The new platforms of health care

E. Ray Dorsey

For the past century, the dominant locations for assessing health and delivering health care have been clinics and hospitals. That is about to change (Table 1).

In The Third Wave, Steve Case, the co-founder of AOL, posited that the internet was poised to “transform major, real-world sectors” like health care. The coronavirus disease 2019 (COVID-19) pandemic has accelerated that transformation through the rapid adoption of telemedicine and remote monitoring. The platforms underlying these new approaches to health, however, are from technology firms, not medical centers.

USE OF DIGITAL DEVICES TO MEASURE HEALTH AND DELIVER HEALTH CARE

Like the nervous system, these platforms enable both afferent (sensing) and efferent (acting) information flows. The afferent paths measure health through an increasing array of digital devices, including portable (smartphone), wearable (watches), and residential (virtual assistants). These devices can now detect abnormal heart rhythms, blood glucose levels, cognitive impairment, and seizures. They do so by capturing objective, frequent data in the real world in contrast to the often subjective, episodic data gleaned from a clinic visit. The results are new health insights and likely earlier and more frequent detection of disease. These platforms are expanding in scale and scope. For example, Alphabet recently completed its purchase of the wearable device company Fitbit, and Facebook has announced plans to build a smartwatch with a fitness focus that can capture health data.

The efferent paths are less developed but are beginning to emerge. The Apple Heart study enrolled 40,000 individuals who had a smartwatch to determine whether occult atrial fibrillation could be detected. If a suspicious heart rhythm was found, the participant was connected to a remote physician from a telemedicine company. As the study illustrated, the big technology firms may not be involved in actual care delivery, but their tools will increasingly serve as the vehicles over which care is provided. All of these moves are part of a broader push by the largest technology firms in the U.S. and China (e.g., Tencent) to invest in health (Table 2). This activity is going beyond hardware and includes investments in clinician-facing software, care delivery, and even health insurance. As big as these companies are, the largest (Apple) has a market capitalization ($2.0 trillion) that is less than what the U.S. spends ($3.8 trillion) on health care per year.

The technology giants are not the only ones entering health as new companies are seeking to develop novel approaches to care. In 2020, venture capitalists and others invested $21.6 billion in digital health companies, several digital health companies had highly successful initial public offerings, and a merger between a telemedicine (Teladoc) and a disease management (Livongo) company resulted in a $36 billion firm. At the same time, telemedicine use soared. In just 1 month, telemedicine visits among Medicare beneficiaries increased 100-fold. At the pandemic’s peak, telemedicine accounted for most patient visits at many medical centers. In the span of weeks, we saw the greatest transformation in health care delivery in the past 50 years.

These developments are part of a broader migration of care from hospitals and clinics to home and mobile devices. Everything from acute stroke care (mobile stroke units) to hospitalizations for pneumonia (hospital at home) are moving toward the home. This transition mirrors what has already occurred in other industries, such as entertainment, banking, and retail. Underlying these transitions are mobile devices, which are amazingly young. The smartphone, first released in 2007, is still a teenager.

BENEFITS AND LIMITATIONS OF HEALTH CARE’S NEW PLATFORMS

The benefits to these platforms are potentially substantial. First, they can capture enormous volumes of data in a person’s natural environment. Rather than dosing insulin based on finger sticks obtained in doctor’s office, insulin can now be titrated based on continuous measurements directly from an individual. Even in the absence of closed loop systems, these large pools of data have value. They can give individuals more control over their health, foster a sense of self-efficacy, and identify previously occult features of a disease. Second, because smartphones, watches, and even home monitoring devices are increasingly ubiquitous, these tools can connect individuals to care. This care can come from a wide range of clinicians who are difficult to organize in traditional clinics but can reach patients via synchronous and asynchronous encounters. Most individuals receive too little care and face significant obstacles to receiving appropriate treatment. This is especially true in lower-income nations where clinics are sparse.

1Center for Health Technology and Department of Neurology, University of Rochester Medical Center, Rochester, NY, USA. Email: ray.dorsey@chet.rochester.edu
Almost anyone anywhere can use some of which could be provided directly to individuals, that libraries near patients. Telemedicine can be provided in clinics or other locations (e.g., homes). All will benefit from simpler tools, some of which could be provided directly to individuals, that almost anyone anywhere can use.

While the benefits are great, so are the concerns around privacy, equity, and duty. The data captured by digital devices can inform countless aspects of behavior and health. These data could be valuable to marketers, employers, and governments. Just as advances in genetics required policy protections for individuals, so too do advances in technology. In 2008, the Genetic Information Nondiscrimination Act was passed by the late Senator Edward Kennedy as the “first major new civil rights bill of the new century.” A similar act for data is needed to avoid discrimination and to recognize explicitly that individuals have the right to determine who can see their data and for what purpose.

Current health care is plagued by inequities. While technology platforms hold the potential to make care more accessible, the results to date have been mixed. Twenty percent of households in the U.S. lack broadband access, and a similar proportion do not have a smartphone. Broadband access should become a public good available to all, and these new platforms should seek to bridge rather than expand the current gaps in health. To do so, some individuals will require assistance, either remotely or in person, to use these new technologies at home. Alternatively, telemedicine can be provided in clinics or other locations (e.g., libraries) near patients’ homes. Educators need to prepare trainees in most clinical disciplines and at all levels. House.

Finally, the technology companies that own these platforms are accountable to shareholders, not to patients or the public. Shareholders may be, and likely are, less concerned with privacy and equity than individuals or the broader society. Professions have a duty to the individuals they serve. Non-profits are ultimately accountable to the public. Technology firms do not share these responsibilities. If their devices will be the new platforms for measuring health and delivering care, the interests of individuals must be protected.

**OPPORTUNITIES AND NEXT STEPS**

This migration will require action from all of us—educators, researchers, payors, and patients. As care moves toward the home and medical devices, medical training will have to prepare future physicians and other clinicians for settings beyond the hospital. Unfortunately, such training is almost absent. In a survey conducted 20 years ago, simple lectures on home care did not exist in half of internal medicine residency programs, and only a quarter of residents had a mandatory house call experience. Educators need to prepare trainees for health care’s future, one that will bring care to patients rather than patients to care.

The first step to that preparation is to expand training outside the hospital. If care is migrating to homes and mobile devices, so should trainees in most clinical disciplines and at all levels. House.

**Table 1. Comparison of health care platforms.**

| Characteristic              | Clinic-based | Technology-based |
|----------------------------|--------------|------------------|
| Principal measurers of health | Clinicians  | Devices          |
| Health measurements        | Primarily subjective | Primarily objective |
| Frequency of measurements  | Episodic     | Continuous       |
| Location of visits         | Artificial like the clinic | Real world including the home |
| Nature of visits           | Primarily synchronous | Synchronous and asynchronous |
| Clinicians                 | Few          | Many             |
| Limiting factors           | Social and geographical | Social and technological |
| Concerns                   | Access, quality, and cost | Privacy, equity, and duty |

**Table 2. Select investments in health by the largest technology firms, 2019–2021.**

| Company        | Market capitalization ($ billions as of May 12, 2021) | Recent activities |
|----------------|-------------------------------------------------------|------------------|
| Apple Inc.     | $2040                                                 | • Collaborated with Eli Lilly and Evidation Health in joint study to detect cognitive decline |
| Microsoft      | $1800                                                 | • Developed Microsoft Cloud for Healthcare, first industry-specific cloud solution |
| Amazon.com     | $1590                                                 | • Partnered with Providence St. Joseph Health to build a “hospital of the future” in Seattle |
| Alphabet Inc.  | $1490                                                 | • Created and expanded Amazon Care for its employees and other companies |
| Facebook, Inc. | $860                                                  | • Acquired a technology company that can control a virtual hand |

and smartphones are ubiquitous. Finally, such care can be centered around the needs of individuals rather than institutions. The most consistent finding from telemedicine studies is high patient satisfaction.

Concerns

Privacy, equity, and duty

Limiting factors

Social and geographical

Social and technological

Table 2.

Select investments in health by the largest technology firms, 2019–2021.

**Company** | **Market capitalization ($ billions as of May 12, 2021)** | **Recent activities** |
--- | --- | --- |
Apple Inc. | $2040 | • Collaborated with Eli Lilly and Evidation Health in joint study to detect cognitive decline |
Microsoft | $1800 | • Developed Microsoft Cloud for Healthcare, first industry-specific cloud solution |
Amazon.com | $1590 | • Partnered with Providence St. Joseph Health to build a “hospital of the future” in Seattle |
Alphabet Inc. | $1490 | • Created and expanded Amazon Care for its employees and other companies |
Facebook, Inc. | $860 | • Acquired a technology company that can control a virtual hand |

**Characteristics**

Clinic-based | Technology-based
--- | --- |
Principal measurers of health | Devices
Health measurements | Primarily objective
Frequency of measurements | Continuous
Location of visits | Real world including the home
Nature of visits | Synchronous and asynchronous
Clinicians | Many
Limiting factors | Social and geographical
Concerns | Privacy, equity, and duty
calls, the gold standard of patient-centered care, should be experienced by all students and more than once (as is the requirement where I work). Similarly, telemedicine should be part of clinical training from the beginning. The scale and scope of these experiences can expand from common synchronous one-to-one encounters to one-to-many group visits to many clinicians connecting to a single patient for complex care management. Similarly, the complexity and demands of telemedicine can increase with training to include support of other clinicians (e.g., through remote intensive care units or asynchronous consultations). Reflective exercises that ask trainees to consider the relative benefits and limitations of these emerging care models from the perspectives of patients, clinicians, and payors could be illuminating.

Researchers must be far more ambitious in the scale and scope of their investigations. In 2015, Apple’s open-source ResearchKit demonstrated the ability of smartphones to enroll thousands of research participants in a single day16. Today, the National Institutes of Health’s All of Us Research Program aims to enroll at least one million Americans in an observational study that includes questionnaires, clinical assessments, collection of biological specimens, and use of digital health technology17. Verily includes questionnaires, clinical assessments, collection of biological specimens, and use of digital health technology17. Verily’s Project Baseline study is embracing these platforms even more to utilize smartphones and other digital devices that over 40% of the world’s population now possess18. Social media and patient registries are powerful tools for recruiting potential research participants, the vast majority of whom are not seen at traditional settings than the hospital6. For example, Medicare

employment or taxes. Studies rely on the goodwill and trust of research participants to occur. Citizens and their representatives determine the financial incentives that educators and clinicians face. The past 2 years have highlighted many of the substantial shortcomings of institution-centered care and provided powerful glimpses of the alternatives that measure health and deliver health care outside of hospitals and clinics. The principal beneficiaries of these new models are not the providers of care and research but the recipients. These individuals will have to make their voices heard for progress to continue. Proponents of institution-based care certainly will.

CONCLUSION
A century ago, advances in transportation (e.g., cars and roads) and technology (e.g., electrocardiograms, x-rays) drove care away from homes and toward hospitals and clinics. Today, advances in technology are reversing that trend. The digital devices that we carry, wear, and have in our homes are now measuring our health constantly and will soon be the means by which we receive care. The infrastructure is now in place (81% of Americans own a smartphone; 20% wear a fitness tracker)19, the capabilities of these devices are increasing, and the desire and need for care in the home are rising. The promise is that our measurement of health will improve and that care will be more accessible. However, for that to occur, we will need to establish new rules for the road and ensure that these platforms are available to all.

Received: 9 April 2021; Accepted: 8 June 2021; Published online: 15 July 2021

REFERENCES
1. Case, S. The Third Wave: An Entrepreneur’s Vision of the Future (Simon & Schuster, 2016).
2. Perez, M. V. et al. Large-scale assessment of a smartwatch to identify atrial fibrillation. N. Engl. J. Med. 381, 1909–1917 (2019).
3. Verna, S. Early impact of CMS expansion of medicare telehealth during COVID-19. Health Affairs Blog https://www.healthaffairs.org/doi/10.1377/hblog20200715.454789/full (2020).
4. Dorsey, E. R., Glidden, A. M., Holloway, M. R., Birbeck, G. L. & Schwamm, L. H. Telemedicine and digital technologies: the future of neurological care. Nat. Rev. Neurol. 14, 285–297 (2018).
5. Fassbender, K. et al. “Mobile Stroke Unit” for hyperacute stroke treatment. Stroke 44, e44 (2003).
6. Cryer, L., Shannon, S. B., Van Amsterdam, M. & Leff, B. Costs for 'Hospital at Home' patients were 19 percent lower, with equal or better outcomes compared to similar inpatients. Health Aff. 31, 1237–1243 (2012).
7. Mair, F. & Whitten, P. Systematic review of studies of patient satisfaction with telemedicine. Bmj 320, 1517–1520 (2000).
8. Hudson, K. L., Holohan, M. K. & Collins, F. S. Keeping pace with the times — the Genetic Information Nondiscrimination Act of 2008. N. Engl. J. Med. 358, 2661–2663 (2008).
9. Topol, E. The Patient Will See You Now (Basic Books, 2016).
10. Institute of Medicine. Crossing the Quality Chasm: A New Health System for the 21st Century (The National Academies Press, 2001).
11. Wilcock, A. D. et al. Association between broadband internet availability and telemedicine Use. JAMA Intern. Med. 179, 1580–1582 (2019).
12. Nouri, S., Khong, E. C., Lyles, C. R. & Karliner, L. Addressing equity in telemedicine for chronic disease management during the covid-19 pandemic. NEJM Catal. Innov. Care Delv. https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0123 (2020).
13. Velasquez, D. & Mehrotra, A. Ensuring the growth of telehealth during Covid-19 does not exacerbate disparities in care. Health Affairs Blog https://www. healthaffairs.org/doi/10.1377/hblog20200505.391636/full (2020).
14. Stoltz, C. M., Smith, L. G. & Boal, J. H. Home care training in internal medicine residencies: a national survey. Acad. Med. 76, 181–183 (2001).
15. Pourmand, A. et al. Lack of telemedicine training in academic medicine: are we preparing the next generation? Telemed. J. E. Health 27, 62–67 (2021).
16. Dorsey, E. R. et al. The use of smartphones for health research. Acad. Med. 92, 157–160 (2017).

Published in partnership with Seoul National University Bundang Hospital
17. The All of Us Research Program Investigators. The “All of Us” Research Program. N. Engl. J. Med. 381, 668–676 (2019).
18. Arges, K. et al. The Project Baseline Health Study: a step towards a broader mission to map human health. NPJ Digital Med. 3, 84 (2020).
19. Trauth, J. M., Musa, D., Sminoff, L., Jewell, I. K. & Ricci, E. Public attitudes regarding willingness to participate in medical research studies. J. Health Soc. Pol. 12, 23–43 (2000).
20. Khozin, S. & Coravos, A. Decentralized trials in the age of real-world evidence and inclusivity in clinical investigations. Clin. Pharmacol. Ther. 106, 25–27 (2019).
21. Gaba, P. & Bhatt, D. L. The COVID-19 pandemic: a catalyst to improve clinical trials. Nat. Rev. Cardiol. 17, 673–675 (2020).
22. Binette, J. & Vasold, K. 2018 Home and Community Preferences: A National Survey of Adults Ages 18-Plus (AARP Research, 2018).
23. Pew Research Center. Mobile fact sheet. https://www.pewresearch.org/internet/fact-sheet/mobile/ (2021).

ACKNOWLEDGEMENTS
Thanks to Meghan Pawlik, BA, for assistance in preparing this paper. Research reported in this publication was supported by the National Institute of Neurological Disorders and Stroke of the National Institutes of Health under Award Number P50NS108676. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

COMPETING INTERESTS
E.R.D. has received honoraria for speaking at American Neurological Association, Excellus BlueCross BlueShield, International Parkinson’s and Movement Disorders Society, National Multiple Sclerosis Society, Northwestern University, Stanford University, Texas Neurological Society, and Weill Cornell and has received compensation for consulting services from Abbott, Abbvie, Acadia, Acorda, Alzheimer’s Drug Discovery Foundation, Ascension Health Alliance, Biogen, BluePrint Orphan, Clintrex, Curasen Therapeutics, DeciBio, Denali Therapeutics, Eli Lilly, Grand Rounds, Huntington Study Group, medical-legal services, Medical Communication Media, Medrhythms, Michael J. Fox Foundation, MJH Holding LLC, NACCME, Olson Research Group, Origent Data Sciences, Otsuka, Pear Therapeutic, Praxis, Prilenia, Roche, Sanoﬁ, Spark, Springer Healthcare, Sunovion Pharma, Sutter Bay Hospitals, Theravance, University of California Irvine, and WebMD; research support from Acadia Pharmaceuticals, Biogen, Biosensics, Burroughs Wellcome Fund, CuraSen, Greater Rochester Health Foundation, Huntington Study Group, Michael J. Fox Foundation, National Institutes of Health, Patient-Centered Outcomes Research Institute, Pfizer, PhotoPharmics, Safra Foundation, and Wave Life Sciences; editorial services for Karger Publications; and ownership interests with Grand Rounds (second opinion service).

ADDITIONAL INFORMATION
Correspondence and requests for materials should be addressed to E.R.D.

Reprints and permission information is available at http://www.nature.com/reprints

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit http://creativecommons.org/licenses/by/4.0/.

© The Author(s) 2021