and ethical implications. For instance, human geographers have fruitfully developed a spatial dimension to understandings of *care ethics* (e.g. Lawson, 2007) – a specifically relational approach to moral actions based on mutuality and reciprocity – and have applied it to consider the ethical responsibilities of local and global actions and caring-at-a-distance. Achieving health equity is ostensibly a core aim of mHealth programs which aim to overcome geographic barriers to care access, and it is conceivable to see how this spatially-explicit conceptualization of care ethics can be useful here. Indeed, concepts central to contemporary human geography that have been applied to understand developments in information and communication technologies (ICT) – e.g., space-time, scale, networks, and mobilities – can also be productively deployed to advance mHealth.

It is perhaps surprising that mHealth appears to be an underexplored research topic in health geography. A search of the leading health geography journals is potentially revealing: the term has never been printed in the pages of *Health & Place* (a top health geography journal), and only briefly referred to in just a single article in *International Journal of Health Geographics* (a leading technology-focused health geography journal). The interdisciplinary journal and frequent venue for health geographic research *Social Science & Medicine* does show some interest in mHealth (~10 articles) in the broader social sciences. However, overall it appears that the term is primarily deployed in the health and medical sciences. The lack of attention to the term does belie a substantial amount of research at the intersection of health geography and mobile technologies which broadly fits the mHealth purview, if not specifically identified as such.

A key area of mHealth research geographers are engaging with is the distributed collection of disease surveillance data using mobile phone-based data collection platforms (e.g. Robertson et al., 2010; Cinnamon et al., 2016). Another important research theme is the use of passive mobile sensor technologies to collect environmental exposure data. Geographers have long been interested in the concept of *activity spaces* (Golledge and Stimson, 1997), the areas of influence on our daily lives often bounded by the places that we live, work, shop, and take leisure. Mobile technologies are enabling significant advances in measuring activity spaces and therefore more geographically-accurate collection of data on, for example, exposures to toxins and pollutants (Steinle et al., 2013), unhealthy food (Sadler and Gilliland, 2015), substances such as tobacco and drugs (Lipperman-Kreda et al., 2015; Mason et al., 2015), and urban social and environmental exposures in children (Loebach and Gilliland, 2016). This area of research is advancing our understanding of *salutogenic* exposures; contact with spaces that are therapeutic or health promoting (Bell et al., 2015). Geographers have also contributed to a growing body of research on the use of location and movement sensors (e.g. GPS, accelerometer, gyroscope) embedded in mobile wearable technologies or smartphones to record and analyze participants' physical activity and mobility (Barratt, 2017; Jestico et al., 2016). Similarly, geographers are researching how mobile apps are used for personal monitoring, fitness, and self-care activities as part of the *quantified self* movement (Boulos and Yang, 2013). There has been some research by geographers on mobile technologies in health care settings, such as mobile point-of-care platforms for managing patient data in hospitals

(Zargaran et al., 2014). Overall, however, geographers have focused more on the health rather than the health care side of mHealth.

mHealth in the Global South using SMS technologies

mHealth in the Global South is frequently considered within the broader field of information and communication technologies for development (ICT4D), a field with considerable geographical influence (e.g. Kleine and Unwin, 2009). Research and practice in this domain focuses on the use of ICTs to improve opportunities and living conditions in less-developed settings with particular focus on business, governance, health, and education (Hilbert, 2012). Positioning mHealth as part of more established ICT4D project enables mHealth initiatives to learn from its well-developed knowledge base. This is not wholly unproblematic, however. Despite the clear linkages between economic development and health, the overall objectives of *growth* and *progress* which underpin development and therefore ICT4D (Unwin, 2009) are not always the best route to health improvement, and so care should be taken in drawing on ICT4D experiences and frameworks to plan and evaluate mHealth projects.

SMS is a simple and highly limited format for data exchange, restricted to 160 characters. Yet in its simplicity lies its significant potential for improving public health research and practice in the Global South. SMS messages can be sent and received between any mobile phones, including basic and feature phones most common in the Global South, and between computers and phones. Messages can be personally tailored and intended for a single recipient, or sent out in bulk to all or a targeted subset of mobile users. It is a largely stable and reliable means of data transfer, enabling instant communications between distributed parties anywhere that mobile networks reach, often working even in emergency situations when networks can be too overloaded to connect mobile phone calls (Revere et al., 2014). It is also a very low cost means of communication; mobile customers typically receive messages at no cost and can send them for very little. For the mobile network operators (MNOs), routing SMS messages over the network is very low cost – estimated at

0.3 cents US per message in 2009 (Keshav, 2009). As such, there is considerable potential to partner with MNOs to enable free messaging for senders and receivers in mHealth initiatives, especially given the desire of many mobile operators to engage in corporate social responsibility activities, as demonstrated for example, by the Safaricom Foundation from the leading mobile operator in Kenya (http://safaricomfoundation.org/).

The use of SMS in mHealth initiatives is relatively well documented, especially in the Global North where text messaging has been used since the 1990s to communicate directly with health care patients or the general public. A common goal of these programs has been to modify individual health behaviours through regular interaction with health information and advice. For instance, Franklin *et al*. (2003) describe an SMS initiative which sent targeted messages and general information to young people with Type 1 diabetes, with the aim of increasing adherence to intensive insulin regimens. A similar study focusing on follow-up care for bulimia nervosa patients found that the system was effective in providing support to patients who had completed inpatient treatment but still required ongoing progress monitoring (Bauer et al., 2003). Although these early uses of SMS have been promising, many examples are small-scale pilot initiatives requiring significant human resources to undertake – especially if targeted or responsive messaging is used – which has limited the potential for scaling up.

There has been some progress towards larger scale mHealth SMS projects that engage a wider population. They are, however, often quite rudimentary in scope, often just used as a platform for distributing generic health information in settings or with groups that lack widespread access to traditional media. Bangladesh has a high mobile penetration rate (even in rural areas), and has exploited it to undertake SMS health campaigns targeting the entire (mobile) population. The country's government has used SMS to send alerts and information about national immunization day and breastfeeding week and reported wide acceptance, although their ability to evaluate the program for effectiveness (e.g., in influencing individual health seeking behaviours) is limited

(Khatun et al., 2015). The MAMA (Mobile Alliance for Maternal Action) and MomConnect initiatives in South Africa have used SMS as part of a multichannel strategy to communicate directly with expectant and new mothers. SMS has been an especially important channel in South Africa, a country which has high rates of maternal deaths in younger women and higher mobile phone usage than that of radio and television (Bateman, 2014). The South African government received a 50% discount on SMS messaging costs from the country's MNOs (Bateman, 2014); cost will hopefully be an uncommon deterrent in the future as more substantial discounts or free messaging should be possible, given the negligible cost to operators.

The potential for scaled-up SMS mHealth initiatives has significantly advanced in recent years, due to the development of computer-based software platforms for creating and operating custom automated SMS messaging services. Platforms such as Frontline SMS (http://www.frontlinesms.com) and the UNICEF-developed RapidPro SMS (https://community.rapidpro.io) are being used across the Global South by organizations engaging in ICT4D activities. A key advantage here is the ability of these systems to enable automated *two-way conversations*, compared to earlier uses of SMS in these contexts largely based on *one-way information sharing.* In these two-way SMS systems, not only information but also questions can be sent out to mobile phone users. If receivers respond to the prompt, the answer is recorded in a database on the host computer/website. Depending on the response, the SMS software can trigger further, custom questions (see Figure 1). The simple ability to answer an automated message means that anyone with a mobile phone in any part of the country – health professional, civic official, or member of the public – can contribute real time information on any health issue. The potential is almost limitless. In particular, these developments can enable much more rapid and effective surveillance of health conditions, information on the social and environmental determinants of health, and monitoring of health resources and infrastructure.

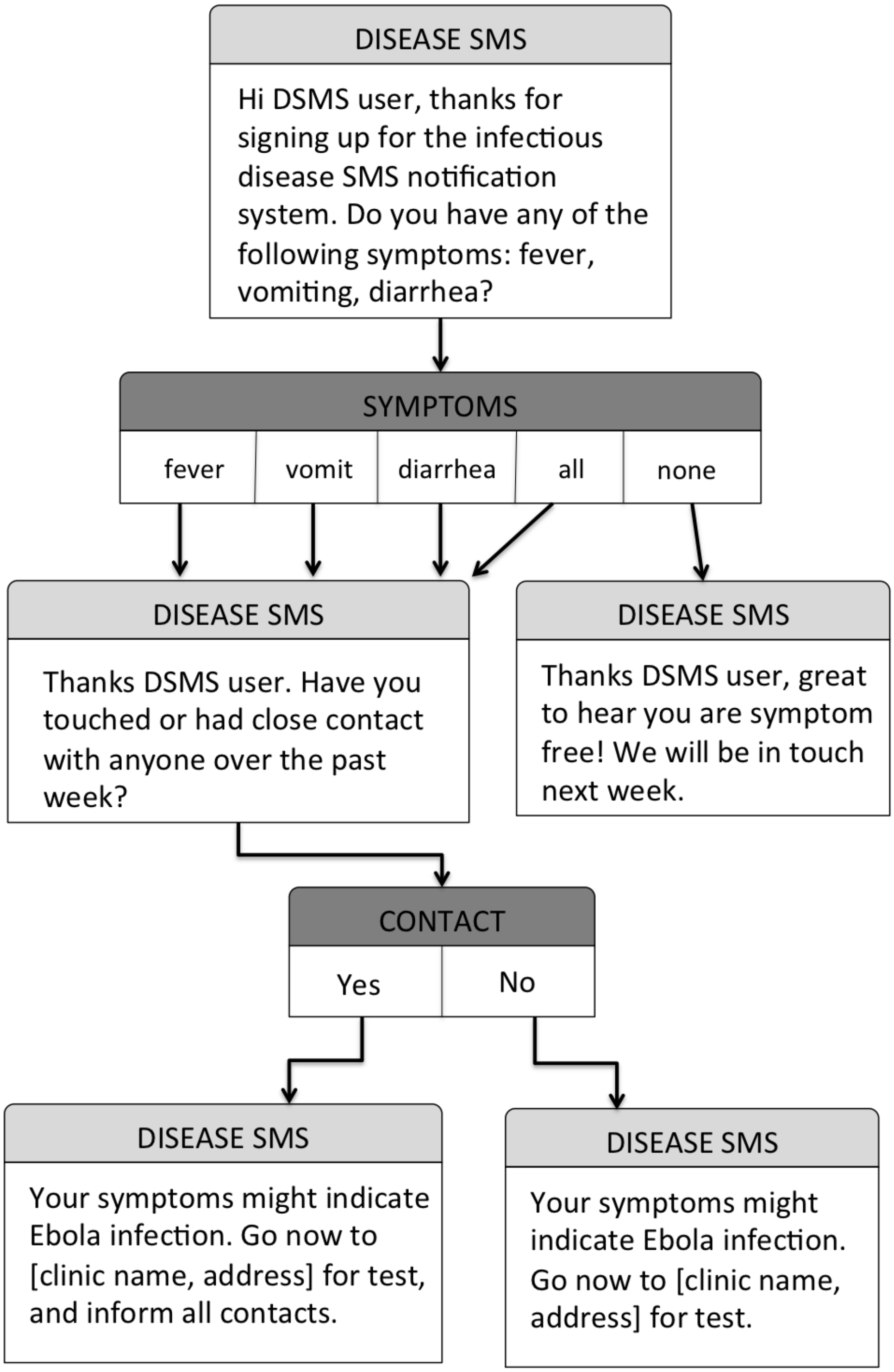

Figure 1: Example of SMS two-way conversation architecture.

A particularly promising application of two-way SMS is its use for health surveillance during emergencies. Cinnamon *et al*. (2016) conducted a study to ascertain how two-way SMS systems can be used to enhance informational awareness in the management of communicable disease outbreaks. Results highlighted the significant potential to enable near-real time surveillance of disease cases via automated SMS based surveys directed to health professionals or emergency responders in remote outbreak zones underserved by other communications or transportation links, as was the case in parts of West Africa during the 2013-2015 Ebola outbreak.

Connecting directly with the public via SMS may stop outbreaks before they happen. *Syndromic surveillance* efforts aim to enable early prediction of outbreaks by accessing various data sources that pertain to disease symptoms, everything from Web searches, to school/work absentee records, medication sales, and weather data (Mandl et al., 2004). Drawing on citizen science and crowdsourcing approaches, two-way SMS systems can also be a source of actively-produced syndromic data for identifying new locations and populations to target with prevention resources. The *Ebola Tracks* SMS system (Tracey et al., 2015), while only a proof of concept and undertaken in a developed country setting (Australia), illustrates the potential use of a basic two-way SMS system for direct patient symptom monitoring and triage for individuals potentially infected with a communicable disease. Developed during the recent Ebola outbreak, the system was pilot tested with participants returning to Australia from Ebola-affected countries in West Africa. Participants were provided with a mobile phone and digital thermometer, and instructions to take their temperature twice daily for 21 days (maximum Ebola incubation period) and respond via SMS with the reading and any noted symptoms. Further SMS questions are triggered if the reading is high, and if there is no response by the participant, an SMS and email alert are sent to an on-call medical officer who is then responsible for contacting and following up with the participant to assess their condition. This type of mHealth application is potentially invasive; restrictive control measures are often necessary under conditions of highly contagious disease outbreaks (see also Koch, 2016), and perhaps more appealing than the alternative of quarantine.

In addition to the use of two-way SMS to collect public health surveillance data, it can also be used to share up to date information on health protocols, resources, and infrastructure to enhance the functioning of the health care system itself. A project undertaken in two remote regions of Malawi enrolled 77% of its community health workers (CHWs) in a two-way SMS information sharing and reporting system, which replaced less effective methods including sending messages via ambulance or using the radio for one-way communications (Lemay et al., 2012). District health managers used the system to send out messages advising CHWs of available resources, training opportunities, and changes in protocols, while the CHWs used the system to ask specific medical questions, to report resource requirements, and to organize patient referrals and transfers. Through such a system, there is the potential to better leverage the non- and para-professional health care workers that are a vital but often-underused health system resource in the Global South. The key premise of equipping these workers with mHealth lies in its potential to function as additional health system infrastructure and opening the possibility for *task shifting* of health care tasks and responsibilities traditionally held by professional or specialist health care providers, which can enable health workers with limited training to receive support and expand their scope of work.

Conclusions: Optimism for the future of mHealth

mHealth is still a relatively new field; its relevance and scope are still evolving, paralleling the dynamism of the mobile technology sector itself. That said, mHealth is a mature enough field to be subject to significant critique. Figure 2 illustrates the phases technologies often progress through over time, from initial introduction to eventual widespread productivity. mHealth consists of a dizzying array of technologies and application areas and so its current position of technological progression is variable. In fact, few mHealth technologies are likely to have made it even to the *slope of enlightenment* stage of progression despite some having a history reaching back to the 1990s.

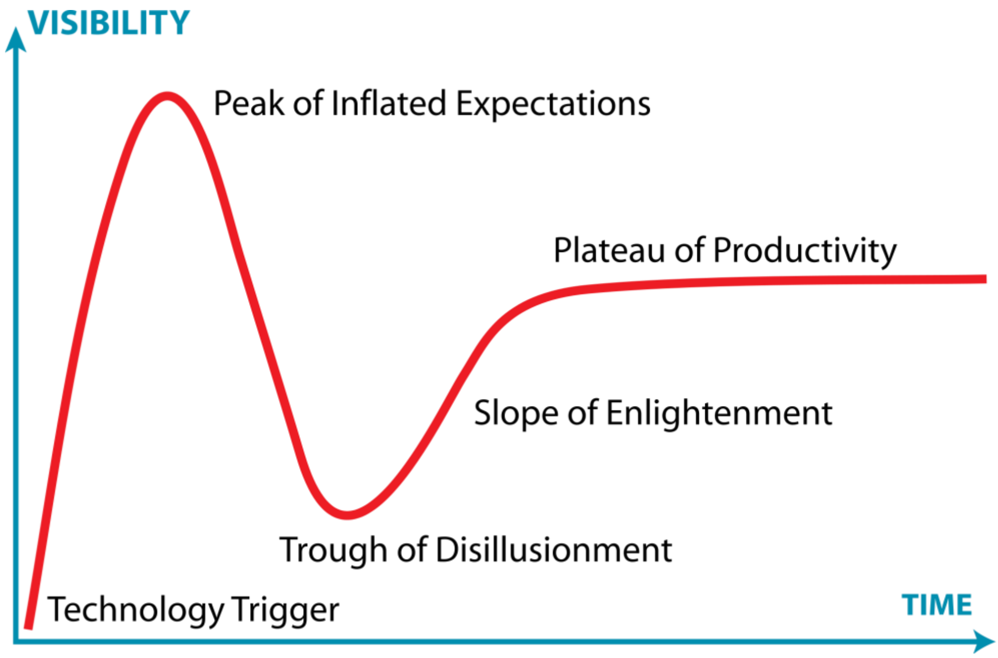

Figure 2: Technology Cycle. This 'cycle' describes a generalized pattern of five key stages that technologies often follow over time - from their introduction, to reaching peak hype, followed by a sharp decline in expectations, and a more slow return to productivity. Creative commons licenced image from Wikimedia Commons, based on Gartner Hype Cycle (http://www.gartner.com/).

Pilotism is a widespread problem, whereby mHealth technologies never emerge out of testing or are never scaled-up. Indeed, as Andreassen et al. (2015, p. 62) note after 20 years of work on ICT projects in health, "most projects remain projects." The ability to confirm health benefits of mHealth initiatives is limited and so it is unclear whether initiatives improve clinical outcomes (Free et al., 2013) and there is little evidence confirming some of the grander ambitions of cost savings, progress towards universal health coverage, and patient and care worker empowerment. Indeed some studies have documented negative impacts of mHealth introduction such as increased costs (Ryan et al., 2012), which suggests that proponents must be wary of technological determinism. In fact, in some cases initiating these so-called *solutions* sometimes just strips time and resources away from established health and medical practices (see Higgins, 2014).

Yet, there is space for optimism about the future of mHealth, especially when considering it as part of the broader social phenomenon of digital citizenship and research on digital lives. The intersection of health, society, and technology is a key space for health geographers and other social scientists to make an important contribution. For instance, work by Hampshire et al. (2015, p. 97) documents how younger generations in Sub-Saharan Africa are engaging in a “digitally-mediated form of therapeutic citizenship” in which they use their mobile phones in informal, but creative and strategic ways to access health information and health care. As we progress towards an even greater recognition of the social and spatial conditions that shape health and health care, health geographers can and should be at the forefront of research on both the formal and informal roles that mobile technologies play in health advancement around the world.

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