How Smartphones Are Changing Health Care for Consumers and Providers

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About the Author

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Note: Inclusion of products and vendors in this report does not constitute an endorsement or recommendation.

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I. Smartphones Meet Health and Health Care

THE TOPIC OF SMARTPHONES IN HEALTH IS AN INTERSECTION of two fast-evolving ecosystems: health and technology. The junction is a dynamic one in which a particular communications platform is advancing both consumers' and providers' engagement with health information technology.

The speed of the uptake has been remarkable for a nation that has been traditionally slow to adopt HIT, as Figure 1 shows. Two-thirds of physicians used smartphones in 2009. About 6 percent of these were using a fully functional electronic medical record or electronic health record system—while only 1.5 percent of hospitals had a comprehensive electronic health record system as of 2008.[1]

On the consumer side, 42 percent of Americans owned smartphones as of December 2009, despite the recession that began a year earlier.[2] In fact, according to cnet, the smartphone market was "unfazed by the recession."[3]

What is it about the smartphone that makes it so attractive to consumers and providers of health care?[4] Unlike any other HIT platform, the smartphone is basically an inexpensive handheld

Figure 1. Consumer Smartphone Ownership, October 2006 to December 2009

Source: "New Survey Shows Android OS Roiling the Smart Phone Market," ChangeWave Research, January 2010.
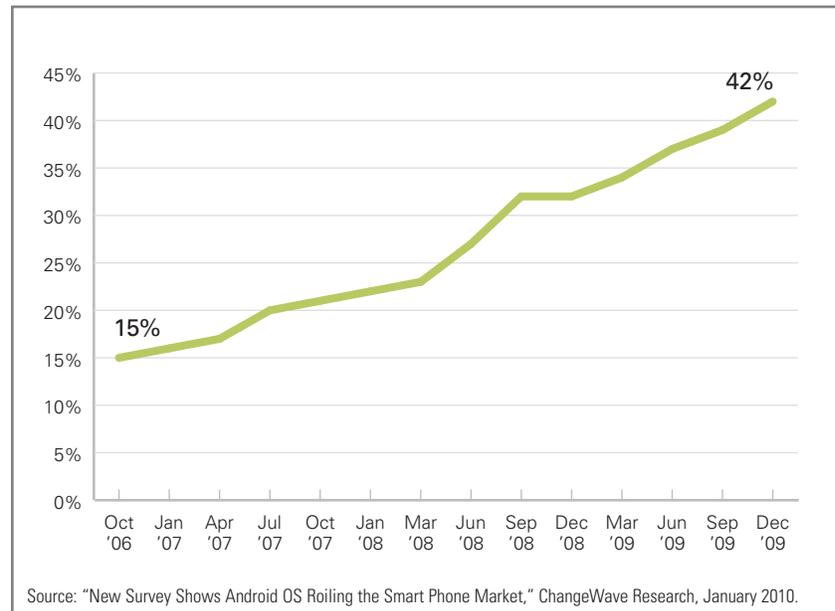
computer that enables users to accomplish tasks anywhere, anytime. It is so intuitive and user-friendly that most people can download and use the many available applications — or apps — without any training or special knowledge about computers.

For clinicians, the smartphone offers an alternative to many health IT formats that have been cumbersome and costly to adopt, and that may interrupt their wor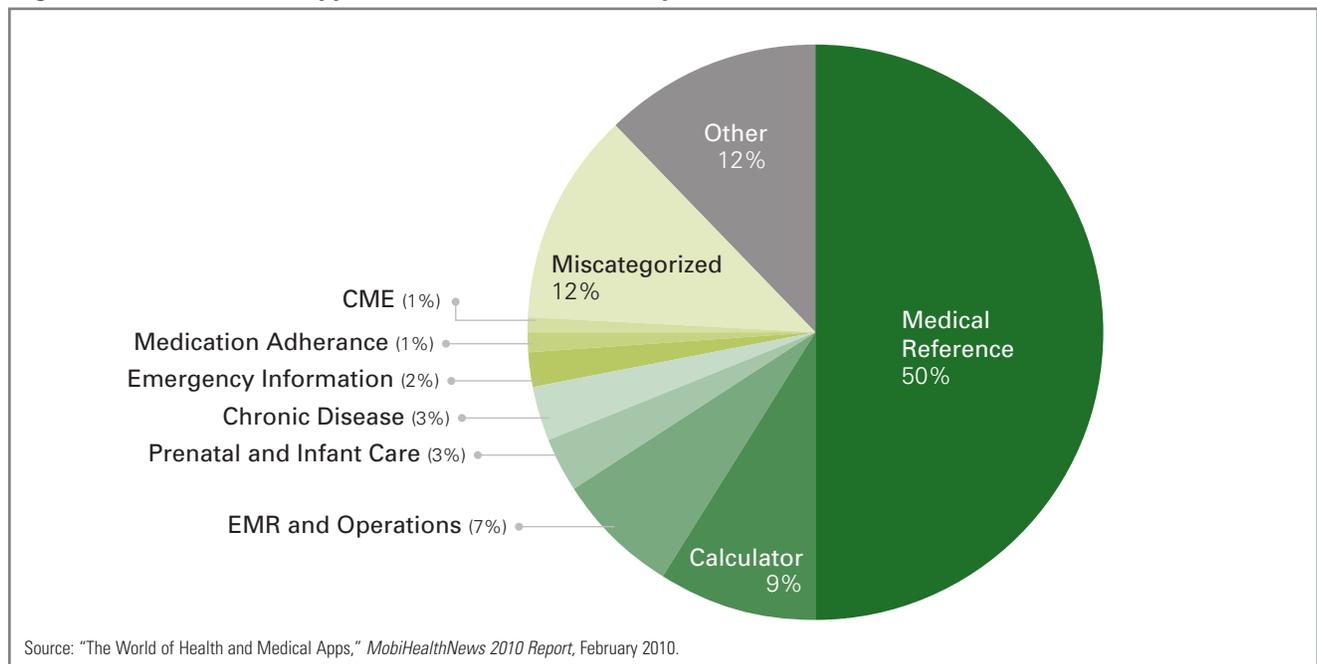kflow. As of February 2010, there were 5,805 health, medical, and fitness applications within the Apple AppStore. Of these, 73 percent were intended for use by consumer or patient end-users, while 27 percent were targeted to health care professionals. It should be noted that, although developers usually have a principal audience in mind, all users can and do download the apps.[5] In the "medical" category, 33 percent of apps are meant for consumers/patients, 32 percent for physicians, 17 percent for medical students, 4 percent for other health professionals, and 2 percent for nurses (10 percent were miscategorized by MobiHealthNews' definition).

Smart and Smarter

In the absence of an industry-wide definition of "smartphone," the boundaries between types of phones are blurring. Here are some general understandings:

- **Cell phones/mobile phones** run over wireless communication networks through radio waves or satellite transmissions. All cell phones provide voice communications and texting via Short Message Service, or SMS.

- **Feature phone or full-feature phones** have additional functions such as a camera, mp3 player, or downloadable games that are available through the wireless provider.

- **PDA phones or personal digital assistants** combine cell phone, Web browsing, and organizer functions such as calendars.

- **Smartphones** run on a specific operating system (OS) and allow download of apps that run on the OS. Major operating systems include iPhone OS, BlackBerry OS, Windows Mobile, PalmOS, WebOS, Symbian, and all types of Linux including Android.

Figure 2. Medical iPhone Apps Geared to Consumers, Physicians, Medical Students, 2010

- Other 12%
- Miscategorized 12%
- CME (1%)
- Medication Adherance (1%)
- Emergency Information (2%)
- Chronic Disease (3%)
- Prenatal and Infant Care (3%)
- EMR and Operations (7%)
- Medical Reference 50%
- Calculator 9%

Source: "The World of Health and Medical Apps," *MobiHealthNews 2010 Report,* February 2010.

Within "medical reference apps," the largest category is medical student study guides (19 percent), followed by clinical consult (9 percent), anatomy (7 percent), and drug reference (7 percent). Within the consumer-focused health and fitness apps, the most popular category is cardio exercise (15 percent), followed by stress management (12 percent), diet (11 percent), and strength training (6 percent). See Figures 2 and 3.

While Apple and the iPhone are the leading source of health and medical apps for smartphones in 2010, more apps are being developed for other operating systems that have or plan to serve both health consumers and physicians.

In 2010, most health consumers regularly seek health information online through trusted portals such as Mayoclinic.com, which has provided health content online since 1995 to "empower people to manage their health." Mayo has now gone mobile. "We're a very content-oriented organization," said Scott Eising of Mayo Clinic. "In our research into the mobile health consumer, we found that people are looking for very action-oriented information. They are not necessarily going to do in-depth research via mobile. If that's the case, they will take content directly from the Web site. So we're asking: How do we create applications for the mobile form factor and platform, and provide action-oriented information?"

For those providers already connecting with patients through electronic health records and personal health records, the stage is set for mobile health, whether on smartphone or feature phone. Kaiser Permanente's personal health record, My Health Manager, has a user base of over 3 million enrollees. It would be a relatively easy transition to morph over to mobile phones.

Kaiser can capitalize on its investment in electronic health records and personal health records — EHRs/PHRs — and develop mobile apps to serve patients managing chronic conditions as well as help healthy enrollees stay that way.

Figure 3. Medical Reference iPhone Apps, 2010

Source: "The World of Health and Medical Apps," *MobiHealthNews 2010 Report,* February 2010.
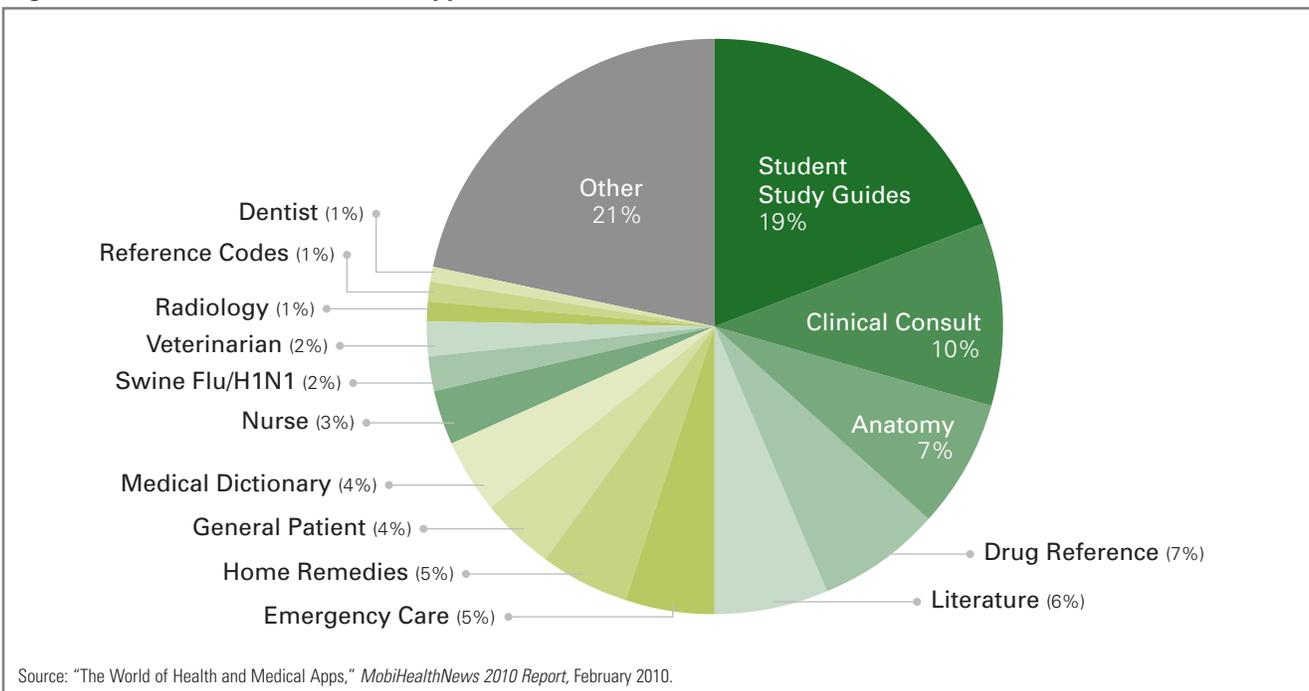
II. Who Are the Consumers of Mobile Internet?

SMARTPHONES ARE TAKING A PROMINENT place among the mobile phones that are used to reach the Internet. Eighty percent of Americans had a cell phone, a PDA phone, or a smartphone as of December 2009, and one-third of people have used a cell phone or smartphone to access the Internet. The number of mobile Internet users increased 74 percent between 2007 and 2009.[6] See Figure 4.

Figure 4. Internet Use on a Mobile Device, 2007 vs. 2009

Source: *Wireless Internet Use,* Pew Internet & American Life Project, July 2009.
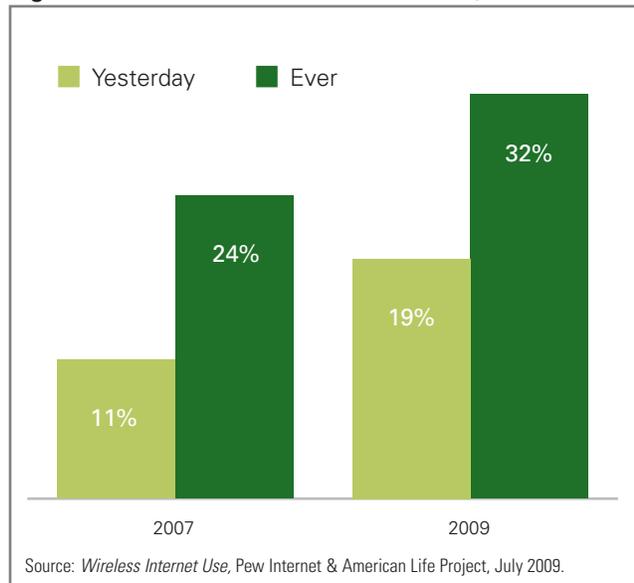
Research by Wells Fargo, the financial services company, found that the "most digital" age cohort is people in their thirties. And while the bulk of younger people have integrated online and mobile technologies into their daily lives, older people are doing so as well. Although 59 percent of adults over 70 responded that they do not use any online entertainment technologies—that means that 41 percent do. Furthermore, 60 percent of people age 45 and over were found to be just as likely to use SMS (text messaging) as they were to make voice calls from their mobile phone.[7]

> **The Marrying Kind**
>
> In *Texting for Health,* B.J. Fogg of Stanford Persuasive Technology Lab observed: "In some ways, we don't merely adopt mobile devices; we marry them. We usually spend more time with our mobile phones than with our spouses or partners…. The best interactions in a marriage will create feelings of trust, competence, and delight."

A consumer segment named techfluentials has been identified by the market research firm GfK.

"Techfluentials see technologies as extensions of themselves, especially in today's social media environment," David Krajicek of GfK explained. "These individuals see those tools as coming to be parts of their lives. Over time, techfluentials will be the next wave of individuals that will become more focused on health as issues and problems arise. They will turn to the tools they're using in other parts of their lives" to manage their health, said Krajicek.

While accessing the Internet via stationary computers is stratified by socioeconomic status, mobile search is not. African Americans are the most active users of the mobile Internet—and their use of it is also growing the fastest. This means the digital divide diminishes when mobile use is taken into account. See Figure 5 on the following page.

Twenty-nine percent of African Americans use the Internet on their handheld on an average day, significantly greater than the national average of 19 percent.[8] Looking across a range of digital activities (some done online using a computer and

Figure 5. Americans Accessing Internet by Tethered or Cell Phone Means, by Race, 2009

Source: *Wireless Internet Use,* Pew Internet & American Life Project, July 2009.
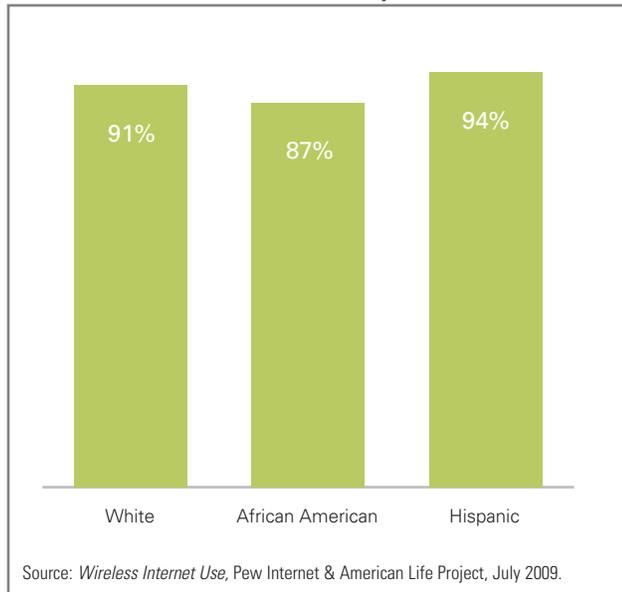
others on a mobile device) African Americans and Whites, on average, have the same level of usage.

The high level of activity among African Americans on mobile devices helps offset lower levels of access to tools that have been traditional onramps to the Internet—desktop computers, laptops, and home broadband connections. Still, there remain disparities between mobile users of the Internet and those who have tethered access. People in rural areas, as well as those who have less education or are over age 65, are less likely to have wireless Internet access. See Table 1.

Table 1. Wireless Internet Use, by Selected Characteristics, 2009

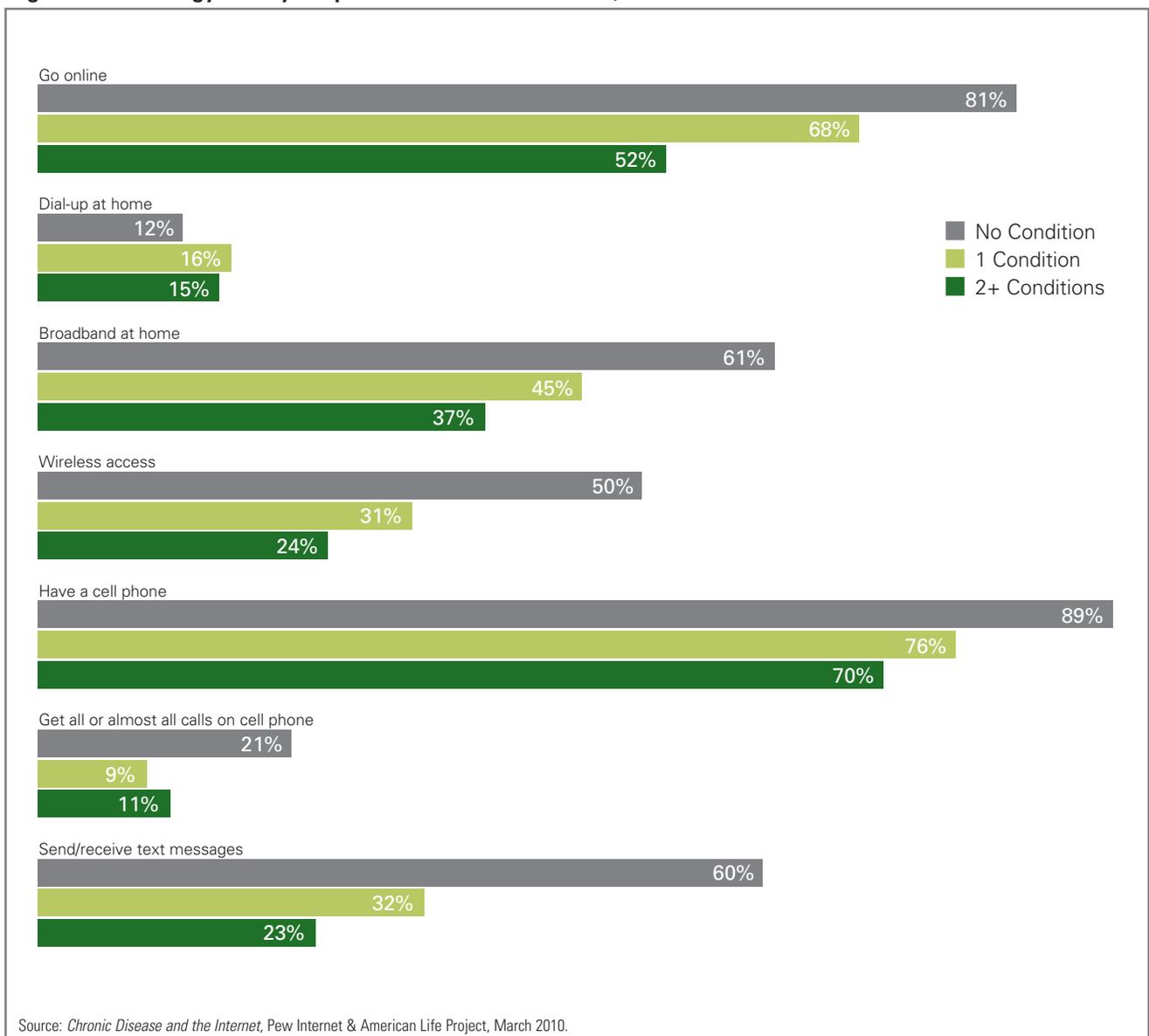|	% OF TOTAL
Total Adults	**55%**
Men	59%
Women	51%
Race/Ethnicity	
White	52%
African American	59%
Hispanic	62%
Age Group	
18 to 29	80%
30 to 49	66%
50 to 64	42%
65+	16%
Annual Household Income	
Less than $30,000	46%
$30,000 to $49,999	55%
$50,000 to $74,999	61%
$75,000 and higher	76%
Educational Attainment	
Less than high school	41%
High school	42%
Some college	63%
College and higher	69%
Community Type	
Urban	57%
Suburban	56%
Rural	45%

Source: *Internet User Profiles Reloaded,* Pew Internet & American Life Project, January 2010.

Mobile health was named by Gartner as one of its top ten consumer mobile applications for 2012. Mobile health monitoring could help payers, both private and public, to reduce costs related to chronic diseases and improve patients' quality of life. Gartner sees that the industry will be able to monetize mobile health services by offering mobile health care monitoring products, services, and solutions to care delivery organizations.[9]

However, there is still a gap between the promise and the reality for health consumers who are ill. As the chart illustrates, people with two or more chronic conditions are least likely to go online, have broadband at home, or receive text messages. See Figure 6.

The opportunity here for developers is that 70 percent of people with two or more chronic conditions have a cell phone.

Figure 6. Technology Use by People with Chronic Conditions, 2008

Go online
- No Condition: 81%
- 1 Condition: 68%
- 2+ Conditions: 52%

Dial-up at home
- No Condition: 12%
- 1 Condition: 16%
- 2+ Conditions: 15%

Broadband at home
- No Condition: 61%
- 1 Condition: 45%
- 2+ Conditions: 37%

Wireless access
- No Condition: 50%
- 1 Condition: 31%
- 2+ Conditions: 24%

Have a cell phone
- No Condition: 89%
- 1 Condition: 76%
- 2+ Conditions: 70%

Get all or almost all calls on cell phone
- No Condition: 21%
- 1 Condition: 9%
- 2+ Conditions: 11%

Send/receive text messages
- No Condition: 60%
- 1 Condition: 32%
- 2+ Conditions: 23%

Source: *Chronic Disease and the Internet,* Pew Internet & American Life Project, March 2010.

III. Smartphone Apps for Clinicians and Consumers

ACCORDING TO MANHATTAN RESEARCH, the number of physicians who own smartphones will increase from 64 percent in 2009 to 81 percent by 2012. An Epocrates survey of its users—published ten days after Apple's announcement of the iPad in February 2010—found that one in five physicians said they were likely to purchase an iPad.[10]

Some of the most widely used mobile applications by physicians are drug and clinical references, and clinical tools such as dosage calculators.[11] Monique Levy, senior director of research for Manhattan Research, said she is seeing the line between the tasks done by physicians on desktop computers and on mobile devices "start to blur." Transaction-oriented point-of-care apps, such as electronic prescribing and evidence-based decision support, are the next growing category for physicians' smartphones.

Following are a few examples of health and medical app categories. The actual market includes many more, and is growing rapidly.

Medical Reference Tools

Alerts and Awareness. Dr. Joseph Kim, physician technology blogger at Medical Smart Phones, sees opportunities for helping physicians stay abreast of clinical information. "Everyone has a spare five minutes in the day," he said. "The question is, are doctors using their smartphones to stay current on breakthroughs and FDA alerts?" Smartphones can be networked into alert systems via Twitter and other platforms. The FDA or CDC could issue alerts to virtually every health provider via the clinician's handheld, setting off an alarm. Clinical advice, guidelines, and news on the latest breakthroughs could be communicated this way in five-minute bits.

"Many doctors are behind the times in practicing medicine. They're applying old guidelines to care," said Dr. Kim. The best way to keep up to date is not by attending a symposium once a year or checking emails, he said. "If you give clinicians the right tools and the right information at the right time, it will improve the way they treat patients." An example is FDA Recalls, a free app on iTunes that provides information about recalled products.

Medical Reference. Because clinical care is information-intensive, it is natural for health information to go mobile as clinicians make decisions at the point of care. Among the most mature mobile reference sources developed for smartphones is Epocrates, an online medical reference company that celebrated its 10th anniversary in 2009. Epocrates offers mobile platforms for the major operating systems including Android, Blackberry, iPhone, Palm, and Win Mobile. More than 125,000 physicians use Epocrates' products on iPhone and iPod touch devices, alone. The first medical application for the iPhone, Epocrates' drug reference, is the most popular free medical download in the iTunes store. A study at Brigham & Women's Hospital in Boston found that 60 percent of Epocrates users reported avoiding three or more medical errors a month.[12] The company's own time-study found that doctors who use the reference tool save at least 20 minutes a day in pharmacy call-backs and real-time mobile information search while in the exam room.

Another major medical reference firm, Skyscape, works with more than 50 health publishers and has assembled the largest library of medical resources available for every smartphone operating system.

Anatomy references include Netter's Anatomy app, which is based on the popular *Atlas of Human Anatomy.* The Medical Encyclopedia by University of Maryland Medical System was one of the ten most popular free apps in the iTunes Store in December 2009.

Like physicians, consumers also access medical reference information via mobile devices. The Evincii app helps consumers look for over-the-counter medication for particular symptoms. This app grew out of a service once available via a kiosk in retail pharmacies. There are also many symptom checkers available for consumers; in 2010, the Mayo Clinic began to offer the Symptom Checker iPhone app in February 2010, similar to the hospital's online version.

Diagnostic Tools

General diagnosis. One of the most popular apps for doing differential diagnosis is Diagnosaurus, written by Dr. Roni Zeiger (currently affiliated with Google Health). The IDdx is an app covering infectious disease diagnosis, based on Control of Communicable Disease Manual. Some diagnostic apps target specific conditions: STAR Analytical Services developed an app that analyzes coughs.[13] The company received a grant to create the app for developing countries. Star's Suzanne Smith noted that coughs are "the most common symptom when a patient presents, and we are relying on doctors and nurses with good old technology from the 19th century."[14]

Lab apps. Smartphones can deliver physicians' laboratory and blood work results as soon as they are completed. This just-in-time reporting can help physicians and patients avoid phone tag. If a value is abnormal, the physician can immediately email a patient follow up instructions. The lab app will evolve next to assist clinicians in interpreting lab

results and providing diagnostic support. Current popular lab apps include ARUP Consult and Care360.

Digital imaging. The OsiriX app can be thought of as a mobile PACS (picture archiving communications system) for the smartphone. At the 2009 annual meeting of the Radiological Society of North America (RSNA), several papers demonstrated the efficacy of using smartphones in digital imaging applications.[15] ERoentgen Radiology Dx is an app that helps radiologists identify the most appropriate radiology exam for a patient.

ECG. There are many electrocardiogram apps that offer images of the most common ECG results. Instant ECG (one of the top ten paid iPhone apps in December 2009), ECG Guide, and ECG Interpreter are among the most used.

Emergency department. Mobile health solutions on smartphones are designed to increase productivity in busy ERs. Physicians use the Vigilance app to track patients' vital signs, transmit live videos from exam and operating rooms, and receive alerts when patients are in distress so doctors can respond even before nurses page them.

Obstetrics. AirStrip OB is an iPhone app that provides obstetricians real-time, remote access to fetal heart tracings, contraction patterns, nursing notes, and vital signs. Obstetricians can monitor different stages of labor even when they are not by a patient's side. This increases the OB's ongoing interaction with the labor and delivery department and gives the doctor real-time data.

Remote physician consultation. Remote physician consults via desktop computers have emerged through services like American Well, Myca Health, RelayHealth, and TelaDoc. They have gained traction in the market as reimbursement is negotiated between payer, provider, and patient. As this alignment of incentives continues, remote

consults will migrate to various devices beyond the desktop computer and, over time, onto smartphones. Qualcomm has 12,000 employees in the San Diego area. The company operates a corporate health center and is creating "the clinic without walls," which uses the Myca platform for managing communications between the care team and the employee. Many Qualcomm workers travel outside of San Diego; Myca enables remote consultations between health center staff and mobile employees via mobile devices like smartphones, which enhances the company's ability to extend wellness beyond the company's physical doors. As Dr. Marion Zabinski of Myca explained, "people are so connected to phones, they're an extension of themselves. You can't have your doctor with you all the time but the phone can keep you on the right path toward health and wellness."

Continuing Medical Education

The Internet is playing a growing role in continuing medical education (CME).[16] Several services provide CME credits using smartphones, including Epocrates Mobile CME, MedPageToday, QuantiaMD, ReachMD, Skyscape CME STAT, and UpToDate. Wolters Kluwer Health, the medical publisher, developed the XtraCredit app that provides CME credit for clinical research done online. CME via smartphones will grow in adoption as mobile Web browsers accommodate more multimedia formats such as Flash.

Patient Records—EHRs and PHRs

This crowded market segment is attracting new entrants who are innovating "lighter" open source solutions, including records apps for smartphones. Several currently offer smartphone capability, including Allscripts, CareTools iChart, eClinicalWorks, EPIC's Haiku, LifeRecord,

MacPractice MD, motionPHR, NextGen, Ringful, and Webahn.

This list will grow "exponentially," according to Dr. Joseph Kim, who says, "we'll see a huge change in the next couple of years. But will physicians know how to use these systems effectively? There isn't much robust clinical decision support backed by evidence-based medicine yet" for these applications.

With the implementation of the American Recovery & Reinvestment Act of 2009 (ARRA), stimulus funding will be distributed to health providers who implement electronic health records (EHRs) according to "meaningful use" criteria. Mobile EHRs could open up physician access to patients if the apps have the same security layers as their desktop counterparts. Then physicians could communicate with patients from anywhere, and not be tethered to the desktop application. "This could change physician access electronically from 24 hours to 24 seconds," predicted Dr. Ted Eytan of The Permanente Federation.

As consumers get more engaged in tracking their health information, personal health records (PHRs) will gain adoption. Four in five U.S. adults believe that online PHRs would be beneficial in managing their health and health care. Nearly one-half of Americans are interested in using an online PHR service.[17] However, PHR adoption remains very low; only 3 percent of U.S. adults had a PHR in 2008. If meaningful use criteria under ARRA include patient-engagement, then PHR adoption should grow.

The PHR supply side is populated with about 20 Internet-based PHRs on the market as of February 2010.[18] PHRs can be stand-alone (where health data are populated by the consumer), tethered to an EMR system (controlled by physicians), or non-tethered (Internet-based PHRs largely controlled by consumers). Because smartphones are extensions of users' personal lives, they could make

useful platforms for personal health records that are managed by consumers themselves.

A handful of PHRs are available via smartphone. Polka works on the iPhone; it stores and analyzes the consumer's personal health data, and offers health reminders. Aetna connects enrollees' smartphone apps to a PHR. The ICE app was developed by Legalzoom and Donate Life America to store users' personal information that can be accessed by first responders (e.g., paramedics, firefighters, and ER workers) "in case of emergency." In addition to this app, there are several other emergency apps incorporating the "ICE" acronym in their names.

Patient and Health Consumer Support

Scott Eising of the Mayo Clinic said, "Part of our vision for Mayo is that it's not only a destination medical center. We are going to take care of patients here and 'there,' whether at home or at work." Patients managing chronic conditions and healthy consumers who want to keep well can be served in a variety of ways. Mayo Clinic launched its first iPhone app, Mayo Clinic Meditation, in December 2009. The clinic followed up this app in February 2010 with the free Symptom Checker, based on its popular online version.

Some apps focus on a single illness. Brett Shamosh, who has ulcerative colitis (UC), created an iPhone app to help fellow patients deal with the condition. "We developed the software to cater to you and your personal condition. If you're willing to talk to us, you have to be incentivized, even inspired, to work with us," Shamosh has learned. As he receives feedback on his GI Monitor app from users, he continues to add user-defined value to the application.

Medication adherence and compliance. Studies on patient adherence to prescribed drug regimens have demonstrated that compliance among patients with chronic conditions may be as low as 20 percent.[19, 20] Many factors are involved, including cost/affordability, ineffective patient/provider interaction, lack of patients' understanding their disease, complex treatment plans, side effects, confusion and forgetfulness, and language barriers.[21]

Technology can play an important role in supporting people to adopt and stick with prescribed treatments. Medication Tracker, MedsLog and Pillbox are among the more popular medication trackers in the iPhone store. The Pillboxer Lite app tracks medications, vitamins, and supplements with a graphic interface that resembles the "Sunday through Saturday" pillbox format. The Pill app can remind women to take their birth control meds. Inhaler Tracker helps asthma sufferers track and record inhaler use.

The HIV/AIDS Red Ribbon Health Manager app generates medication reminders via both email and text. Users can opt for one or both. The app incorporates Observations of Daily Living (ODLs), which enable users to track aspects of their lives that are germane to their conditions.

For multiple sclerosis, i-inject is an app available for iPhone that sets medication reminders, tracks rotation of injection sites, runs medication reports, and enables emailing to physicians.

Mobile and home monitoring. A number of apps connect patients with chronic conditions to clinicians, caregivers, and health coaches on a continuous basis. Sensor technologies combined with mobile communications can be used to track various health measurements for patients or loved ones. Among a long list of sensors that can be incorporated into smartphones and used for health monitoring are:

- Accelerometers that register different motions and walking "gait";

- Infrared photo-detectors that measure body temperature, heat flux and heart rate; and

- Glucometers to measure blood glucose.

People with diabetes have access to a large array of mobile monitoring devices, some of which are available through smartphones. Roche Diabetes Care, the maker of Accu-Chek blood glucose meters and insulin delivery systems, partners with Mylestone Health's Glucose Buddy, which integrates with Roche's iPhone app. The app calculates the impact of the user's meals, activities, and other actions on blood glucose levels.

MedApps began as a smartphone-based monitoring application. However, given the relatively small user-base of smartphones in target populations (chronically ill people, seniors), the company subsequently re-engineered its offering in the form of a wireless handheld device, the HealthPAL. This device looks like a wireless phone, but operates differently. Patients managing chronic conditions do their regular monitoring through their usual devices including blood pressure cuffs, glucometers, spirometers, pulse oximeters, and weight scales. The Bluetooth-enabled HealthPAL device communicates the user's health data to providers for their monitoring, review, and reporting. The data can also be routed to a health record repository such as Microsoft HealthVault or Google.

Home care. Nearly 40 percent of home health agencies use some kind of point-of-care system in the field. Use of handhelds for home health is expected to have significant growth. One in every three home care managers uses a smartphone. Most use a BlackBerry, with 50 percent of the market, followed by iPhone (15 percent), Microsoft (15 percent), and Palm Treo (6 percent).[22]

Wellness and fitness apps. Many hundreds of smartphone apps for health consumers focus on

wellness, fitness, and nutrition. Examples are: The Carrot, Eat This/Not That (based on the popular diet book), SparkPeople, and WebMD Mobile (with over 1 million iPhone downloads in 2009). Other wellness apps are focused on complementary and alternative medicine, such as those offering support for sleep and meditation like the Mayo Clinic offering.

Managing conditions. A highly activated group of health consumers has adopted mobile devices to help manage chronic conditions. In early 2010, apps were available for the most common chronic conditions including (alphabetically) anorexia, asthma, cancers, chronic obstructive pulmonary disease, Crohn's disease, diabetes, glaucoma, heart disease, HIV/AIDS, hypertension, migraine, and multiple sclerosis, among other diseases. Most disease-specific apps in the iTunes Store are aimed at clinicians as "medical apps," although they can be downloaded by anyone.

Ed Daniels, an expert on point-of-care technology, defines "symptom-driven" health apps as those where navigation is controlled by user-entered medical information, and where the application may be programmed to use that data to record patient symptoms over time, to recommend treatments, or to connect the user with services, physicians, and hospitals.

Caregivers of children or aging parents might find smartphones useful for streamlining complicated and/or long-distance care for their loved ones. In a survey of parents of children with diabetes conducted by the Center for Connected Health, most expressed interest in enrolling in a mobile phone glucometer service, with two-thirds of parents feeling very positive about a proposed prototype. According to the researchers, "enthusiasm decreased with increasing annual service cost."[23]

IV. The Market for Smartphones and Health: Some Barriers

ACCORDING TO A PRICEWATERHOUSECOOPERS survey, one-half of U.S. health consumers are willing to engage in online care and consultation with clinicians over a phone. Only one-quarter prefer to stick with the traditional delivery model (Figure 7).

Some market forces foster adoption of mobile health technologies, and in particular smartphones; however, several key barriers will slow the progress of adoption.

Figure 7. Consumers Willing to Use Alternative Methods to Get Care, 2009

Note: Segments may not add up to 100 percent due to rounding.

Source: *Top 10 Health Industry Issues in 2010: Squeezing the Juice Out of Healthcare,* PricewaterhouseCoopers, December 2009.
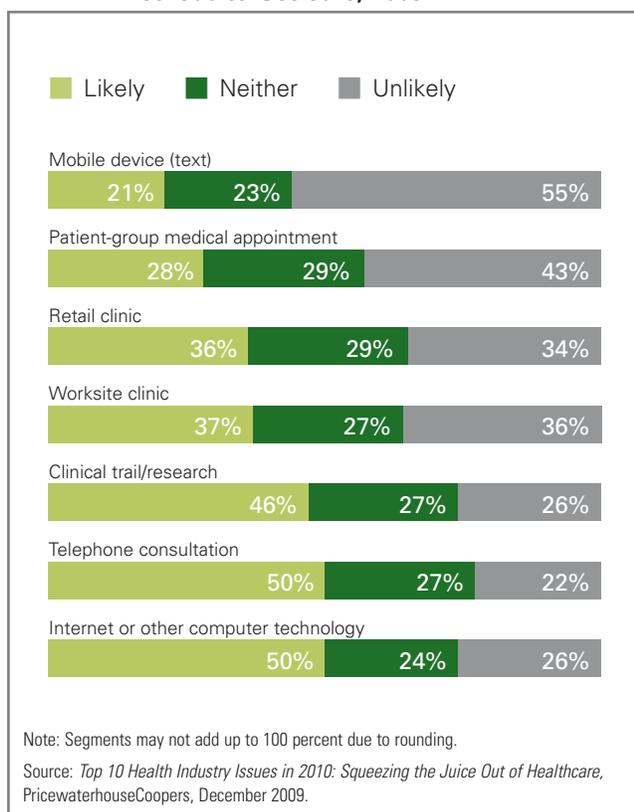
Where is the patient in the app? Too much app development is done by technologists, seemingly without much user input. "In an hour-long presentation by a major telecoms company at an mHealth conference, the word 'patient' was not mentioned once," observed Rob Havasy of the Center for Connected Health. In general, enterprise developers see more potential for profits in hospitals and physicians and not in the consumer segment.

As health apps proliferate in this early phase of mobile health, "Too many health smartphone apps are ill-conceived," observed B.J. Fogg, director of Stanford's Persuasive Computer Lab, who has studied the role of technology in changing people's health behaviors. "They're not going to change anybody's behavior," he said. Fogg's advice is to "Put hot triggers in the path of motivated people." Smartphone apps can do this very well—if properly designed and targeted to those people who truly want to engage in their health. It should be noted that apps for people who are sick need to be appropriately designed in order to be accepted in the already complicated lives of these patients and their caregivers.

Driving the app economy. The payment system and health stakeholder financing drive much of the app economy. The result is that some app categories are well populated while others are not. Conditions that are associated with products such as pharmaceuticals, medical devices, and health plans—like diabetes—have the most apps. Some are the creations of companies that stand to gain from patients' use of their products. An app created by a drug company could benefit the company, prescribers, and patients; for example, a

dosage calculator that applies only to a specific drug prescribed for the patient could be useful. Whatever entity sponsors the development of a health app, the sponsorship should be transparent to the end user.

Shop till you drop. How can consumers efficiently locate a health app that will be useful to them? "Discoverability is a big issue," asserted Brian Dolan of MobiHealthNews. "It's overwhelming to enter an apps store and start a search." The process by which consumers seek health apps is cumbersome. Most of the health/fitness apps in the iTunes Store have relatively few reviews on which a consumer can make an educated purchasing decision. "I haven't seen a lot of user communities focused on apps yet," Dolan said. "This is also true on the clinician side." Further, it is difficult to ascertain whether a particular app is new or an update incorporating learnings from users and more robust functionality.

Caveat emptor, health app downloader. It is difficult to distinguish the safe, medically credible apps from the less-safe ones. "Anyone can create an app and put it in an app store, warned Dr. Joseph Kim. "This is concerning." He indicated that apps with branded logos from a government agency (e.g., CDC, FDA, or NIH) or academic institution (with Mayo Clinic, Cleveland Clinic, Johns Hopkins, and the University of Maryland among the most active health app sponsors) are some of the most credible apps for consumers to download for personal use.

Downloading an app doesn't make you a doctor. Consumers who are very technology-savvy may choose to download medical apps developed for health professionals. These consumers may believe that the downloading and use of medical apps is a replacement for consulting a physician. However, there is a difference between participatory health and practicing medicine.

The looming presence of the FDA. It is not clear whether health and medical apps are "medical devices" under the FDA's definition, although they are not currently regulated by the agency. However, when smartphones connect to sensors and automatically collect patient data, the FDA may take on a regulatory role. In January 2010, the FDA advised software developer MIMvista that its imaging app for the iPhone would need to undergo pre-market approval to gain marketing clearance. This requires clinical trials, a process that is time-consuming and expensive. "If software is intended to provide cure, mitigation, treatment, or prevention of disease, then the FDA may consider it a medical device," according to Ed Daniels of Point-of-Care Partners. The "wild west" nature of the health apps store may be a recipe for FDA regulation toward the objective of protecting consumer safety. "The FDA may want to make an example out of one or two apps to remind everyone that the agency is paying attention to health apps. 'First, do no harm' applies," said Daniels.

Advertising as a business model. Presumably to protect its turf in the mobile ad space, Apple posted information on its iPhone developer Web site alerting developers about incorporating location-based information (such as GPS) into apps. Apple warned that if such location-based information were, "to enable mobile advertisers to deliver targeted ads based on a user's location," the app would not be accepted by the iTunes Store.

Size and wiring matter. Mobile health solutions will help providers and institutions manage care in lower-cost settings, and extend scarce resources from expensive digital imaging hardware to expert clinical specialists and visiting nurses. Larger institutions that are well staffed and use electronic medical records will be in a good position to adopt mobile health tools. But, "even we struggle," acknowledged Rob Havasy of the Center for Connected Health, part of the large Partners Health System in Boston. "For
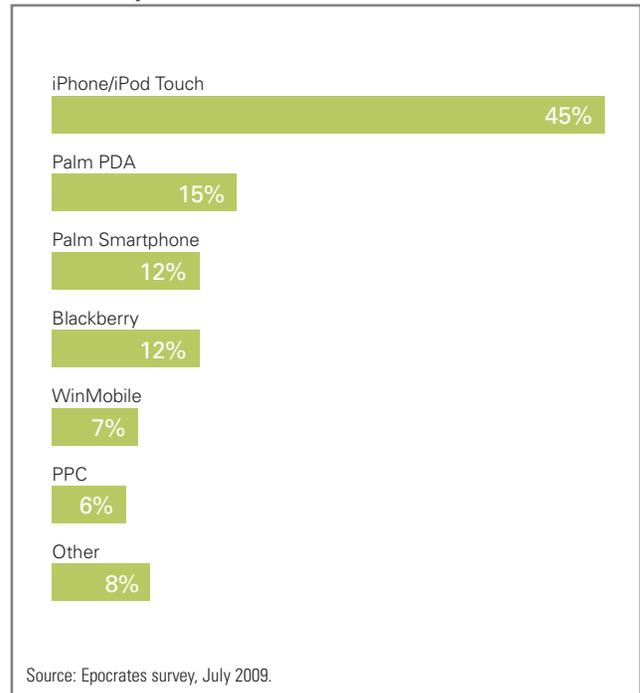
smaller hospitals, it will be that much harder when their staffs aren't as used to using EMRs and CPOE."

Physician practice workflow. With the advent of HIT stimulus money incentivizing hospitals and providers to adopt EHRs, physician practices will become more digitized. The biggest challenge to physicians, according to Dr. Joseph Kim, will be, "How will smartphones get integrated into the workflow of physician practices? Does a physician adopt a smartphone or an in-between computer and phone like an iPad or tablet device? All of these are useful digital interfaces." Dr. Ted Eytan noted that physician practices will be asking how mobility can help them perform better for their patients. If a practice is a more mature user of EHRs, he added, then mobility will be as much about patient workflow as doctor workflow.

For new doctors, the transition will be smoother. Some medical schools now issue smartphones: Georgetown, The University of Louisville, and Ohio State University are among the schools that require students to use one. Today's medical students are "digital natives," so using a smartphone at the point-of-care comes naturally. As of July 2009, among medical students who did not have a smartphone, 50 percent planned to buy one within the year; 59 percent of these planned to acquire an iPhone or iPod touch, and 21 percent planned on buying a Blackberry.[24] See Figure 8.

Participatory health. Patients, charged with paying more for health care and making more clinical decisions for their and their families' care, have begun to adopt technology-based tools to enable deep health engagement. Most Americans now turn to the Internet to seek health information, and at least 50 percent of Americans would like to email a physician to communicate about conditions, appointments, prescriptions, and test results. See Figure 9 on the following page.
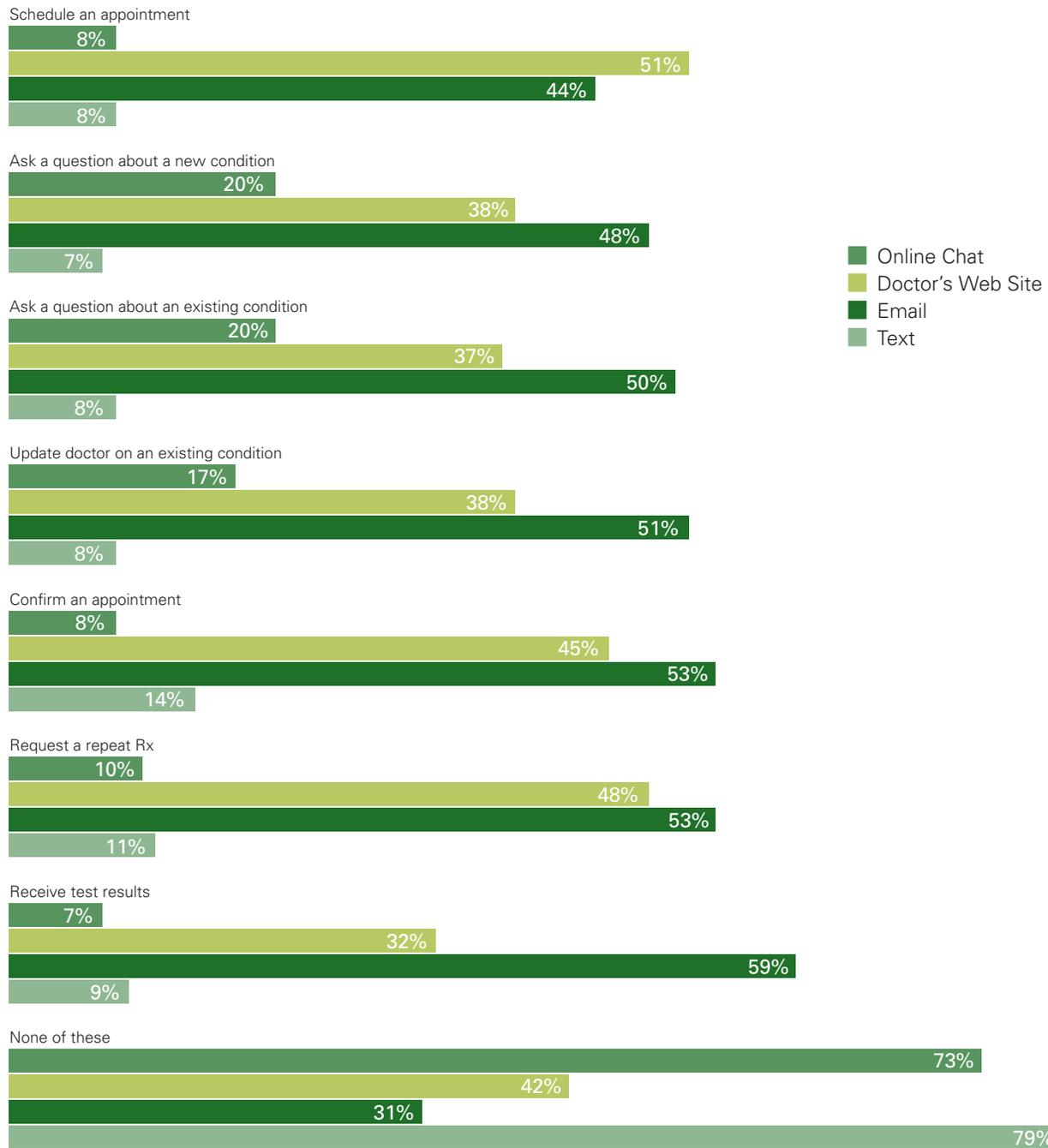
Figure 8. Medical Students Who Own Mobile Device, by Brand, 2009

iPhone/iPod Touch — 45%
Palm PDA — 15%
Palm Smartphone — 12%
Blackberry — 12%
WinMobile — 7%
PPC — 6%
Other — 8%

Source: Epocrates survey, July 2009.

As reimbursement models for physicians move toward bundling and patient-centered medical homes, there will be greater incentives for doctors and patients to partner in leveraging health information technology — including smartphones.

Privacy and security. Keeping personally identifiable health information secure is a long-standing challenge. The advent of mobile health requires strong encryption and strong authentication. Nonetheless, more patients are recognizing the value of digital health records. Researchers at some of Boston's most prestigious medical institutions recently found that, "especially for the chronically and acutely ill, privacy is of far less concern to patients than to health professionals."[25]

Figure 9. Consumers Interested in Email Communication with Their Doctor, 2009

Schedule an appointment
- Online Chat: 8%
- Doctor's Web Site: 51%
- Email: 44%
- Text: 8%

Ask a question about a new condition
- Online Chat: 20%
- Doctor's Web Site: 38%
- Email: 48%
- Text: 7%

Ask a question about an existing condition
- Online Chat: 20%
- Doctor's Web Site: 37%
- Email: 50%
- Text: 8%

Update doctor on an existing condition
- Online Chat: 17%
- Doctor's Web Site: 38%
- Email: 51%
- Text: 8%

Confirm an appointment
- Online Chat: 8%
- Doctor's Web Site: 45%
- Email: 53%
- Text: 14%

Request a repeat Rx
- Online Chat: 10%
- Doctor's Web Site: 48%
- Email: 53%
- Text: 11%

Receive test results
- Online Chat: 7%
- Doctor's Web Site: 32%
- Email: 59%
- Text: 9%

None of these
- Online Chat: 73%
- Doctor's Web Site: 42%
- Email: 31%
- Text: 79%

Legend:
- Online Chat
- Doctor's Web Site
- Email
- Text

Source: *Consumers Would Embrace Email Communication with Their Doctor,* Lightspeed Research, September 2009.

V. Looking Forward: Insights from the Early Adoption Phase

ULTIMATELY, SMARTPHONE TECHNOLOGY is only as important as its ability to empower users to communicate and collaborate in the interests of health. The technologies are changing quickly in terms of hardware platforms, software, and connectivity. New Bluetooth standards will make phone devices for consumers cheaper and easier to use in 2011. When 4G (fourth generation) wireless devices enter the market, smartphones will further mature and take on more robust functionality. Augmented reality software will enable smartphones to interact with the real world. And cell phones will morph into smartphones as their software incorporates more advanced functions and adopts open source mobile operating systems such as Android. The smartphone is but one platform among a growing array of mobile health devices, as Table 2 illustrates.

The early adoption phase of smartphone apps in health provides some insights for health information technology use in general, and apps in particular.

Low financial threshold. Smartphone apps do not require large up-front investments from health providers or consumers. There is a low barrier to entry. Apps are simple to adopt, pilot, and either continue to use if found valuable or abandoned. This is important at a time when health providers' access to capital is highly constrained and when return-on-investment for big-dollar HIT projects is often difficult to measure or too low to justify.

Small is beautiful. Smartphones are about the size and shape of a prescription pad, a medium that doctors have long experience pulling out of a pocket and recording on. A desktop or laptop computer is far more cumbersome. The iPad may emerge as

Table 2. Mobile Platforms Used for Health, 2009

MOBILE DEVICE	HEALTH EXAMPLES
Activity detector	Wellcore Activity Monitor
Cell phone	TellMe Networks—text message reminders for medication adherence (Microsoft)
Messaging platform	FrontlineSMSMedic—private, two-way network using open source software and cell phones
Motion sensor	FitBit, Nintendo Wii
Pager	ALRT Technologies' Constant Health Companion—prescription alert device
PDA	MEDLINE Database on Tap, NLM Mobile, LabNotes
Mobile Personal Emergency Response System	MobiWatch M-PERS
Senior phone	Jitterbug
Smartphone	iPhone health apps—sensors for diagnostics, such as glucose monitoring
Medical-specific platforms	Implantable diagnostics—including patient vitals monitor, smart pills, wearable diagnostics, wireless pillbox

Source: "Adapted from TripleTree LLC," *Wireless & Mobile Health,* 2009

an attractive "in-between" small device for health providers, but as of April 2010, it is too early to forecast.

Respect the universal platform. The White House launched the program Text4Baby (www.text4baby.org) in February 2010. It aims to promote maternal and child health in the United States, where the infant mortality rate ranked 30th among 31 developed countries in 2008.[26] The program is a public-private partnership between several U.S. government agencies, health care

companies, academic institutions, and virtually all of the major telecommunications network providers, who are waiving fees for these text messages. To move the needle on public health, it is important to choose a platform that is universal. Today, that ubiquitous platform would be cell phones and not smartphones. But in a matter of years, not decades, feature phones will fast morph into "smart-erphones." For large health plans, health systems, and payers, smartphone health apps can be deployed in targeted population health programs. Consider Kaiser's My Health Manager, used by 3 million members: Even if 10 percent of Kaiser's EHR users have smartphones, this represents 300,000 patients.

EHRs as smartphone apps. The killer app for physicians on smartphones could be electronic health records adoption. One of the major announcements at HIMSS 2010 was Epocrates' development of an iPhone- and Web-based electronic health record. One in three U.S. physicians has an Epocrates app loaded on a smartphone or other handheld device. Functions might include a prescription app, an over-the-counter information app, or a medical calculator. According to Epocrates, the average clinician uses one of its applications six times a day. Small physician practices already using Epocrates products will probably be more receptive to adding onto their current applications than to switch to a new, untested IT partner for EHR adoption.

"My office is where I am." Physicians' work is mobile, and smartphone apps can seamlessly fit into the workflow and increase productivity, which can result in both opportunities for revenue enhancement and greater job satisfaction.

"My life is 24x7." For people managing chronic health conditions such as asthma, diabetes, heart disease, and GI issues, sound health management is rooted in making good health "micro-decisions" every day. Health apps on a smartphone can bolster

good decisions at the moments they are made, from nutrition choices to shopping for healthy foods and tracking steps.

Still a wireless divide for the most vulnerable. While cell phones are fairly ubiquitous in the U.S. across socioeconomic strata, smartphones are not yet, and wireless connectivity isn't evenly distributed, either. B.J. Fogg observed, "If a county health department rolled something out on smartphones, it could be discriminatory. Any agency that builds a health program on a smartphone would battle the digital divide." Therefore, in the short term, Fogg recommends that mobile health programs be built for cell phones using text. "Virtually everyone has a cell phone, and everyone can text. It's here and now, if you're going to do an intervention that reaches the masses." When Dr. Richard Katz of the George Washington Medical Center partnered with WellDoc on a mobile health solution for patients with diabetes, he found that only a handful of patients among the 700 had a smartphone with the right plan for the study. "This is why so much of what we do with technology is home grown," pointed out Rob Havasy.

The first generation of smartphone apps has yielded value for consumers and clinicians who have adopted them because they are agile, easy-to-use, hand-held, and mobile. These features have not been the traditional hallmarks of health IT. They empower providers and patients on the go. The relatively speedy disruption that apps have had on health providers and consumers is just the beginning of a "small is beautiful" phase of health care information technology and delivery.

Whatever comes next will undoubtedly build on the characteristics that have made smartphones so popular.

Endnotes

1. Centers for Disease Control, National Center for Health Statistics. "Electronic Medical Record/Electronic Health Record Use by Office-based Physicians: United States, 2008 and Preliminary 2009," December 2009.

2. ChangeWave Research. "New Survey Shows Android OS Roiling the Smart Phone Market," January 4, 2010.

3. CNET news. "Smartphone market unfazed by recession," November 6, 2009, news.cnet.com/8301-1035_3-10392252-94.html.

4. Hein K. Phones Top List of Most-Trusted Brands. *Brandweek,* October 17, 2009. Compared to other consumer goods, wireless phone manufacturers have very loyal consumers—more loyal than any other brand category. Among smartphones, Apple's iPhone has the most loyal customers of any brand. In fact, six brands of mobile phones fell in the top 30 of Americans' most beloved brands as of September 2009.

5. MobiHealthNews. "The World of Health and Medical Apps," *MobiHealthNews Research Report,* February 2010.

6. Horrigan J. "Wireless Internet Use." Pew Internet & American Life Project, July 2009.

7. TelecomEngine. "Statistics pointing towards continuing dominance of SMS," December 21, 2009.

8. See note 6.

9. Gartner. "Gartner Identifies the Top 10 Consumer Mobile Applications for 2012." November 18, 2009, www.gartner.com/it/page.jsp?id=1230413.

10. Business Wire. "One in Five Physicians Likely To Purchase an iPad, More than 60 Percent Intrigued By New Device According to Epocrates Survey," February 4, 2010, www.businesswire.com/portal/site/home/permalink/?ndmviewid=news_view&newsId=20100204006741&newslang=en.

11 Manhattan Research. "Physicians in 2012: The Outlook for On Demand, Mobile, and Social Digital Media," October 2009.

12. Epocrates. "Brigham and Women's Hospital Study Shows Doctors are Taking Action to Improve Patient Safety and Care," December 9, 2005. www.epocrates.com/company/news/10233.html.

13. Bland, E. "Cough Into Your Cell Phone, Get Diagnosis," Discovery News. November 8, 2009, news.discovery.com/tech/cough-cell-phone-diagnosis.html.

14. Ibid.

15. Choudhri AF, et al. Handheld Device Review of Abdominal CT for the Evaluation of Acute Appendicitis. RSNA 2009; Abstract SSE09-03.

16. The Accreditation Council for Continuing Medical Education (ACCME). *ACCME® Annual Report Data 2008,* www.accme.org/dir_docs/doc_upload/1f8dc476-246a-4e8e-91d3-d24ff2f5bfec_uploaddocument.pdf.

17. Markle Foundation. Americans Overwhelmingly Believe Electronic Personal health Records Could Improve Their Health, June 2008.

18. Chilmark Research. *iPHR Market Report,* February 2010.

19. Kripalani S, Xiaomei Y, Haynes RB. Interventions to Enhance Medication Adherence in Chronic Medical Conditions. *Archives of Internal Medicine.* 167(6): 540–549.

20. Osterberg, L, Blaschke T. Adherence to Medication. *New England Journal of Medicine* 353:487–497.

21. National Consumers League. Prescription Medication Adherence Provider and Patient Perspective Final Report, June 18, 2009.

22. Research in Motion. The Blackberry Report: The National State of the Home Care Industry, October 10, 2009.

23. Pena, V., A.J. Watson, J.C. Kvedar, and R.W. Grant. "Mobile Phone Technology for Children with Type 1 and Type 2 Diabetes: A Parent Survey." *Journal of Diabetes Science and Technology.* Volume 3, Issue 6, November 2009.

24. Epocrates. 4th Annual Future Physicians of America survey, July 2009, www.epocrates.com/company/mediaroom/mediaresources/surveys/4th_fpasurvey.pdf.

25. Walker, J., D.K. Ahern, L.X. Le, and T. Delbanco. "Insights to Internists: I Want the Computer to Know Who I Am," *Journal of General Internal Medicine,* Volume 24, Number 6, June 2009, 727–732.

26. Centers for Disease Control. "Behind International Rankings of Infant Mortality: How the United States Compares with Europe," NCHS Data Brief, Number 23, November 2009.