Healthcare Delivery in the Digital Age

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Abstract

Emerging technologies are having a disruptive effect on healthcare delivery as systems evolve to meet changing healthcare needs of individuals and populations. Eight realities/trends are briefly examined, and a vision of a transformed healthcare system is presented.

Keywords

Emerging technologies · Healthcare delivery
Home-based care · Hospital-at-home
Retail-based clinics · Employment-based care
Community-based healthcare · Health apps
Mobile health · Consumer health · Patient engagement · Patient empowerment

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Learning Objectives

- Cite current technology-based realities/trends that are driving change in current healthcare delivery and examples
- Describe projected changes in healthcare delivery due to these realities/trends in terms of where, how and by whom healthcare will be delivered
- Describe barriers that need to be overcome to realize the change

22.1 Introduction

Much has been written about the impact of emerging technologies on healthcare. Many entrepreneurs and investors are developing innovations to improve clinical workflows, to enable predictive analytics, and to deploy wide scale interoperability. Many of these innovations are disruptive to *current* healthcare delivery, but over time, *together and synergistically,* they will form the basis of sustainable transformations that have not before been possible, but that will have far reaching impacts on future healthcare delivery. We consider eight realities/trends that are already impacting and transforming healthcare.

1. *Reductions in Hospital-Based Care*

   For many reasons: economic, policy and regulation, disease epidemiology, and prac-

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tice changes, hospitalization/inpatient length-of-stay (LOS) has dropped significantly [1, 2]. Two major types of technical/workflow innovations that are making this overall reduction possible are:

(a) Innovations in clinical care technology, in medical devices that are miniaturized, handheld, ingestible, wearable, mobile, and operable and connected by broadband connection [3–8], have helped reduce LOS in intensive care and inpatient facilities by allowing patients to receive the same level of care and quality in home and community settings [5].

(b) Innovations in care coordination, which extend clinical supply chain and services beyond the hospital. "Hospital at Home" is a care model that organizes and leverages medical goods and services: pharmaceuticals, laboratory, imaging, 24-hour physician and nursing coverage and other bedside support [9], uses business, logistics, and engineering to deliver "High-Tech Home Care". Services, including intravenous infusion therapy, total parenteral nutrition, chemotherapy, analgesia/pain management, respiratory support (ventilators, oxygen), and telemedicine, reduce costs and safety risks of hospitalization. "Hospital at Home" has been shown to deliver as good or better outcomes in patient mortality, health, functional ability, quality of life, disease-specific outcomes, and overall satisfaction, in comparison to inpatient care. And despite a heavy reliance on technology, care has been shown to be less costly than traditional hospitalization [10].

2. *The Rise of Retail Healthcare*

Retail Healthcare is still in its infancy, with compelling evidence of emerging innovative models, of which we examine three exemplars – Community-Based Retail Clinics, Community-Based Telehealth and Employment-Based Care.

(a) Retail Clinics: MinuteClinic®

Prior to 2001, most healthcare encounters occurred in hospitals/emergency departments, clinics, or offices. In 2001, MinuteClinic® of Minnesota piloted retail clinics to provide acute care in community-based stores. In 2005, MinuteClinic® was acquired by CVS Health. As of 2021, CVS Health's MinuteClinic® currently leads the industry with more than 1100 locations in the US, with plans to increase its healthcare offerings by creating an additional 1500 "HealthHUBs" to focus on chronic disease management. Other chain stores have created similar products (Other examples are Walgreens HealthCare Clinics® and Kroger Little Clinics®).

In 2017, over 2200 retail clinics in the US reported revenues of $1.4 B in 2016, with a 20% increase for each of the previous six years. In 2021, nearly 9000 retail and free-standing urgent care centers in the US are spurred by strong patient and consumer demand and high satisfaction with short wait times, walk-in options, extended hours, convenient locations and transparent pricing [11–13].

Retail clinics leverage health technology to deliver care: electronic medical records, rapid diagnostic testing, electronic prescribing and telehealth. Initial clinician concern about lack of continuity and the quality of care by non-physicians have been offset by the accessibility and acceptability of retail clinics, comparable to emergency departments or physicians' offices [14–16]. **A**mong consumers/patients, **r**etail clinics have rapidly become popular, with evidence of higher patient satisfaction, shorter waiting times, lower costs, and care quality on par or better than traditional healthcare settings. There is also evidence that retail clinics may provide healthcare access to medically underserved populations.

(b) Community-Based Telehealth: VA-Walmart Partnership

In December 2018, the Department of Veteran Affairs (VA) and Walmart announced a collaboration to enable Veterans to access VA-led telehealth services in Walmart stores "to serve Veterans

through technology…providing Americans with more affordable health care," and to provide "integrated, seamless access to healthcare no matter where a Veteran resides…from anywhere to anywhere."[1]

This model is a departure from traditional VA-led healthcare offerings as the first formal collaboration between the US federal government and a private retail conglomerate, designed to enable healthcare anywhere, to increase convenience and to lower costs for patients and consumers, thereby improving the population health of Veterans.

(c) Employment-Based Care: AmazonCare®

In September 2019, the Amazon Corporation launched Amazon Care®, a service to provide its employees immediate access to high-quality care via chat or video conference (typically in less than 60 seconds). Amazon Care® has two components: 1) virtual care, which connects patients via smartphone app messaging/video (Android and iOS) to confidential live chat with a nurse or doctor, and 2) in-person care, which dispatches medical services to a patient's location, ranging from prescription delivery and routine blood draws to listening to a patient's lungs.

Until March 2021, Amazon Care® was available only to employees in Washington state, when Amazon announced plans to make its virtual care component available to companies and to Amazon employees in all 50 states by Summer 2021. There are plans to expand its in-person care component to Washington, DC, Baltimore, and other cities in coming months.[2] It remains to be seen if this form of retail healthcare will ultimately succeed.

(d) Retail Pharmacy: Amazon Pharmacy®

In November 2020, Amazon announced two new pharmacy offerings. Amazon Pharmacy, a new store on Amazon, allows customers to complete an entire pharmacy transaction on their desktop or mobile device through the Amazon App. Using a secure pharmacy profile, customers can add their insurance information, manage prescriptions, and choose payment options before checking out. Prime members receive unlimited, free two-day delivery on orders from Amazon Pharmacy included with their membership. Also Prime members can access savings on medications at Amazon Pharmacy when paying without insurance, as well as at over 50,000 other participating pharmacies nationwide. The Amazon Prime prescription savings benefit saves members up to 80% off generic and 40% off brand name medications when paying without insurance. Through this program some medications will be available for as little as $1 per month. Customers also have online self-service help options combined with phone access to customer care at any time 24/7 to answer questions about medications.[3]

Insights gleaned from the Amazon Care® and Amazon Pharmacy® experience include:

- There is compelling evidence of the acceptance of the Amazon Care® model from its national expansion, after an 18-month local pilot.
- Amazon Care® is largely outside of traditional healthcare insurance (and regulation), representing potential dis-

[1] https://www.managedhealthcareconnect.com/content/walmart-va-collaborate-new-partnership-offer-telehealth-services

[2] Amazon Care to launch across U.S. this summer, offering millions of individuals and families immediate access to high-quality medical care and advice—24 hours a day, 365 days a year, March17,2021 https://www.aboutamazon.com/news/workplace/amazon-care-to-launch-across-u-s-this-summer-offering-millions-of-individuals-and-families-immediate-access-to-high-quality-medical-care-and-advice-24-hours-a-day-365-days-a-year

[3] Introducing Amazon Pharmacy: Prescription Medications Delivered. BusinessWire, Nov 17, 2020. URL: https://www.businesswire.com/news/home/20201117005429/en/ [last accessed 27 October 2021].

ruption to traditional healthcare insurance/business models.

- Amazon Care®, unlike traditional healthcare, appears to occur without the need for (or for less) inpatient care, representing potential but significant disruption to traditional hospital finances.
- The Amazon Care® paradigm could represent a new patient experience of healthcare, driven by a) the speed of access to a medical provider (nurse or doctor) within 60 seconds of a patient request and b) unparalleled convenience, empowered by the two-way Web-enabled interaction, regardless of time or patient location. These enhancements may be powerful enough to outweigh potential hesitancies they have with the service.
- Amazon Pharmacy® is a hybrid service integrating some traditional pharmacy services with medication and customer service benefits not previously seen in healthcare. This service is offered to employers but is also offered directly to all consumers. The costs, benefits and convenience of the service may be hard to replicate in traditional pharmacy systems.

3. *Shifts in Population Demographics*

America is graying. In 2016 in the US, there were 49 million people 65 years or older. By 2030, all US "boomers" will be over 65 with one in five being an "older adult". By 2060, 95 million will be over age 65, representing growth in this population (from 15% to 25%) and in the "over 85" population (doubling to 11.8 million by 2035, and tripling to 19 million by 2060). Beyond 2030, older adults are projected to outnumber children for the first time in US history (2034). The total US population is expected to grow by 79 million people by 2060, crossing the 400-million threshold in 2058 [17].

The aging population is also becoming increasingly diverse, racially, and ethnically. In 1900, one in eight people in the US were "non-white". Starting to rise in 1970, one in five were a race other than white by 1990, growing to one in four over the next decade. By 2060, this proportion of "non-white" is projected to be one in three, or 32 percent of the US population. The non-Hispanic white population is projected to shrink from 199 to 179 to 199 million due to falling birth rates and rising number of deaths.

From a different perspective, millennials, who currently represent 30 percent of the population, are diverse, with 44 percent represented by ethnic and racial minorities, compared to 25 percent of baby boomers [18]. Millennials report not having a personal healthcare provider, and not wanting one, satisfied to obtain their healthcare through digital means or from retail healthcare outlets.

These changes in patient demographics will affect population health needs, thereby shaping healthcare services:

(a) More senior patients with more and progressively complex chronic diseases of varying severity will require comprehensive ambulatory services.
(b) Increases in patient diversity will require care and support services to be culturally appropriate to promote patient engagement and empowerment.

To meet these needs, traditional healthcare delivery service structures and processes will need to change, to evolve, especially in their increasing dependence on digital health solutions and technologies for outreach to patients, when and where they need it.

4. *The Rise of Consumer Health Technologies*

Consumer digital health technologies assist patients and their families in managing health and chronic disease. The prevalence of digital tool ownership is high, with 96% of Americans owning cellphones, 81% owning smartphones, 75% owning a laptop/desktop and 50% owning a tablet/e-reader. Reliance on smartphones for online access is especially common among younger adults, non-whites

and lower-income Americans.[4] Use of smart TVS, wearables and speech-enabled tools is growing, with 46% using digital speech assistants.

Smartphone platforms provide consumer-accessible mobile app programs that are transforming users' engagement with people, products and services:

(a) Apple and Google Play stores have approximately five million apps/programs available that are actively used by smartphone users at least 11 times per day [19]. There are now over 318,000 health apps available in app stores worldwide, with over 200 health apps added each day. Collectively, health apps have been downloaded almost three and a half billion (3.35 billion) times.

(b) "Health & Fitness" apps [20] can be categorized as:
- *General Health & Wellness Apps* that track nutrition and calories, sleep patterns, and help manage stress
- *Telemedicine Apps* that provide virtual patient care by licensed doctors
- *Health Management Apps* that
  - support self-care and monitoring of specific health conditions (heart disease, diabetes, pregnancy, mental health etc.)
  - allow patients and providers to share personal health data, remotely
  - assist patients and their caregivers to track and manage medications

Consumer health apps can work in concert with other medical technologies. For example, the PatientKeeper® app (from Epic Systems) enables providers to access patient clinical/EHR data via mobile devices, laptops, tablets and other devices, allowing access to data and information anywhere and anytime patients need or want to access them. It has been estimated that if health apps were used across all diseases, a potential savings of as much as *$46 billion* a year could be realized.

The evolution in personal digital and health technology is changing consumer expectations in healthcare as it is in all sectors of the service economy. New value propositions: more and faster healthcare delivery options, increased convenience and lower costs, are going beyond the Institute of Healthcare Improvement's Triple or Quadruple Aims [21]. New variables of importance are being included in healthcare value propositions as provider systems seek competitive advantage in attracting and retaining patients.

5. *The Availability of Broadband Internet/5G*

Increasingly, Broadband Internet connectivity is required to assure interoperability and security of medical devices and the availability and reliability of data flow for effective and secure healthcare. Broadband Internet can be delivered via fixed (fiber optic, cable, DSL) or Mobile (cellular or wireless) connections to the network. The current network architecture, 5G (the fifth generation) will enable higher data transmission speeds than previously, with much lower latency and a higher network density (allowing more devices to connect). This is the critical infrastructure for enabling the Internet of Things (IoT, the network of computing devices embedded in everyday objects) to become a practical reality and to develop robust digital health ecosystems that can deliver "on demand" "anytime/anywhere" care services to patients [22].

6. *The Use of Artificial Intelligence*

Artificial Intelligence (AI), the simulation of human intelligence or behavior for learning, reasoning, and problem solving, is not a single technology, but a range of processes and behaviors generated by computational models and algorithms. Progress in handling massive and "big" data has accelerated advancements of AI, Machine Learning (ML) and Natural Language Processing (NLP). New powerful solutions have been developed to solve complex real-world problems in image and speech recognition, "big data" analytics, with applications in healthcare.

[4]Mobile Fact sheet, Mobile phone ownership over time, Aptil 2021, https://www.pewresearch.org/internet/fact-sheet/mobile/

(a) Machine Learning, (ML) the current dominant approach in AI, uses model ("training") data to identify patterns, then uses the model to make predictions from new ("test") data. ML algorithms can thus learn and improve from experience over time without explicit programming. ML is widely used in other types of AI technologies, such as NLP, voice and vision technology, and robotics.

(b) Natural Language Processing (NLP) uses computational methods to automatically analyze and represent human language. NLP can be used to extract critical information about patients from data, to improve diagnostic and therapeutic recommendations [23].

AI and ML have many applications across healthcare, from wellness, screening and diagnostics, predictive modeling and analytics to interventional and treatment support, including robotics and other forms of assistive devices, virtual care, remote patient monitoring, drug development, testing and prescribing just to name a few. These innovations are generating insights that are instantly available to medical providers at the point of care [24, 25].

Many practitioners (83%) experience a steep learning curve in using AI based digital health technologies in care, with most (84%) remaining receptive to its use in clinical practice (84%). At the same time, half of physicians (51%) worry about the longer-term impacts, including job loss, in using these technologies for patient care. Other concerns include: inherent racial and gender bias in AI-based technologies, including clinical decision support [26] that may be "… related to missing data and patients not identified by algorithms, [and by] misclassification, observational error, and misapplication…". Diligent attention must be taken to ensure AI systems are developed and utilized in an equitable manner that does not exacerbate existing healthcare disparities and inequalities.

7. *The Use of Robotics*

"Robotics" represent different kinds of tools that support healthcare delivery:

(a) *Surgical Robots*: Three types of systems are currently in use.
- *Active Systems* that work without human involvement and complete pre-programmed tasks.
- *Semi-Active Systems* that allow both pre-programmed and direct human control
- *Master-Slave Systems* that are controlled entirely by human activity (ie. a surgeon's hand movements transmitted to and reproduced by a robot) [27].

(b) *Socially Assistive Robots (SARs)*: These aid patients through social interaction. SARs can enhance the quality of life for the elderly, for individuals with physical impairments and for rehabilitation therapy for cognitive, developmental and social challenges and to support therapists. SARs:
- Provide education and feedback, coaching patients through tasks, assisting with treatment compliance, and monitoring treatment progress.
- Interact physically (not socially) by moving a user's body through motions [28–32].

(c) *Software Robots ("Bots")*: These are software programs that automate tasks. Conversational agents are frequently implemented[5]
- *Chatbots* can simulate conversations via text, image, or voice. Simple Chatbots are rule based and limited in their range, dependent on predetermined keywords and commands programmed by the developer.
- *Voice Assistants* can interpret speech, respond verbally and take actions (Examples include: Siri, Alexa, Cortana).
- *Simple agents* are increasingly used to execute tasks such as booking appointments, medication reminders, appoint-

[5] What are software Robots, Think Automation, https://www.thinkautomation.com/bots-and-ai/what-are-software-bots/

ment reminders and sharing other health information without human involvement.

- *Smart agents* are enabled by AI/ML and NLP/Natural Language Understanding (NLU) and have the potential to undertake more complex tasks that involve greater interaction, reasoning, prediction, and accuracy including triaging patients, conducting follow up patient evaluations and even sophisticated patient health education [33–35].

In summary, Robots are actively being used in healthcare: to aid surgeons in performing procedures remotely [36–38], to engage patients in health education and to assist them in accomplishing complex tasks, and to automate clerical tasks such as scheduling appointments, reminding patients about appointments and assisting in other patient care tasks.

8. *Evolution of the Internet of Things (IoT)*

The Internet of Things (IoT) is the collection of physical objects, digital tools, devices, platforms and systems, connected by wireless or wired broadband Internet networks to allow bidirectional transfer of data and instructions between components in an active data ecosystem [39], to provide access to data and functionality for coordinated actions at the point of need. The transformative power of the IoT lies not only in the intrinsic capabilities of its components, but also in the integration and coordination of automated activities across a network anytime and anywhere it is needed. Examples include:

(a) Retail pharmacy chains such as Wal-Mart use IoT to monitor and maintain food temperature in refrigeration units and to optimize energy consumption for environmental heating and cooling control during shopping and non-shopping hours
(b) Smart Homes and Smart Communities will use IoT to help improve wellness and optimize human performance in every aspect of life [40]. Smart products like scales, blood pressure cuffs, fitness and sleep monitoring devices in the home will actively integrate to form a "health-aware" ecosystem [41], that will be transparent and "always on" to detect, understand and respond to individual health problems as they happen anywhere the patient is located within the community [42].

22.2 Implications of Digital Transformation in Healthcare

The realities/trends described are already occurring in medical practice, healthcare delivery and in daily life. First, digital health tools are already supporting personalized direct healthcare of individuals with new levels of access to real-time data for ongoing diagnosis and therapy. Second, the organization and delivery of healthcare is changing, out of necessity, bringing it out of the office and hospital to wherever the patient is, whenever the patient needs and wants care.

This new reality raises two questions:

- With better (lower risk and lower cost) care options available to patients, is there any compelling reason for maintaining traditional (high risk and high cost) forms of care and care delivery (ie. Will there be ongoing need for hospitals and inpatient facilities)? The compelling answer is no.
- If there is no reason for maintaining traditional forms of high-cost care (ie. hospitals, as we know them), what WILL healthcare systems of the future look like?

Predicting the future is fraught with challenges, but it is increasingly clear that those hospital systems that will survive will be those that proactively embrace these realities/trends and the opportunities and challenges they present, and that can innovate to provide quality and value of care to patients.

22.3 A Possible Vision of the Future

Possible scenarios for the future organization and delivery of US healthcare have been described [43–47], without a comprehensive vision or consensus that accounts for realities we have described and for the national trends that are shaping healthcare today. These trends include:

- an increasingly aged and diverse national demographic,
- significant and growing shortages maldistribution in healthcare providers,
- a focus on both social and medical/genetic determinants of health,
- the rising costs of care, and
- the possibilities and roles of technology.

We briefly assess future healthcare delivery toward a more comprehensive vision. We do not believe this, nor any other model is perfect, yet it provides a valuable basis for continuing discussion.

22.4 Components and Distribution of a Future Healthcare Delivery System

Figure 22.1 summarizes the major components of this vision. In brief, there will be a continuing contraction in inpatient (hospital) services. This contraction will likely be fatal to many current institutions, resulting in a major restructuring of inpatient care.

1. *(Inpatient Care) Critical Care Remaining in Hospitals: 10–15%*

   Surviving institutions will focus on high acuity, critically ill and medically complex patients who will require procedures and therapies that cannot be provided in a less structured settings, and after all other alternatives have been exhausted. Many conditions that could only be treated in intensive care units previously, are progressively being managed with clinical technology support in ambulatory and home settings. Thus, even hospital-based critical care will decline in demand. Likely, care in remaining facilities will be carried out by physician providers and teams. Unlike today, though, this type of care will likely represent the smallest proportion of care volume nationally, eventually only 10% to 15% of all care.
2. *(Hospital at Home) Inpatient Services at Home 15–25%*

   Due to advances in patient care technologies, more patients will receive care that had traditionally been performed in inpatient settings, in community, ambulatory or home settings (ie. NOT non-inpatient). Advances in broadband enabled health technologies will further contribute to the value and cost effectiveness of this and ambulatory models of care. This trend is already increasing with the advantages and progression of the "Hospital at Home" care model [48–53]. The share of total volume for the Hospital at Home care model may comprise as much as 15% to 25% of the total of all care.
3. *(Smart Care Communities) Geographic Ecosystems of Care 30%*

   Healthcare and technology partnerships, with stakeholders from IBM, Microsoft, Google, Apple, and Amazon, as well as from the automotive [54] and residential [40, 55] industries are exploring opportunities in the health sector. In near future, patient care encounters, delivery and transactions will take place "anytime/anywhere" within Accountable Care Organizations (ACOs), in which virtual healthcare systems/teams (all participants) will be responsible for the care of people living within a geographic region. Such Geographic Ecosystems, as part of Smart Cities and Smart Communities could be optimized for post-acute care and chronic disease self-management at both individual and population levels. Management teams, including patient navigators, community health workers ("promatores") would be overseen by physicians, nurse practitioners and nurses [56–60]. In the more distant future, this regional model of healthcare delivery may account for as much as 30% of total.

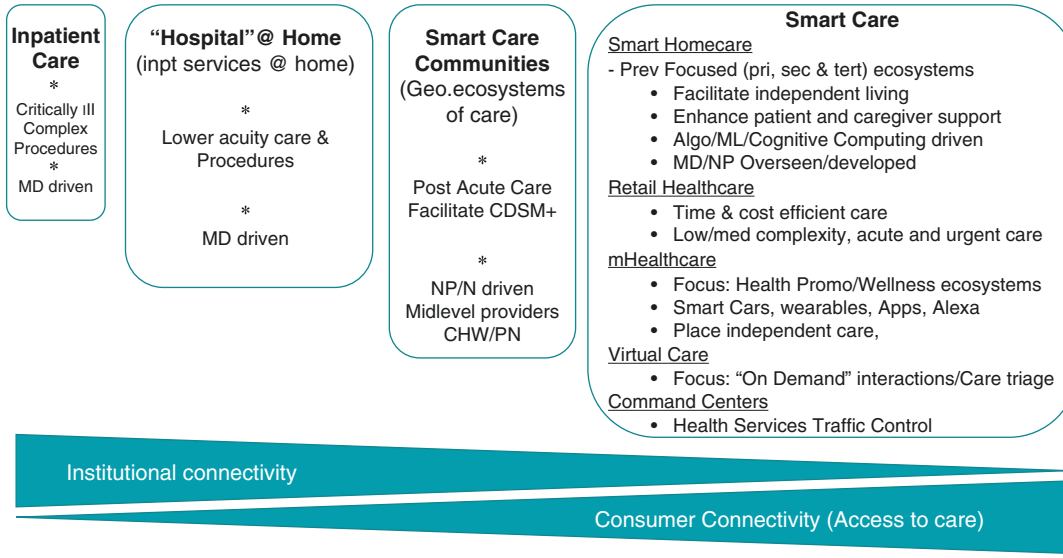

Fig. 22.1 The Future Organization of Healthcare Delivery

4. *Smart Care 40–50%*

   Digital health and consumer health informatics may well become the largest component of such a care delivery model, accounting for 40% to 50% of total care volume. The term "Smart Care" highlights the fact that more sophisticated broadband-connected consumer devices, will autonomously detect, decide, and react to patient needs based on predetermined algorithms. Many solutions will be built into the environment as part of a health-centric IoT, interacting with patients continually and ubiquitously. Smart Care tools and environments have the potential power of passive intervention, with impacts similar to that of water fluoridation, iodination of salt, and airbags. Likewise, Smart Homes and Automobiles could be integral components of a broader consumer health ecosystem that is "always on", following people wherever they are, to help individuals live independently, safely, to focus on wellness and prevention.

   As this model of care delivery grows, there will be need for health technology "air traffic controllers" and "control centers" with key responsibilities for optimizing data and information flows and use of community resources. Some health systems are already thinking about these possibilities and preparing to act. For instance, Mercy Hospital system in Missouri has developed the first operational "Hospital Without Beds" – focusing on optimizing care via technology, at a distance to patients within its network [61].

5. *Broadband: Making it all work together*

   Full-scale broadband connectivity – both institutionally and in the home – is central to this vision of health care delivery. As the two arrows at the bottom of the Fig. 22.1 illustrate, if we focus on only on institutional connectivity, some consumers may have little or no access to services. If, instead, we also prioritize consumer access to Broadband Connectivity, all consumers will have access to at least some forms of effective health care goods and services.

22.5 Two Examples of Ecosystems of Care

We present two hypothetical scenarios that, incorporating some of the ideas discussed, envision how digital and digital health technology advances can change the delivery of healthcare. The elements depicted herein are currently available or projected to be on the market within

1–3 years. No one has, to date, connected these entities and technologies to create working always available systems to deliver the vision of anytime/anywhere care whenever and wherever the patient needs it.

Case Studies: A "The Asthma Home"

John is a seven-year-old boy with moderate chronic asthma requiring the use of a rescue inhaler approximately once per week. His family recently moved to a new Smart Community in the city that has been optimized for families with seniors or children with chronic diseases. John's new home has multiple sensors and technologies built into the home that work automatically and which are "always on". These sensors can detect any number of issues, concerns and medical conditions commonly affecting seniors and children, including asthma. Over time, the Smart Home "learns" the habits and behaviors of each family member and optimizes the care that it provides them. When an issue arises, the home can, in many cases, accurately and automatically determine the existence of a medical problem (such as an exacerbation of asthma) and correctly initiate a course of action that would address the issue.

One night, after bedtime, John begins to have to work harder to breathe. Before he wakes up, the Smart Home detects that this is happening and recognizes it as an early sign of an asthma attack. His parents are asleep in the next room and unaware of his changing condition. Before John fully wakes up, the Smart Home raises the humidity level in his room and releases an appropriate amount of prescribed nebulized medication, into his room where it reaches him. As John breathes the warm, moist, medicated air, his asthma attack is prevented without human intervention, his parents unaware of the incident until they receive a mobile phone alert detailing what happened. His parents quickly go to his room to check on him, and find him sleeping comfortably and soundly in his bed.

Case Studies: B "Auto-Ambulance"

It is 6 pm and Alex, an overweight, 50-year-old business executive is fighting rush hour traffic to get to his 5-year-old daughter's school Christmas program after an intense 12-hour day at work. While driving, Alex begins to experience numbness in his left hand and facial drooping. His Smart Car detects that Alex is now responding inappropriately to road and traffic conditions and that his speech is slurred, making it impossible to understand his verbal commands. The Car immediately switches to autopilot and relays this information, including his vital signs to the Cloud-Based Artificial Intelligence Emergency Analytics & Response System. (CAEARS) which immediately attempts unsuccessfully to make audio contact with Alex. The Car also notes that Alex has suddenly become totally unresponsive determines that this likely represents a medical emergency. CAEARS immediately relays this information, along with an estimated time of arrival (ETA) to the nearest Hospital Emergency Department (ED). CAERS then commands the car to navigate to the Hospital. The Car sends an electronic signal to the Smart Traffic Light grid designating Alex's vehicle as an emergency transport. The Traffic Light grid communicates with Alex's on-board navigation system to provide the most direct route to the Hospital. Alex arrives at the Hospital ED where the waiting medical team is quickly resuscitates him and diagnoses an impending stroke, and is able to administer life-saving treatment by which Alex experiences complete recovery.

22.6 Conclusions

A vision of what healthcare delivery will look like in the future requires changes in definitions:

- Changes in the definition and recognition of what "healthcare" is, to include non-traditional services, some of which may be mediated through technology and that may not involve a human provider, such as patient monitoring and data collection.
- Changes in the definition and recognition of what a "care provider" is, to include formal and informal caregivers, as well as autonomous technologies, providing care and information about patients.
- Changes in the definition and recognition of where "healthcare encounters" occur, outside of hospital, emergency, or clinic settings, to include community, home and other non-office settings, using mobile and online technologies to support on-demand care.

Barriers to changes, largely driven by traditional healthcare payments, are being overcome by ongoing realities and trends, many of which have been driven by the ubiquitous and disruptive opportunities offered by digital, mobile, and broadband technologies. Compelling innovations in service delivery, supported by consumer/patient acceptance and demand, are gaining traction and pushing changes.

Question/Answer

1. What is the major shift in point-of-care in the digital age?
   (a) The shift in care with mobile and cloud-based technologies and services is away from hospitals and more to ambulatory and home-based care, with measurable improvements in outcomes, delivery and patient safety.

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