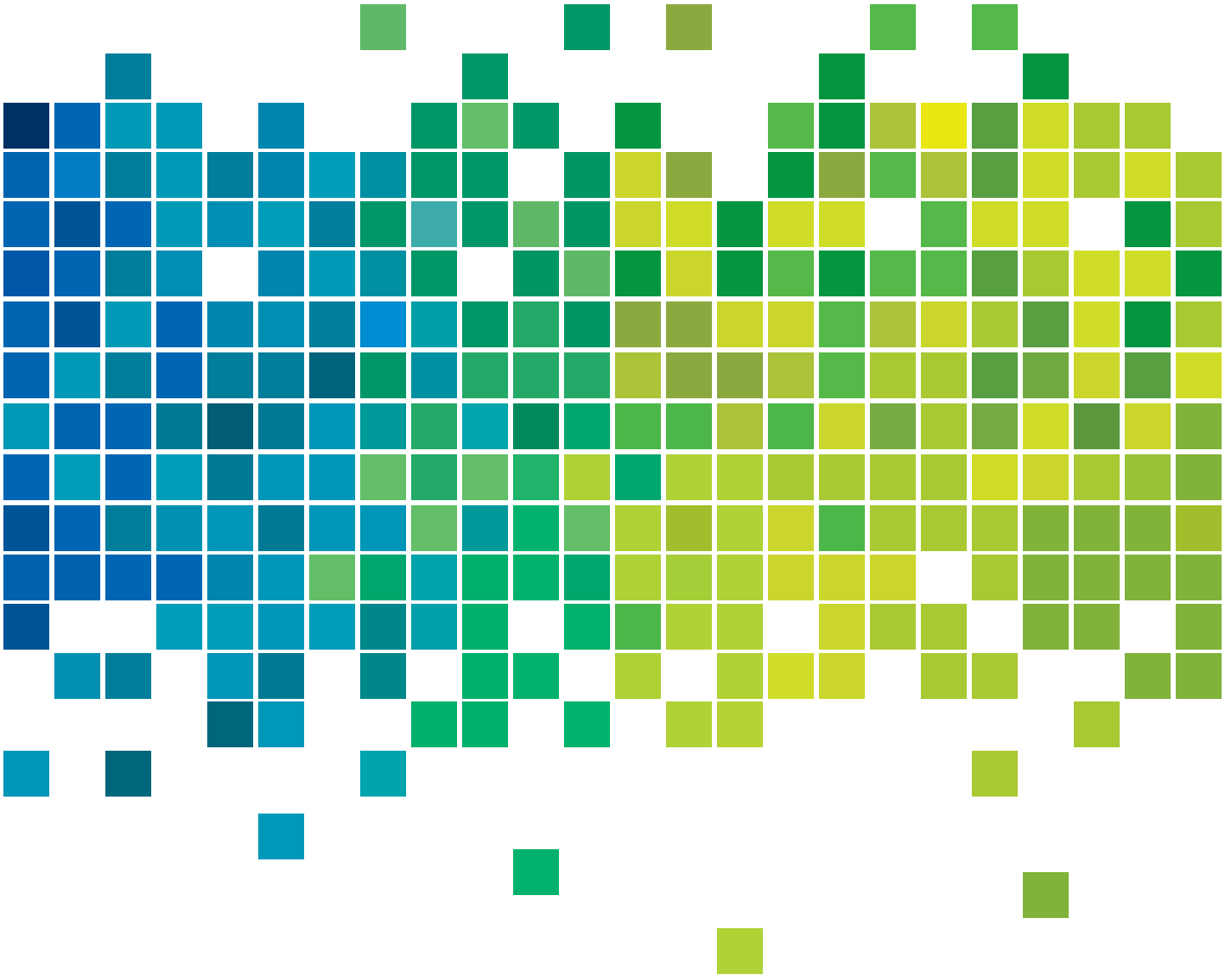
BOOTING UP MOBILE HEALTH

FROM MEDICAL MAINFRAME
TO DISTRIBUTED INTELLIGENCE



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Health Horizons Program

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HEALTH HORIZONS PROGRAM

The IFTF Health Horizons Program offers its clients a deep understanding of the global health economy and the social forces that will shape health and health care in the next three to ten years. We identify and evaluate emerging trends, discontinuities, and innovations in consumer behavior and social media; health and medical technologies; health care delivery systems; and food, nutrition, and sustainability. Our forecasting process helps organizations work with foresights to develop insights that lead to specific strategic actions they can use to better position themselves in the marketplace.

INSTITUTE FOR THE FUTURE

The Institute for the Future (IFTF) is an independent, nonprofit strategic research group with more than 40 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is located in Palo Alto, California.

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INTRODUCTION

HEALTH CARE IN THE AGE OF EXTREME MOBILITY

The world is on the move more than ever before. The United States has long enjoyed high levels of mobility, and the rest of the world is seeing an unprecedented expansion in personal mobility. Our definition of mobility is expanding too, beyond just physical movement, to include virtual and temporary kinds of movement.

Simply put, the increasing mobility of people, goods, money, and knowledge throughout a global economy is a new business reality. Today, the rest of the global economy is adapting to the increased mobility enabled by ubiquitous information and communication technologies. While some narrow segments of the health care sector have adopted these technologies for many uses, so far the fundamental structure of health care in the United States has resisted change.

Health care in America is still based on the early-20th century model that arose after millions of American workers moved from farms to factories in the late 19th century. During this period, the health care system as we know it was developed—a fixed, capital-intensive industrial network of service delivery points and supporting infrastructures built around huge hospitals and centralized processes. This industrial model of health care was organized according to the same management principles of standardization, scale, and efficiency as the factories its patients worked in.

Over the next decade, however, a bottom-up transformation of mobility will create a growing number of dilemmas for the health care industry and forge a new landscape of health needs, management, and service delivery innovation. This new world of mobile health will be more than its technology. New technologies and the services they enable will be just one piece of a larger strategy for engaging consumers anywhere, anytime. Mobile health is emerging at the intersection of dynamic changes in mobility patterns, health care delivery, and new mobile technologies and networks. As a result, mobile health will encompass a whole set of new business and consumer practices that fundamentally transform the health care system as we know

it. Ultimately, mobile health will create more distributed health care systems that will move from an episodic to a continuous-care model, supported by decentralized, integrated care interwoven seamlessly into our daily lives, and driven by even more advanced smart systems that help us sense and understand our actions and environments.

Three forces will drive this transformation from fixed to mobile health. First, extreme mobility practices and new enabling technologies in our pockets and embedded around us will change the way we interact with the world. Second, the century-old industrial health model is poised for change and the rise of extreme mobility is slowly dismantling the antiquated framework. Third, mobile communications and computing devices will become a primary means of accessing information and communicating on the go. Already, the devices we carry with us today—mobile phones, smartphones, PDAs—boast better capabilities than the most powerful desktop computers of the late 1990s, and are connected to a vast web of people and resources as never before. As open mobile ecosystems unleash innovation, the services available on these devices will come to match their raw computational potential. Moreover, our homes, offices, and public spaces will contain more embedded intelligence, augmenting the sensing, processing, and display capabilities of mobile devices. The convergence of constant connectivity, a decentralizing health care system and extreme mobility will reshape the delivery and provision of health care services extensively.

1 THE WORLD ON THE MOVE

Before we dive into the emerging mobile health landscape, it's worthwhile to take a broad look at the growing role mobility plays in the global economy. But what do we mean when we talk about mobility? Mobility's importance stems from its deep connections to the patterns and rhythms of daily life, and how people develop and meet everyday needs and desires. A traditional view of mobility focuses on the physical movement of people, vehicles, and goods. Historically, routes of travel used to be the only tool for organizing our daily activities. With the emergence of information and communication technologies, however, mobility is becoming multidimensional. Goods, services, people, and information are moving around the world faster and more efficiently than ever before, and being brought together in new and more productive combinations. The movement of information, knowledge, and money through telecommunications means that our paths of movement are dictated by virtual flows of information that we receive on our mobile devices.

THE UNITED STATES: FROM HIGH TO EXTREME MOBILITY

The United States has long been defined by high levels of personal mobility, which has been a source of competitive advantage, economic and social flexibility, and personal productivity. Throughout the nation's history, mobility has driven many policy decisions. The development of the West, first by wagon, then by railroad, and the Interstate Highway System were the result of mobility-enabling policy initiatives in the 1950s. More recent examples of broad regulatory efforts to drive continued expansion of mobility include the liberalization of the commercial aviation and telecommunications industries. The result is that firms and labor are able to relocate quickly in response to changing markets, as they did when they moved south and west during and after World War II. In fact, workers are so mobile today that firms routinely locate near pools of talent seeking pleasant places to live, a stunning reversal of traditional workforce relocation.[1]

The mobility expansion of the last fifty years in many ways defined the United States. Our homes, our work, our social lives, our political views are all deeply shaped by our desire for high levels of mobility. Over the next decade, Americans will continue to push the frontiers and pioneer even more varied forms of mobility. We'll see a rapid evolution of behaviors and practices that exploit the capabilities of mobile communications and computing to coordinate groups on the fly. As sociologist John Urry argues in his book *Sociology Beyond Societies*, we will move from a world in which society and place are the organizing concepts to one in which mobilities and flows define our human world.[2]

IFTF has developed five lenses that organizations can use to understand these new and expanded forms of mobility:[3]

Physical mobility, or the movement of people by air, rail, and automobile transportation that exposes them to new places, resources, and people and also shapes the requirements and usage of many personal technology devices.

Residential mobility, or changes in the places where people live that influence the supply of labor and the flow of money on a local and global scale by shaping product and service requirements and widening social and family networks.

Financial mobility, the ability of individuals to manage the flow of funds across space and time.

Virtual mobility, the ability to project your influence in places and at times you are not physically present by using information and communication tools for remote control and coordination, or to enhance and augment social connectivity. Financial mobility includes not only the movement of money across national borders and social barriers, but also the ability to borrow through consumer credit and micro-loans. These new mobilities give people access to the mechanisms for financial reward large corporations have employed for decades. Virtual mobility exposes individuals to new ideas and new spheres of influence independent of or in conjunction with physical travel, and in much less time.

Ephemeral mobility, or the temporary movements of people, both voluntary and involuntary, that are endemic in a more crowded and urbanized world and that generate need for temporary and often lightweight infrastructures. Think of mobile workers and their repurposing and selection of public spaces for focused, creative, and collaborative work.

Three important drivers of change explain how this expanded view of mobility will begin to intersect with health care over the next decade:

- The rise of new daily choreographies, or scripts for everyday life
- The car's emergence as a mobile living space
- The growth of mobile work

New Daily Choreographies

For much of the 20th century, the daily life of households was dictated by "rush hour," the diurnal tide of workers and students moving from home in the morning and back again at night, synchronized by alarm clocks and time clocks. Routes of travel from point to point used to be the main tool for organizing daily activities.

More often these days, however, our paths of movement are dictated on the fly by information we receive on our mobile devices. The 20th century choreography of scheduled appointments and fixed meeting points is rapidly being replaced by ad hoc meetings in temporary places enabled by instant communication. We coordinate families and social groups on the fly, shattering schedules into a constant stream of negotiations about when and where to gather for activities. Our travel patterns are becoming less like straight lines back and forth between home and work, home and stores, and more ad hoc, and less predictable.

The Car as Mobile Living Space

The changing daily rhythms of individuals, households, and organizations, coupled with increasingly spread-out suburbs, means that more of our time is spent traveling between multiple locations in cars. Instead of just traveling between home and work for the traditional commute, we are using our cars as a kind of mobile living and work space. A survey by Arbitron in 2003 found that Americans spent 15 hours a week on average in their cars, some 14% of waking hours, traveling an average of 306 miles per week.[4] Add to this the use of portable information and communication devices, and it seems that more and more of our lives are conducted on the go. We eat in our cars, conference in our cars, go online in our cars, do homework in our cars, watch DVDs in our cars (at least our passengers do), change clothes in our cars, and so on. This has far-reaching effects, not all of them good. As has been widely reported, a 2004 landmark study linked this growing time spent in cars with higher rates of childhood obesity, for example.[5]

Working On the Go

If more of life is being conducted on the move, it makes sense that more work will be done the same way. For a record number of jobs these days, "work" is defined less by place and more by movement, as more work is being done on the go outside of a traditional office, shop, or factory. According to a 2005 study by market research firm IDC, the mobile workforce is expected to reach 850 million by 2009, approximately one-quarter of the global workforce. In the United States, the mobile workforce is projected to grow at 3% annually, reaching 113 million by 2009.[6]

Earlier surveys suggest that this growth is being driven not by traveling businesspeople but by workers who rarely leave town but are often in meetings or away from their desks. This group was expected to grow in number by 10% annually to over 13 million from 2002 to 2006.[7] Expanded mobility during the workday is also driven by home-based teleworkers, who intersperse episodic work sessions with personal trips, and by workers who use mobile devices to work during vacation and leisure time. Indeed, the support of mobile workers is now driving the IT budgets of most large organizations.

THE EMERGENCE OF EXTREME MOBILITY

These drivers point toward the continued expansion of mobility tools and practices in the United States, building on already high levels. Over the next decade, we will see the emergence of a kind of extreme mobility characterized by physical movement augmented and coordinated by swarms of personal technologies, social networks, and intelligent environments. The kinds of behaviors that will characterize this shift include both financial mobility tools such as remittances that underpin the global mobility of labor, giving rise to transnational communities, and ephemeral forms of mobility—such as pilgrimages, conferences, meet-ups, and flash mobs—that combine blended physical and virtual elements and challenge traditional distinctions between mobile and stationary.

This shift to extreme mobility has monumental consequences for every aspect of business and government in the United States. The consequences are particularly critical for health care, because health care is such a fundamental service, and because the U.S. health care industry has resisted change for so long, it will be particularly affected by the growth in extreme mobility. To respond to the challenges of mobility, the health care sector will need to become at least as mobile as the people its trying to reach. Health care systems and industries will have to consider not only new points of service, but also new networks of care and new kinds of interactions. Mobile health will extend beyond the simple act of incorporating smart mobile technologies into the current health care infrastructure. In the coming decade, mobile health will fundamentally change health care delivery to include more distributed and decentralized approaches to clinical, consumer, and public health.

2 HEALTH CARE:

DISMANTLING THE OLD HEALTH FRAMEWORK

The health care system, organized early in the 20th century around hospitals and acute care, hasn't adapted to the post-war expansion of personal mobility in the United States. By the 1920s, modern hospital and clinical care systems were structured around antiseptic surgery, which practiced a "new kind of medicine—precise, scientific, and effective."[8] This focus on surgery and the medical technologies that enabled it shifted the epicenter of care from the home and the community to the clinical setting, and placed the focus on interventionist care with measurable outcomes, "overshadowing the more humble and inconclusive efforts of internal medicine."[9] For the most part, this acute care model prevails today.

The rise of extreme mobility in the 21st century, however, is slowly dismantling this century-old framework. Signals of a transition to a more decentralized, distributed health care system include:

- Health care is moving from an acute, episodic care model to a more continuous, chronic care model.
- Points for care delivery are expanding from centralized locations to more outpatient and convenient care options.
- Diagnostics are being marketed not only as tools for health professionals, but also for consumers, and over-the-counter diagnostics are growing more popular.
- Information is being decentralized and redistributed into the hands of patients.
- Shifting from large, fixed technologies requiring high levels of capital investment, lightweight technologies are leading the next wave of innovation.

FROM EPISODIC TO CONTINUOUS CARE

The profile of diseases in the United States has changed dramatically over the last century, moving from acute to chronic conditions. Currently, the majority of Americans with health insurance are taking prescription drugs to treat at least one chronic health condition—in other words, it is more common for Americans to have a chronic illness than not.[10] As many as 25 million Americans experience major limitations in activity resulting from a medical condition, and 70% of the deaths in this country are attributed to a chronic illness.[11]

The traditional hospital-centered, third-party-payer health care system as we know it just isn't designed for dealing with the continuous care these kinds of conditions require, but it is even more challenging for the almost 47 million Americans without health insurance. An estimated one-third of the uninsured have at least one chronic condition, and lack of adequate medical care may help to explain why chronic illnesses decrease the quality of life for millions.[12]

Source:
milkeninstitute.org

The economics of chronic illnesses are correspondingly somber. The Milken Institute's 2007 report on the economic burden of chronic illness marked a watershed moment in the understanding of the true impact of chronic conditions. Examining seven medical conditions (diabetes, heart disease, hypertension, cancers, stroke, pulmonary conditions, and mental disorders), the study found that the failure to address chronic conditions sufficiently costs the U.S. economy more than $1 trillion annually.[13] The Milken Institute's findings are supported by other research organizations, which have highlighted that caring for patients with chronic conditions accounts for more than four-fifths of all health care expenditures, or more than $1.4 trillion annually.[14]

More importantly, the Milken Institute's report distinguished direct costs incurred in the form of treatment, which account for an estimated $277 billion annually, and indirect costs experienced in the forms of presenteeism (low productivity at work because of an illness or medical condition) and absenteeism, which account for an estimated $1.3 trillion in lost economic output annually. By 2023, the authors anticipate a 42% increase in the number of cases of the seven identified chronic conditions, resulting in $4.2 trillion in treatment cost and lost productivity combined.

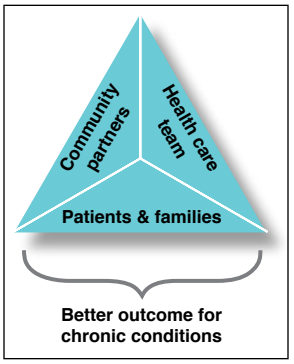
Despite the well-documented epidemiological transition and the resulting financial burdens, care for chronic illness is still being delivered through a health care system largely developed a century ago. The present health care infrastructure is designed to address acute, episodic care. To prevent the devastating health consequences of chronic conditions that more of us are experiencing, however, a more continuous, preventive, and holistic understanding of health care is needed.

The World Health Organization (WHO) is pointing the way. The WHO has issued country guidelines for reducing the global epidemic of chronic disease. These guidelines are based on the notion that the promotion of healthy lifestyles and prevention of premature death and unnecessary disability due to chronic illness require only limited interaction with resources traditionally supplied by the formal health care delivery system.[15] The WHO supports a "health care triad" of care: a partnership between patients and their families, health care teams, and supporters in the community.[16] Most notably, in order to promote behavioral and lifestyle changes, patients must be empowered to take a central role in their own care. This puts the patient, not the hospital, at the center of the individual's

Source:
who.int

personal health ecology, which can be defined as the whole set of health care resources, information resources, relationships, and communication webs that an individual might use to stay healthy.

As financial, resource, and capacity constraints continue to weaken an already encumbered health care system, more individuals and institutions will look to harmonize health care delivered in the formal health care settings with health practices carried out in their increasingly mobile lives. Early indications suggest that mobile technologies have the potential to integrate the WHO's health care triad.



Source: who.int.diabetesactionon-line/about/ICCC/en/

FROM CENTRALIZED TO EXPANDED POINTS OF CARE

What we think of today as the obvious, rational choices for location of care evolved from the need to provide medical care centrally, in an organization operating similarly to a factory or other large institutions. Over the last century, hospitals became temples for high-technology medical care, drawing human capital and technological innovation into medical campuses across the country. In the next decade, the trend to toward centralization is likely to be reversed. Mobile technologies will accelerate a larger trend of care moving out of hospitals and traditional clinical settings. We are already seeing some signs of this transition. Driven by advances in technology, greater scrutiny by government and insurers, changes in reimbursement systems, price competition among hospitals, new players in care offerings, and a growing acceptance of outpatient treatment, the rate of growth in private hospital spending is on the decline.[17]

This projected decline in hospital spending runs counter to trends anticipating an increased demand for services currently provided by hospitals. With the demographic transition driven by the aging baby boomers underway, it would seem that hospital spending would be projected to grow. Elderly populations have historically accounted for a disproportionate number of hospital admissions. Between 1997 and 2004, for example, the elderly population represented only 12% of the population but 35% of total hospital admissions.[18]

So why is hospital spending likely to decrease? Although many cite the lower reimbursement rates of the Center for Medicare and Medicaid Services (CMS) as the explanation for reduced hospital spending, the reduced average length of stay (ALOS), and the increase in outpatient services may also be contributing to the decline. Outpatient surgeries now account for 60% of total surgeries and, considering the substantial workforce shortages facing U.S. hospitals in the next decade, the trend to outpatient services will likely continue. This notable change in in-patient care will support the larger trend of decentralization in health care.[19, 20]

CMS Centers for Medicare & Medicaid Services

Source: cms.hhs.gov

Another way that people may be reducing hospital spending is by seeking care in unconventional places. The recent, well-documented rise of the convenient care industry—also called retail clinics—has demonstrated that demand exists for fast, affordable treatment for routine medical conditions and preventive care delivered outside traditional clinical settings. Recently, the buzz around retail clinics popping up in big-box chains such as Target and Wal-Mart as well as drugstore chains such as CVS and Walgreens has waned, with retailers reassessing projections and scaling back aggressive expansion plans.[21] They're not abandoning the idea completely, however. Retailers are now developing clinics in partnership with hospitals and health care systems in the local markets in which they operate. Wal-Mart, for instance, intends to open 400 in-store medical clinics by 2010 by co-branding with local health care systems such as St. Vincent Health System in Little Rock, Arkansas.[24]

In addition to retail clinics, the convenient care industry is now expanding into the workplace. Large employers such as Continental Airlines, BMW, and Toyota are entering into deals with the pharmacy and drug store Walgreens to provide health care and well-being services for their employees at the workplace.[22] These burgeoning partnerships between hospitals, workplaces, and retailers will spark increased attention to the role of mobility in health care delivery.

The reduction in hospital stays along with increased competition from outside players delivering care more conveniently and affordably are driving the future growth of outpatient and convenient care.

FROM PROFESSIONALTO SELF-DIAGNOSTICS

Supporting the unbundling of the hospital is the growth of over-the-counter (OTC) diagnostics. Diagnostics, often viewed as a less attractive investment opportunity when compared to the allure of the revenues associated with developing the next blockbuster drug, are drawing increased attention lately. Driven by innovative technological advancements in therapeutics, skyrocketing health care costs, and a growing consumer base interested in participating actively in the management of their health, there has been a recent introduction of numerous breakthrough products that are combining drugs and diagnostics into consumer-friendly devices.

In clinical settings, diagnostics are essential, contributing to "60 to 70% of all key decision-making, including admittance, discharge, and medication."[26] In the home environment, certain OTC diagnostics play an important role in health management. OTC glucose monitoring and pregnancy testing already comprise a $6.3 billion market.[27] According to a 2006 report by Cambridge Consultants, the diversifying OTC diagnostic market is projected to grow modestly over the next two years. Beyond 2010, however, "the market will expand more into the consumer sector, and could rival that for glucose testing."[28] By placing more diagnostics directly in the hands of consumers, people will increasingly be equipped with the tools necessary to oversee their health conditions.

Past experience exemplifies the impact at-home diagnostics can have on health information in this country. The home pregnancy test, introduced in 1978, symbolized a "private little revolution," enabling women to take control of their reproductive health care.[23] Not only did the at-home pregnancy test contribute to improving women's health, but the OTC pregnancy test "moved the moment of discovery from the doctor's office (back) to the home." As Sarah Leavitt explains:

> Women in this generation who take home pregnancy tests are able to know something about themselves and their futures in a time frame that was simply not possible for their grandmothers, or even their mothers. The kit modified the network of actors involved in diagnosing pregnancy, taking the event from the doctor's office to the home. Its revolutionary status, therefore, is small but personal, removing the moment of pregnancy diagnosis from the institutional gaze of the doctor to private gaze of the pregnant (or not-pregnant) woman herself.[24]

Source:
Acu-Test *Mademoiselle*, December 1973.

The diagnostic tool did not replace a consultation with a health professional, but it did put the information into the hands of women. Similarly, the development of new, sophisticated at-home diagnostics will both relocate the moment of diagnosis and reshape our relationship with our health professionals. Genomics, proteomics, and metabolomics as well as DNA, RNA, protein chips, and

microarrays are “rapidly redefining the taxonomy of disease as biomarker-identified subgroups.”[25] As a result, new market categories for diagnostics are emerging, with some being developed for the direct-to-consumer market. For instance, the Silicon Valley startup, 23andMe, offers customized genomic scans to provide information about one’s ancestry, inherited traits, and disease risk.[26] While presently it seems peculiar to undergo genetic sequencing without the close oversight of a health professional, some suggest that soon preventative or upstream diagnostics will be the norm. “We take our blood pressure, track our cholesterol, count our calories. Our genome is now just one more metric at our disposal. It is one more factor revealed, an instrument suddenly within reach that can help us examine, and perhaps improve, our lives.”[27] OTC diagnostics are supporting the larger trend of health care information moving (back) to the home and in the hands of people.

Source: 23andme.com

FROM CENTRALIZED TO DISTRIBUTED INFORMATION

Many of the changes that took place in health care finance and delivery in the 1990s put greater emphasis on patient or consumer engagement in their own health care decisions. Rooted in the logic behind consumer-directed health plans is the idea that consumers who are equipped with good information will be empowered to make the appropriate decisions to manage their own health proactively, thereby keeping costs down.

What seemed to be left out of the equation, however, is the fact that, with the introduction of more sophisticated medical technologies in the 20th Century, most health information was put in the hands of medical professionals, not patients. As a result, the information is often presented in confusing, complicated language not readily understood by the average person. As Joel Howell writes, “Defining most forms of medical knowledge as privileged information for the health care provider [has been] defended as a necessary consequence of the increasingly technical nature of medical care.”[28] In other words, placing the information about one’s health in the possession of the provider and not the patient was an unforeseen effect of the introduction of technology into health care delivery.

This information asymmetry is being challenged, however, by recent trends in consumer health care as well as larger societal trends around openness and transparency. Moreover, following the 1999 Institute of Medicine’s seminal report, which found that an estimated 100,000 patients die each year due to medical errors, patient safety has received increased attention as well.[29] More of us are recognizing that we need to be more responsible for the management of our own health, and are thus growing increasingly accustomed to supplementing our interactions with health professionals with additional resources.

To give health care consumers better information about the quality of their own health care, new indicators are sprouting up to measure everything from the quality of care of specific physicians or hospitals to the transparency in the fee-for-services at different locations or in different markets. The Internet is emerging as a primary source for this kind of health information. More than 122 million people, or 56% of American adults, sought information online about a personal health concern in 2007. While people are seeking information from a variety of sources, reliance on the Internet doubled from 16% to 32% between 2001 and 2007.[30]

People are not going online just to seek information from static resources like medical articles or medical encyclopedias. Given that the Internet transcends geographic boundaries, health care consumers are forming online communities for support and information. They are able to tap into any number of online affinity groups to find, filter, and make sense of complex and fragmented health information, putting a whole world of information at their fingertips. In this way, they build distinct networks around interests, principles, and values that transcend physical communities.

FROM HOSPITALS AS INNOVATION CENTERS TO LIGHTWEIGHT INNOVATIONS

Historically, the introduction of new medical technologies has occurred in hospitals, which for the last century or so have been the epicenter of medical care. These technologies have tended to be large, expensive machines, requiring significant capital and economies of scale to justify the investment. The introduction of mobile technologies, on the other hand, is not following traditional medical technology adoption practices. Rather than coming top-down from the institutions themselves, mobile technologies are spreading from the bottom up. In other words, patients are utilizing their personal mobile technologies to supplement their care with or without the recognition of their health care providers.

Source: mobileburn.com/news.jsp?Id=2335

Early experiments in applying mobile technologies to improve health outcomes have focused predominantly on diet and nutrition, two areas in which personal choices can make large differences. MyFoodPhone, launched in 2006, is an early mobile health application.[31] Participants use their mobile phone camera to snap a photo of their food choices, and send the photo via the network to a nutritionist who then responds with real-time advice and support. Another example, the mDIET mobile phone application, is a push-pull system. It uses expert system logic to "push" messages via the mobile phone to support critical decision-making in real time, and enables users to "pull" information by text and voice communication over the same phone. Dr. Kevin Patrick at the University of California, San Diego demonstrated the efficacy of mDIET to improve diet behaviors and reduce weight in a randomized controlled trial among overweight adults.[32]

Smoking cessation is another behavioral health area for which mobile technologies are being used. To curb smoking, HME-STOMP (Health Messaging Engine—Stop Smoking Over Mobile Phones) targets smokers who are interested in quitting by issuing customized SMS text messages before and after "quit day." In New Zealand, Txt2Quit sends text messages to participants for 26 weeks. The messages contain reinforcing support, facts about smoking, and tips for quitting. When STOMP underwent randomized testing, the group using the mobile phone demonstrated twice the percentage of self-reported quit rates at six weeks than the group that did not have access to STOMP (28% as compared to 13%).[33] Having recently received the Telecommunication Users Association of New Zealand (TUANZ) 2008 Award for Innovation, HME-STOMP plans to expand the service beyond the United States and New Zealand to Canada, Singapore, and Australia.

Source: quit.org.nz

By using mobile technologies to improve behavioral health practices in these ways, the users themselves have moved health care out of the hospital and clinician's office and into the world in multiple settings—the home, the car, the office, walking down the street. Although there is not a lot of experience with user-led innovation in health, it is coming, driven by extreme mobility and exciting developments in easy-to-use, lightweight mobile technologies.

Bottom-up adoption of mobile technologies into health practices is likely to have a disruptive impact on where and how care is delivered, an impact similar to that of large capital-intensive medical technologies in the past. The X-ray machine, for example, slowly shifted the locus of health care delivery from the home to the hospital. In retrospect, the rollout of such technological diagnostics was incremental, in part because providers and patients alike were unfamiliar with the intervention. But, as Joel Howell argues, the prolonged resistance to implementing the new technology was less about the resistance of physicians and more about the dearth of processes for deploying the technology en masse.

In the late 1890s when hospitals purchased their first X-ray machines, there was no structure into which such a diagnostic tool could fit: there were no physicians performing tests for fees; there were no forms for reporting results of any kind.[34]

Source: en.wikipedia.org/wiki/Filke:Anna_Berth_Roentgen.gif

Once physicians became more accustomed to applying technology for the provision of care, however, adoption of technology occurred much more quickly. “Having already established a mechanism for sharing reimbursement with the physician-operator as well as a format for reporting test results from special units, the hospital could incorporate a new technology with relative ease,” explains Howell.[35] Whereas the X-ray took almost 20 years to become adopted, the ECG, “a less clinically valuable tool, found rapid acceptance.”[36]

It’s likely that mobile health technologies will experience a similar evolution. Without the appropriate reimbursement incentives, established practices, and policies to support health applications of these technologies, adoption will be slow and fragmented. Everywhere we look, however, increasing mobility is enabling innovation to develop quickly, and is encouraging people to use technology in novel ways. The dynamic experimentation occurring outside of the core business practices, such as mDIET and HME-STOMP, may develop into the most interesting and potentially important innovations in health and health care. Once the system catches up to the practice, the system will be re-booted and changed forever.

HEALTH CARE IN THE WORLD OF EXTREME MOBILITY

These transitions—user-led innovations in health and health care, a chipping away of the medical information asymmetries of the past, new locations for diagnostic discovery and the resulting new relationships between patients and their medical providers, and a move toward more continuous care delivery models—are slowly dismantling the century-old health system and are influencing new approaches to health care across the spectrum of care. Yet, despite these trends toward favoring care delivered outside of the hospital, most providers have yet to develop a comprehensive outpatient strategy. Outpatient services are still considered complementary to the central in-patient services provided inside the facilities. In the coming decade, providers will need to incorporate outpatient care into their core growth strategies. An integrated mobile health strategy will be embedded into larger growth strategies for successful hospitals and health care systems. Essential to developing the strategy will be understanding the technological changes underway that are supporting mobile health devices, services, and applications.

3 THE TECHNOLOGICAL FOUNDATIONS OF MOBILE HEALTH

Eric Dishman of Intel Digital Health uses a metaphor drawn from the world of high tech to explain the transformation needed in the way health care is experienced, managed, delivered, and financed. He suggests that the "medical mainframe" model needs to undergo a shift to a personal health care model akin to the transition from the highly centralized computers that took up whole floors of office buildings and were available only to the initiated to personal computers (whether desktop or laptop) available to just about anyone.[37] In much the same way that a tiny piece of code "boot-straps" a sophisticated computer operating system, booting up mobile health will require several specialized technological components to work in unison.

For over a decade, mobile web development has been hampered by a lack of interoperability and open standards. But the mobile web is rapidly evolving from an innovation backwater into the most exciting area for the evolution of new services. The mobility explosion is driving investment and innovation in mobile technologies. These technologies include devices, services, applications, and platforms that will enable the creation of high-value health services that can be accessed inside and outside the traditional health system.

Four sets of technologies will form the foundation of a mobile health ecosystem of platforms, applications, and services:

- Powerful, inexpensive mobile devices
- Open wireless networks
- Low-cost, ubiquitous mobile sensors
- Interoperable medical information services

POWERFUL, INEXPENSIVE MOBILE DEVICES

Communications devices that also provide powerful personal computing capabilities—"smartphones"—are rapidly gaining in popularity, and are already being used to promote and support anytime, any place health care. The use of smartphones in the United States doubled in the past year.[38] In Japan, the third generation (3G) of mobile phone standards, enabling network operators to offer users a wider range of more advanced services has reached almost 90% market penetration in less than seven years.[39] The emergence and adoption of smartphones are strong early signals that most people in the world will eventually have access to similar, but less expensive, devices. iPhone-like devices from Samsung, LG, and other leading phone manufacturers are already selling for $79 to $199. Prices will continue to drop, and the availability of these mobile computers/phones will continue to spread.

The term 'smartphones' is already becoming a slightly archaic term. Voice and text phones are rapidly morphing into 'mobile computers,' with, as the minimum specifications, massive local data storage, robust I/0 for peripheral sensor networks, basic capabilities for Web and data communications, full motion video, high fidelity audio, and location sensing. The economies of scale resulting from rapid adoption of these devices is driving prices down to the point that everyone will be able to afford to carry a mobile computer.

Within weeks of the release of the new Apple iPhone, dozens of health- and wellness-related applications hit the market. Along with low-cost notebook computers, the iPhone and similar devices, such as the Nokia nSeries or Microsoft Smartphones, are the new benchmark for our expectations for a mobile platform.

Source: openhandsetalliance.com

Nokia has long recognized that mobile phones are morphing into personal Web devices; it is the global leader in the sale of smartphones.[40] Many Nokia devices use open-source operating systems like Linux or Symbian. (Symbian was proprietary before being acquired by Nokia, who made it open source with a consortium of other mobile technology companies.) As a result, we can expect to see a flood of interesting new mobile applications and services on Nokia and related devices. Already, NTT DoCoMo, Japan's largest mobile carrier, has introduced its first "Health Phone," the Raku-Raku PHONE V, based on the Symbian operating system.[41]

Google has also gathered a consortium of technology companies and wireless carriers to form the Open Handset Alliance, which is offering a powerful platform, an open-source operating system called Android. Like the iPhone and Nokia devices, Android may also have important implications for

mobile health, with the development of scalable mobile health-enabling devices, applications, and services in the offing.

OPEN WIRELESS NETWORKS

As powerful new web-enabled mobile devices begin to proliferate, they will no longer depend solely on currently available broadband wireless networks from carriers and community providers. They will operate portably across different kinds of wireless networks. Examples include WiMax, LTE, and WiFi.

- **WiMax** is a new wireless network, capable of delivering 70 megabits per second (Mbps) to devices within a 30-mile radius. A number of carriers worldwide are deploying WiMax networks. In the United States, Intel, Sprint, and Google have announced they are working together to deliver WiMax services across the country, starting in 2008 in Baltimore.[42]

- **LTE** (Long Term Evolution) is envisioned as a competitor for WiMax. It will offer over 100Mbps of throughput. LTE is quickly emerging as a possible dominant next-generation standard in the United States. Verizon and AT&T currently have competing formats (CDMA and GSM respectively). LTE will start appearing in the United States in 2010 with mass coverage by 2012.[43]

- **Wi-Fi:** When wireless communications were prototyped in hospitals, some medical IT personnel were concerned about potential interference with hearing aids, pacemakers, and other medical devices. These fears have diminished, as IT experts have learned how to install Wi-Fi networks that don't interfere with medical devices.

LOW-COST, UBIQUITOUS MOBILE SENSORS

Today, sensors are increasingly integrated into systems of every kind, from doors and other building fixtures to everyday electronic devices. The diffusion of sensors into our everyday lives is just beginning, but by 2020, ubiquitous sensing will have a transformative effect on health care. Over the next decade, we'll see the emergence of health-aware environments, collections of mobile and embedded devices that monitor every aspect of personal and environmental health. In other words, just about every object around us will have sensing, processing, and communication capabilities that will track a range of health indicators and provide feedback on them. Over 30 different kinds of consumer health sensors that can be integrated into computer applications are on the market today.

Sensors will become pervasive on and in our bodies, creating wireless body networks (BANs) that monitor vital body parameters and movements. Progress toward this vision is being made in many medical and technical domains, but wireless carriers have, so far, restricted the designs of short-range BANs. For example, the Bluetooth format could be used for networking many types of wearable health devices, yet its use, thus far, has been restricted to phone headsets, limiting software capabilities for networking other devices, including health sensors.[44] Both Verizon and AT&T have announced with great fanfare that they are opening their networks to "any applications, any devices," but quietly they are requiring that any such devices running on their networks be certified as compli-

Source:
Continuaalliance.org

ant with their rigorous specifications.[45] So far, there is little evidence that these carriers are planning to allow handsets to serve as an open wireless hub for wearable health sensors. Several other mobile technology companies, however, have joined the Continua Health Alliance, which is completing work on standards for wireless connections between medical devices and sensors that will include Bluetooth.

Naturally, for low-cost wearable sensors and health-aware environments to deliver critical health care benefits, an agile certification and regulatory regimen will be necessary to validate and certify the medical and health efficacy of these technologies.

INTEROPERABLE MEDICAL INFORMATION SERVICES

In the future, medical information will follow people seamlessly as they move within the health care system. Over time, economic and political pressure are compelling the development of standard Electronic Medical Records (EMRs) or Electronic Health Records (EHRs) that combine clinical, administrative, and laboratory information. In a recent poll of physicians, nurses, and hospital administrators, almost half of the respondents estimated that it would take ten years before EHRs are deployed in most U.S. hospitals. Almost 90% responded that, once implemented, the use of EHRs will revolutionize health care.[46] A 2005 RAND Corporation study concluded that the widespread adoption of EHRs based on interoperable standards could save the U.S.'s health care system more than $81 billion annually.[47]

Interoperability is critical to the success of EHRs. In the past, dozens of medical domains have used different terms for identical biomedical phenomena, creating much confusion, as you might expect. The ongoing development of a Medical Semantic Web is contributing significantly to medical data interoperability. It uses XML techniques for self-identifying medical data based on digital health records, and other sources like UMLS (Unified Medical Language System), a National Library of Medicine framework for harmonizing medical terminologies.

BUILDING THE FOUNDATION FOR MOBILE HEALTH

As the new devices, networks, sensors, and EHRs become interoperable and diffused into the marketplace, they will provide the platform for a truly mobile health care system. On the surface it will look a lot like our current system. In reality, however, the new system will be fundamentally different. Early market signals are showing us just how different this might be.

4 IMPLICATIONS:

MOBILE HEALTH BOOTS UP THE INTERSECTION OF MOBILITY, HEALTH AND TECHNOLOGY

At the nexus of extreme mobility (Chapter 1) and prevailing trends in health and health care (Chapter 2), we will see the emergence of a mobile health ecosystem of products, services, and interactions over the next decade. As the technological foundations of mobile health are laid down (Chapter 3), people will see value in integrating these new offerings into their lives and expanding the kind of practices and resources they rely on to manage their health. As a result, we are likely to see dramatic changes in the way we take care of ourselves, access health and health care information, interact and engage with providers, and so on.

What's the new mobile health care system going to look like? At first glance, it won't look much different from the current hospital-based system. We will still have hospitals. We will still have health insurance. We will still have doctors, nurse practitioners, and other health professionals taking care of us. Just as bricks-and-mortar banks still exist, there will always be the need for expensive medical technologies, highly skilled surgery, and various forms of hospital and palliative care. The difference will be that growing alongside the traditional hospital system, or perhaps more accurately, growing in the interstices of the traditional system, will be an emerging mobile health "ecosystem" of products, services, and interactions that changes the larger system in fundamental ways.

Critical to understanding the implications of mobile health is recognizing that mobile technologies, while they are likely to be the most visible indicators in mobile health, are only one piece of a larger business dilemma facing the health care industry, public health organizations, and patient-consumers themselves. Mobile devices and mobile services extend existing models of health care by layering more convenient and efficient interfaces to familiar service infrastructures, care providers, and relationships. A broader view of mobile health, however, points toward the need to develop more robust strategic frameworks that understand how health care systems and related industries will need to be restructured to serve a highly mobile population when and where it wants health services. Integrating mobile phones into our care delivery system as it is presently designed, in other words, is the low-hanging fruit, but mobile health won't stop there. We see the adoption of mobile technologies as a necessary

step in the evolution of the broader concept of mobile health

This emerging mobile health ecosystem will include many new elements that do not currently play a central role in health care delivery and innovation: entrepreneurs, context-aware mobile devices, open-health service infrastructures, user innovations, social networks, patient-managed medical records, telemedicine in the home, and other forms of distributed health care and health delivery networks. All of these components will act together to reinvent health and health care in a world of extreme mobility. To respond to these potential changes, health care systems and industries will have to consider not only new points of service, such as retail clinics, but also new networks of care and new interactions. The components of mobile health will not be limited to increasingly sophisticated mobile technologies with context-aware capabilities. Mobile health will bring with it fundamental changes, changes in how care is delivered, and who is responsible for making critical decisions. As the forecasts that follow suggest, mobile health will lead to a more distributed, decentralized approaches at all levels of clinical, consumer, and public health.

THE MOBILE TRANSFORMATION OF RETAIL BANKING

The retail banking sector provides a sneak preview of what might happen to health care as shifts in mobility and health itself intersect with technological change. Looking back over the last decade, we find that mobility has transformed every aspect of the retail banking business—technology platforms, business models, physical infrastructure, workforce skills, marketing, and support services Ten years ago, branch banks were still first and foremost places for the distribution and collection of cash deposits. Rapidly, this function was decentralized to a vast network of automated teller machines (ATMs). ATMs provided anytime, anywhere access to cash for increasingly mobile customers with rising service delivery and personalization expectations, a larger market trend. During the buildout of ATM networks, the bank branch itself underwent an overhaul. Located in the costliest prime retail locations in any given community, bank branches had to be recasted for a highly productive use. They have today been repurposed as showrooms and venues for developing and maintaining relationships—a crucial function in an increasingly deregulated and competitive marketplace. Their physical stature as big, safe places for storing cash and valuables has been recast as purveyors and platforms of brand identity. Concurrently with the wide rollout of ATMs and the retooling of branch offices, banks launched a slew of web-based and mobile banking services to cover the gaps in engagement, the moments when not even ATMs were readily accessible to extremely mobile customers. What's important here is that mobile services were not the central piece, but an interstitial component of a broader strategic response to exploding consumer mobility. Mobile services served to stitch together and fill holes in a web of interactions that continue to rely on face-to-face relationships to create different kinds of value than in the past, by cementing trust, reinforcing brands, and conveying the value of new and complex products and services. Mobile services did not drive this shift, but were an important tool in the banks' ability to respond to changes in consumer's prevailing mobility practices and behaviors.

What's also illustrative about retail banking's foray into mobile services is that there were many failures early on. Rather than abandon the platform, retail banks waited for technology to catch up with their needs and re-launched mobile services. For example, in Europe, banking by mobile phone was launched once in 2000-2001 using the WAP protocol which was an early and severely limited kind of mobile Web protocol. It failed, but a few years later new mobile banking services were launched using faster 3G networks and better browser technology that more closely resembles the desktop Web. As mobile health boots up, we should expect and even welcome these failures as we can learn from them. Services offering in the banking industry, designed with the insights of earlier failures, are now commercially successful. Perhaps the largest takeway from the experience of retail banks is that the impact of mobile and distributed platforms like ATMs and the web was not simply about expanding points of service, but about a wholesale transformation of what the service is, how, where, when it is delivered, and the design of the underlying business models. We no longer think of distributed banking simply as a more convenient way to get cash after hours, we think of it as anytime, anyplace access to our finances. Over the next decade and beyond, mobile health will undergo a similar transformation.

5 FORECASTS:

TRULY MOBILE HEALTH

The innovations in mobile health that we are beginning to see today (on page 24) are merely the tip of the iceberg. To date, few mobile health applications have been systematically deployed in a way that markedly affects how we seek health information, participate in health activism, or manage our health and health care.

Taking the miscellany of examples as a whole, however, we see that mobile health is indeed in motion, with the potential to infiltrate all aspects of health and health care. The forecasts that follow try to determine just how far they are likely to go.

CLINICAL HEALTH

Clinical health care will change in at least two ways: the boundaries of professional and do-it-yourself medicine will continue to blur, and the expansion of mobile health will lead to the effective delivery of remote health care.

Blurring Professional and DIY Medicine

After a century of a health system driven for the most part by episodic, acute care, the time is ripe to return to a more preventive and holistic understanding of the provision of health care as a continuum. People are already including their eating habits and exercise routines in their notion of health care, but they are now adding environmental factors—their homes, offices, and neighborhoods—to have a broader understanding of the determinants of good health. Their interactions with clinicians and clinical health facilities, therefore, constitute just one component of their personal health strategies. IFTF refers to these extra clinical practices as do-it-yourself (DIY) health, after the DIY trends in the craft, manufacturing, and technology communities where they are creating or repairing things for themselves without the aid of professionals. In the future, integrating extreme mobility practices and the capabilities of mobile technologies will reshape the way clinical health is perceived within a larger health ecology.

The emerging concept of biocitizenship will put patient-consumers even more fully at the center of their own health ecologies. In 2007, IFTF's Health Horizons program introduced Nikolas Rose's concept of the bio-

A THOUSAND FLOWERS BLOOMING

In 2007, Stanford University professor Dr. B.J. Fogg hosted a conference discussing mobile phones as platforms for persuasion in health, commerce, and activism. The conference was an extension of the research conducted at Dr. Fogg's Persuasive Technology Lab, which focuses on how the design of computing products—from websites to mobile phone software—can influence attitudes and behaviors.[57] While applications are being built for mobile technologies to support a myriad of activities throughout the world from commercial transactions to activism, a key takeaway from the conference was the unexpectedly disproportionate emphasis on the use of mobile phones for health and health care.

Since the Stanford conference, health-related applications for mobile technologies have blossomed. Mobile devices are being employed to deliver everything from health information to health care. Some of the more interesting areas are:

- **Prevention and wellness.** In conjunction with the move from basic mobile phones to smartphones with enhanced data processing and connectivity, new health and wellness-related applications seem to appear weekly. Device manufacturers, network operators, and third-party programmers are all experimenting with applications aimed at consumers interested in using technology to support their diet, fitness, and drug regimens. As an i-scale that measures and tracks the portions and ingredients of meals, as a mobile fitness journal, as a calorie calculator—the smartphone is becoming an essential collaborator for practicing anytime, anyplace health management.[48]
- **Compliance.** The "Pill Phone" application, launched by Verizon Wireless in the spring of 2008, enables customers to access drug information and to set dosage and schedule medication reminders using their mobile phones. Promoted as the mobile version of the popular medication reference guide, The Pill Book, the application has access to photos of over 1800 commonly prescribed drugs and allows users to acquire information about dosages, side effects, drug interactions, and so on.[49]
- **Clinical health.** To do their jobs these days, many doctors, nurses, and allied health professionals are constantly on the move. Recent applications built for smartphones are supporting the natural mobility required of most clinical health care occupations. Mediquations, for example, is a medical calculator designed specifically for the iPhone, which allows health professionals to access medical calculations, scoring, and properties for 68 common medical algorithms and formulas.[50]
- **Health advocacy.** Taking advantage of its simplicity, accessibility, and low cost, the American Cancer Society's Cancer Action Network (CAN) uses mobile text messaging to deliver action alerts, event information, localized content, and important legislative information to individuals interested in cancer advocacy issues.[51]

- **Health education/promotion.** SMS text messaging has proved an effective communication tool for reaching sexually active young people seeking advice about sex and health. The Internet Sexuality Information Services (ISIS), with funding from the San Francisco Department of Public Health, STD Prevention and Control, designed SexInfoSF.org for San Francisco youth between the ages of 12 and 17 to obtain sex and health information confidentially, through text communication via their mobile phones.[52]

- **Global health.** The public-private partnership Phones for Health, announced in early 2007, joins mobile phone operators, handset manufacturers, and technology companies with Ministries of Health, global health organizations, and other partners to leverage the widespread adoption of mobile phones throughout the world to improve health systems. The GSM Association's Development Fund, the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), Accenture Development Partnerships, Motorola, MTN, and Voxiva are developing Phones for Health for health workers in ten African countries. The health workers will have standard Motorola handsets equipped with a downloadable application to enter health data. The data will be transferred either through a SMS data channel or through a packet-based mobile connection into a central database housed on the Web. As Paul Meyer, Chairman of Voxiva, the company that designed the software, explains, "Health workers will also be able to use the system to order medicine, send alerts, download treatment guidelines, training materials, and access other appropriate information."[53]

- **Public health.** Not only is the mobile phone supporting remote monitoring and disease surveillance by facilitating data transmission over the mobile network, but health workers in the field can now take images of specimens and send them to an expert for diagnosis. After years of a huge disconnect between laboratory research and public health needs and resource constraints, the mobile phone is finally bridging the gap. A ubiquitous communication device in almost all parts of the world these days, the mobile phone is serving as the technological platform for applications tackling public health issues. For instance, Cellscope is an inexpensive attachment developed by bioengineer Dan Fletcher at the University of California, Berkeley that allows the digital camera on mobile phones to serve as a microscope.[54]

logical citizen to explain how patient groups have formed social affinities based on biological data or status (such as groups built around manic depression, for example, or HIV), have created lobbying movements around these affinities, and have developed online communities around specific diseases and their experiences with their own or "local biologies."[55]

Source: bookdepository.co.uk/book/9780691121918/The-Politics-of-Life-Itself

Mobile technologies will enable people to apply new media tools to enhance the power of biocitizen groups and give them the ability to collect biological data, both at the level of the body and the larger environment. With the increasing number of sensors and cheap, portable diagnostics, we will see a greater ability to measure the effects of the environment on the body. Biocitizens will leverage this increased access to information to form communities of action focused on certain health concerns and conditions, such as breast cancer or autism. Because they will no longer be tethered to a computer to access information, biocitizens will have a constant connection with health communities inside and outside a clinical setting. These connections will support individuals' abilities to take informed actions and make different types of demands on their health care providers. Both access to data and increased affinities built upon similar data may have the effect of changing the nature of health politics in the future, moving more of the power into the camp of the biocitizen.

Clinical health care will not disappear in a health care delivery system dominated by mobility trends, nor will its role be particularly diminished. Mobile health will support the transition toward the "health care triad," as articulated by the World Health Organization (the partnership between patients and their families, health care teams, and supporters in the community), by integrating clinical health into a larger ecology of health and health care in which the patient, not the hospital, is at the center. It all will become part of the patterns and rhythms of daily life, and how we develop and meet our needs and desires.

From Mobile to Remote Health Care

Further down the line, mobile technologies are likely to support the development and expansion of mobile health care to include remote care delivery. Since the deployment of information and communications technology infrastructure, tele-radiology, tele-pathology, and other forms of telemedicine have been the Holy Grail for the more equitable provision of medical care in the remote areas of the world.

Examples abound, from across the globe, of linking rural areas traditionally lacking health care facilities with modern medical facilities in urban centers in an effort to provide a more equitable delivery of health care. Access to computers in health care clinics in communities with some level of connectivity allow for remote delivery of health services. By tele-diagnosis, results of simple skin tests and remote screenings for conditions such as diabetic retinopathy can be communicated to the local health care provider within hours, allowing the patient to undergo appropriate treatment much earlier.[56]

Mobile devices offer many advantages as a telemedicine platform:

- They are already being used as portable, secure containers for identity in the form of contacts, calendars, digital media, and messages. In East Asia, RFID-enabled phones are widely used as electronic wallets to pay for transit and retail purchases.
- Sociological studies indicate that people have a complex and intimate psychological and emotional relationship with their mobile devices.[57]
- They are small, relatively inexpensive, and frequently and easily upgraded when new features are developed.
- Mobile devices leverage an existing network infrastructure that is regularly upgraded.

The potential of mobile health to reshape and improve access to clinical care for millions across the globe is encouraging. As Saroj Mishra and Indra Pratap Singh explain:

> The impact of mHealth is likely to be more far-reaching than other developments such as nanomedicine and genetic therapy, as it will create an urgent need to review the way health care is financed and blur the boundaries between professional medical help and so-called "do-it-yourself" medicine (i.e. minor treatment or self-medication without consulting a physician, but based on previous medical treatment experience, popular medical literature, or a pharmacist's advice).[58]

Much like video-conferencing, telemedicine has often been promised but has failed to catch on in a big way, in large part due to the expenses and resources associated with the cost of implementing the necessary technological infrastructure. In the next decade, however, as mobile health emerges, remote delivery of care will make a comeback with mobile phones serving as a versatile platform for delivering health care remotely. Mobile devices are already being used to transform the once impossible monitoring and reporting of sleep disorders because "the mobile device is [an] always present, already deployed, existing infrastructure to piggyback upon."[59]

PUBLIC HEALTH

In the realm of public health, extreme mobility will mean the quicker spread of public health crises but at the same time will let some of the developing nations in on the innovation game.

More Epidemics, But More Manageable

The mobility explosion that has set the stage for mobile health may also be sowing the seeds for an unprecedented wave of public health crises. Historically, high levels of mobility have been associated with the migration of diseases and the onset of epidemics. The SARS outbreak in 2003 demonstrated how the air transportation system had created new global mobilities for pathogens. However, our ability to measure the health status of large populations is severely limited. As V. Rodwin writes in his article, "Urban Health: Is the City Infected?"

> The reason for which we have so little solid evidence is that we have no routine information systems for monitoring the health of populations living in cities. While institutions responsible for disease surveillance and control—at the international, national, and local authority levels—collect vital statistics and epidemiological data by geographic location, national policy is made without systematic analysis of information for monitoring health status, public health infrastructure and the performance of health systems in cities.[60]

While increased mobility is likely to accelerate the transmission of disease across previously effective local, regional, and international barriers, mobile health will provide entirely new capabilities for public health officials to model and monitor the mobility of infected populations. At Northwestern University, a team led by Albert-Laszlo Barabasi is developing methods to use mobile phone networks to model the way people move in large cities.[61] By analyzing the communication between mobile phones and cellular towers, this technique can measure the flux of people into and out of small geographic areas. The ability to improve models of human mobility using this kind of rich data will transform public health research, and its ongoing use will alter the way public health is managed during crises.

Mobile phones are already being used to create distributed platforms for environmental sensing. At the California Institute for Telecommunications and Information Technology (Calit2) at the University of California, San Diego, researchers have developed Squirrel, small, battery-powered mobile sensors that can identify pollutants.[62] The sensor then communicates through a Bluetooth wireless transmitter to a user's mobile phone, informing the user of the unseen environmental hazards surrounding him or her. The information is both communicated to the individual and aggregated, as the phone routinely transmits the collected data to a public database. Laboratories will undoubtedly produce novel approaches to implementing mobile technologies to improve health data surveillance, collection, and detection, but the Global South may prove to be the most fertile testing ground for innovative solutions to public health needs.

Source: Calit2.net

User-Driven Innovation From the Global South

As mobile health models emerge in the developed economies, they will increasingly be influenced by innovations from the Global South, where mobile devices play a much more central role in the computing infrastructure.

IFTF research in the largest emerging markets—Brazil, Russia, India, and China—has identified infrastructure and health as two primary zones of insecurity for people. Health care systems in these nations have come under tremendous strain from urban migration, privatization, and expanding health needs.[63] In poorer nations, including much of Sub-Saharan Africa, 20th-century models of centralized, institutionally managed health care are not scalable outside major cities. Over the next decade, as these forces play out in the presence of rapid diffusion of mobile technology, we expect high levels of experimentation and innovation in mobile health devices and services. These countries will be the main proving ground for decentralized, mobile models of health care delivery. Instead of being the greatest threat to public health, the slums and informal cities of the Global South may be the most valuable source of mobile health innovations simply because they have no other options.[64]

Already, foundations are actively investing in many pilot projects in field reporting, health information dissemination, and patient monitoring. For instance, The United Nations Foundation, in partnership with the World Health Organization, DataDyne.org, Ministries of Health, and Vodafone, are turning to mobile technologies to support capacity of developing-country health workers. The Mobile Health for Development program is supporting the development of the free and open-source EpiSurveyor software for mobile devices. By the end of 2008, more than 800 health workers in 22 countries in sub-Saharan Africa received mobile phones equipped with the software.[65] These efforts all seek to make big leaps in public health and health care delivery without major capital investments. The lesson here is that useful innovations in lightweight approaches to mobile health will often come from outside the United States. These innovations could be valuable imports as our own health systems come under increasing stress.

To date, these efforts have largely sought to extend whatever health infrastructure already exists, and assumed that systems in developing countries will remain relatively stable, just with new and extended capabilities. However, we believe that most experts underestimate the potential for highly disruptive new models that build upon the past decades of success in other areas such as micro-finance and regenerative commerce. These models—what John Seely Brown terms edge innovations—operate outside of established networks, authorities, and infrastructures, yet are able to pool resources at the community level.[66]

For instance, efforts to improve health care for India's vast and vastly scattered rural population offer models for future mobile health platforms. According to Krishnan Ganapathy, founder of the Apollo Telemedicine Networking Foundation:

> [T]he day is not far off when we hope to devise an instrument which we have given the name mDoc and we already have got the specifications. We hope that in the not too distant future we will be able to bring low-cost affordable equipment to the masses. The mDoc will have certain sensors which will measure the blood pressure, the ECG, etcetera, transmit this totally non-invasively to their doctors and when this becomes a reality, a patient herself or anyone in the house can use this equipment so you do not even require a paramedic or a nurse.[67]

Source:
3bnetworks.com

At first glance, the suggestion of adopting health practices from abroad, particularly in the developing world, seems almost too radical to take seriously. Yet, mobile health services will be only one offering emerging out of a larger movement to focus the development of the mobile web on social development in Asia, Africa, Latin America, and the Middle East.[68] The recent announcement of Google-backed O3b Networks' initiative to deploy a global communications infrastructure with the explicit intent "to offer affordable, high-speed Internet access services—effectively bridging the digital divide between developed and emerging markets" will connect consumers, businesses, schools, and health care facilities in the globe's most disadvantaged areas. As O3b founder, Greg Wyler, explains:

Only when emerging markets achieve affordable and ubiquitous access to the rest of the world will we observe locally generated content, widespread e-learning, telemedicine and many more enablers to social and economic growth which reflect the true value of the Internet. O3b Networks will bring

multi-gigabit Internet speeds directly to the emerging markets, whether landlocked in Africa or isolated by water in the Pacific Islands.[69]

If the health care sector can leverage the exciting developments in technology infrastructure throughout the world, it will be able to improve health systems and, as result, the health of the populations most in need of care.

CONSUMER HEALTH

Today, consumers rely on a broad range of resources to manage their health and make health care decisions. Some mobile self-care systems are already becoming available, promising to transform our phones into "in the hand" toolsets that can help us maintain our good health or manage a condition we already have.[70] As the future of mobile health unfolds, we'll see some fundamental changes not only in the kind of resources and tools consumers rely on to manage their health, but also changes in the way consumers will think about and interact with their bodies; generate, track, and engage with information; and tap their social networks to navigate a world of choices in an expanding health economy. Some of the expected changes include:

Health Management Will Expand to More Contexts and Settings

Armed with mobile devices, consumers will manage their health in more contexts and in settings unlike ever before. Expect the home, the car, the office, and on-the-go to be relevant and important settings for interacting with one's health. This trend will also make consumers rethink the role of place in health management and generate new expectations for health in the home, the workplace, and the community. Already, the recently unveiled "FitBit Tracker," a small, wearable, wireless device that functions as a pedometer and a diet monitoring system is receiving substantial speculative commentary.[71] The device uses a motion sensor akin to the technology embedded in a Nintendo Wii to track movement, and every time the user passes by the wireless base station, information is uploaded and processed on a website. By visiting the website, users can review the collected data on their movement and sleeping patterns, and add information about food choices.[72]

Source: fitbit.com

Peer-to-Peer Health Management Will Redefine Self-Care

Mobile health will accelerate the trend toward patient self-care but also open up new models for managing health. With the rise of health 2.0 and user-generated media, we are already witnessing a shift away from the model of individual decision-making in health care to a model of peer-to-peer health management. Mobile health has the potential to accelerate peer-to-peer practices in health as mobile devices become tools for connecting, communicating, and monitoring others like you. Networks will form for people with diabetes, heart disease, or colleagues in the office who are trying to reduce stress.

Just-in-Time Information Will Drive Health Transparency

One of the most disruptive shifts will come in the form of just-in-time health information making the risks in decision-making more transparent than ever before. As mobile health evolves, consumers will be able to access product, service, and provider information (e.g., metrics of quality and performance) in context and just-in-time at the point of purchase or at the clinician's office when important health care decisions are about to be made. What's more, online platforms that aggregate and diffuse consumers' opinions about manufacturers and retailers combined with mobile devices that put this

vast collective intelligence at consumers' fingertips will lead to unprecedented collectives of informed consumers, collaboratively obtaining information, reducing risk, and making decisions.

Mobile Health Collectives Will Map Health Risks

New mobile technologies will allow people to collectively map and evaluate their communities' food and health resources. Mash-ups, which integrate layers of data onto online maps, can be used to collect and graphically share information about health resources and risks in a given location. The connection between place and health concerns represented in mash-ups can focus on hospital closures, ground air and water contamination, self reported illnesses, and even fast-food restaurant density.

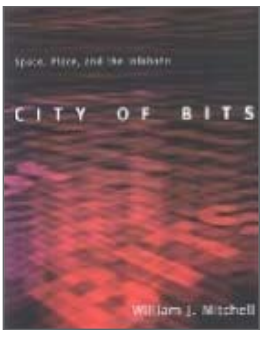
All of these developments will only accelerate as we see a rapid expansion in the number and variety of health sensing and diagnostic capabilities in mobile devices over the next decade. The number of applicants for health and health care will continue to grow; and they will likely continue to target the behavioral causes of the disease burden including smoking, obesity, and lack of physical activity. Consumers will find novel ways to integrate them into their lives, as with most technologies. Some of these user-generated practices may yet define entirely new forms of mobile health.

BLENDING PHYSICAL AND VIRTUAL MOBILITIES TO ARRIVE AT TRUE MOBILE HEALTH CARE

The mobility explosion will chip away at the present design of health care delivery to include more distributed and decentralized approaches to clinical, consumer, and public health, In the end, while mobile health will be deeply disruptive to current health care models, it won't mean that hospitals disappear or that all health services will be delivered through a mobile handset. The mobile handset, though an effective and efficient tool, has its limits. Indeed, we know that the purpose of approximately 90% of mobile phone conversations is to discuss past, present, or future face-to-face meetings. Mobile phones are not tools for disengagement, but rather allow people to manage their complex daily routines on their own terms. Rather than let us spend less time with others, they let us spend more time with the people we want to be with, in the places we want to be with them.

As an industry deeply embedded in communities, the health care system needs to be aware of the new ways people will combine physical and virtual mobility to structure their lives and obtain the services they need. As William Mitchell foresaw in his 1995 book *City of Bits: Space, Place and the Infobahn*:

> We are entering an era of electronically extended bodies living at the intersection points of the physical and virtual worlds, of occupation and interaction through telepresence as well as through physical presence, of mutant architectural forms that merge from the telecommunications-induced fragmentation and recombination of traditional architectural types, and of new, soft cities that parallel, complement, and sometimes compete with our existing urban concentrations of brick, concrete, and steel.[73]



Source:
City of Bits by William Mitchell

The significance of this is that as mobile health initially provides new opportunities to complement and augment existing health care systems, the smart thing to do strategically is to use this time to respond more holistically to the challenge of delivering services to an extremely mobile customer base.

CONCLUSION

CONSTANT CONNECTIVITY PLUS EXTREME MOBILITY EQUALS TRULY MOBILE HEALTH CARE

In the past, the widespread diffusion of medical technologies has resulted in dramatic disruption in health practices and the delivery of care, often in unanticipated ways. Today's common usage of the X-ray machine, for instance, was not an obvious outcome when it was first introduced into health systems. As Joel Howell explains:

> The X-ray was first used in a exploratory, experimental fashion, and pictures were taken of patients with many different conditions. Only after the social system in which it was applied had changed did specific indications for its application become accepted.

Howell suggests that "for contemporary technology assessment, changes in both organization and conceptual systems are critically important, albeit difficult to predict, in determining how technology will be used."[74] Ultimately, it will be the harmonization of traditional heath care organizations' policies and practices with the needs and practices of people, patients, and biocitizens that will determine the role of mobility in the future of health care.

As Francois Bar, Francis Pisani, and Matthew Weber explain, "In today's Information Society there is a growing field of research that is focused on how society adopts new information communication technologies, adapts to them and uses them."[75] The unprecedented rate of diffusion of mobile technologies has sparked an increased focus on their potential to create novel socioeconomic opportunities and contribute to social development. Less discussed, however—and, according to Bar, Pisani, and Weber, more critical to understand—is appropriation, or "the process through which mobile phone users go beyond mere adoption to make the technology their own and to embed it within their social, economic, and politicalpractices."[76]

As users appropriate the new technologies in the next decade, they will help bring about the convergence of constant connectivity and extreme mobility. With this new basic infrastructure, the health care system will begin to move from the traditional model of acute episodic care to a continuous chronic care model.

In the near future, more people will rely on a wide range of sources for health information, and they will expect to obtain more information in real-time, relevant settings so they can make informed decisions. People will look to harmonize the actionable information they are obtaining in their online and offline communities with that being communicated by their care providers. To do so, they will increasingly rely on mobile devices, for example, to access information while in a clinical setting in order to vet the information being provided there. Such real-time information synthesis will help more of us make better decisions. It is not simply that more information will be available but that the information will be filtered and supplied in such a way as to be actionable at the point of care.

The new model will be built on the assumption that people must be supported to make positive health decisions not only during appointments with their health providers, but continuously, throughout the day, wherever they may be, by means of smart mobile technologies, which enable the delivery of real-time information and intervention. The patient-provider interaction will change because the patient, through context-aware services and information, will have almost all the information about his or her health ailment on hand. The provider will become a kind of consultant, one who has the discerning judgment to assist the patient in making the appropriate health choices. Further, critical public health campaigns will not be deployed only through the traditional, formal channels of media and health institutions, but through peer-to-peer networks in the form of SMS text messaging as well.

In this way, truly mobile health will help change the way health care is delivered and managed at all levels of the system, thereby creating a health care system for the 21st century: decentralized, distributed, and, continuous, and with patient-consumers at the center of their health ecology.

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