

Knowledge Technologies Transform Health Care in 2020

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Hi,

I'm Dr. Carpenter. I graduated from medical school in 2000, completed a family medicine residency and have worked for a local advanced primary care 'Health Home' for many years. I watched knowledge technologies evolve from my residency where we did not have an electronic health record to the advanced knowledge technologies we all depend upon today. It took strong government involvement with standards setting, incentives, and penalties to get the health care industry to make the 5 year transition, but eventually providers decided they couldn't live without advanced knowledge technologies. The systems also became net revenue generators by reducing practice costs. Let me illustrate the current state of knowledge technologies through stories of a few of my patients and the practice of health services in our community.

My Oldest Patient

Mrs. Lillie Cartwright is nearing the end of her life at 106, but still lives alone at home after the death of her husband four years ago. Knowledge technologies and assistive devices allow her to manage quite well in spite of her multiple chronic diseases (including progressing Alzheimer's) and physical disabilities, and give peace of mind to her children and myself as her health manager.

A key component of her assistive knowledge technologies suite is SAM her robotic assistant and friend. SAM is agile, has functional arms that can assist in many ways, learns from experience, has voice and haptic interfaces for receiving user commands, and has a user appropriate persuasive, reassuring 'personality.' SAM's 'head' is holographic so it can either be a user preferred humanoid likeness or the image of whoever is telecommunicating through 'him.' When Lillie's daughter Heather virtually visits, she holographically becomes SAM and can direct the robot around the house as she follows her mother and has an ongoing conversation. At the same time she can assess how well Lillie is managing. SAM monitors Lillie's health, reminds her to take her medicines, helps prepare meals, and assists in many other ways. Because SAM is an integral part of the home health knowledge support system, it is instructed both by system protocols and instructions from remote providers to help Lillie manage her health and maintain her independence. SAM is also Lillie's faithful friend as she slowly loses contact with reality.

Most of the time my medical encounters with Lillie are also done virtually through SAM as the ubiquitous biomonitoring devices and her personal health record dash board trends give me the information I need to follow Lillie's health progress. I see Lillie in the office a couple times a year, and she has only been hospitalized once in the past three years.

My Young Millennial Patient

Reggie is only 27 years old but has advanced diabetes, hypertension, hyperlipidemia and cardiac disease as a result of early childhood obesity. He is tech savvy, independent and demanding. He manages his chronic diseases at home and is a pro at navigating his health services in virtual reality to get medications, tests and appointments in ways that are convenient to him, to manage third party reimbursement, and to communicate with his health team anytime, anywhere he chooses. He manages the most sophisticated version of *Google Personal Knowledge Portal* (PKP) – an advanced personal health record – with comprehensive medical information from auto biomonitor capture and detailed entries by Reggie himself. He also demands complete data capture for his PKP from any health provider services.

He was an early adapter of the recently introduced 'Health Advocate Avatar V1.0.' This digital knowledge entity works through a compelling interactive female 'personality' in cyberspace to provide continuous monitoring, coaching, advice and support to serve his unique needs. 'She' learns to help Reggie comply with therapies, reminds him to take medicines, and uses persuasion to encourage healthy behavior. The avatar has access to Reggie's *Google PKP*, knows his needs and preferences, and taps into the accumulated wisdom of available health databases, evidence-based knowledge and consolidated opinions of the world's experts. Although the Avatar has been commercially available for only 3 years, its capabilities are growing rapidly.

Reggie actively participates in the 'Patients Like Me V4.0' diabetes group, not only keeping up with the latest knowledge about management, but also by submitting all his personal data to a large diabetes database supporting clinical research and ascertaining the most effective evidence-based therapies for diabetes and its complications. He participates in the site's virtual support group where those with similar conditions can converse, share information and help each other emotionally. He is also active in the site's diabetes advocacy group that sponsors basic research, clinical trials and a strong lobbying effort that has dramatically changed policies in support of young people with obesity and severe chronic diseases. People like Reggie are a true driving force in the dramatic changes of health reform over the last decade.

The result of Reggie's commitment to a healthy lifestyle and faithfully fulfilling disease management obligations through the assistance of knowledge technologies is that his diabetes, high blood pressure and triglycerides are under excellent control and he is avoiding the serious complications so many with diabetes encounter. Both Reggie and this Health Home team get rewarded for his superb outcomes.

My newest citizen

Maria, a middle aged single mother, has been in America for only 3 years and just became a citizen. She does not speak or understand English well, only received a few years of education, and is overwhelmed by the complexity of American health care. She works hard to support her three children and has few resources. Her recent pregnancy was complicated because of severe asthma.

Maria, doesn't much like technology, but is comfortable with video calls (even if she must ask a question and wait for a detailed answer an hour later) with a nurse health coach who speaks Spanish. She readily accepted the nonintrusive wireless monitoring devices we put in her home and that she wears to continuously monitor her pulmonary status. The home knowledge system automatically captures the data, turns it into knowledge about her health and relays it to the Health Home without her direct involvement. The Health Home knowledge system sends her video health reminders and simple to answer questions let her health team know how she is doing. It also makes Maria feel like someone cares and is watching over her health and that of her children. I see her in person at least quarterly and we manage through a digital interpreter or with virtual help of our Spanish speaking nurse coach.

As we have a monthly global fee for all of Maria's care with a significant bonus for keeping her asthma under control the Health Home has collaborated with community resources to assist in supporting her family in addressing the social determinants of health so important for good outcomes.

My Practice

I work with 20 other professionals in a 'Health Home' practice in my community. We provide continuous comprehensive primary care in a collaborative setting tied together by knowledge technologies. We are dependent on our sophisticated knowledge management system in five key ways:

1. Client Health Knowledge Portals (CHKP) are our advanced electronic health records with customized user dash boards, logical patient data analysis with easy navigation,

and synchronous/asynchronous communications among all professionals managing a customer's care. The CHKP makes it easy to monitor and intervene in maintaining a client's health. As authorized by the customer, data is shared between his PKP and our CHKP.

2. The CHKP assists me in monitoring a customer's health status and identifying any changes needing attention, provides prompts to ensure the customer receives necessary tests and interventions at appropriate times, and provides just-in-time access to the latest evidence-based effective therapies as I prescribe treatment. Now that prospective personal medicine is so complicated the CHKP helps me analyze a customer's genetic and proteomic profiles to select the best personalized therapy for the person's unique disease characteristics and metabolism (pharmacogenomics).
3. The CHKP system is my virtual portal for synchronous (real-time multiway communications) or asynchronous messages back and forth to customers or colleagues in text, auditory, video or full feature virtual world modes. These days about 90% of my customer interactions are by remote communications. I have discovered that virtual relationships can convey human emotions and compassion, even in dealing with tough mental health issues. Office or in-person at home visits are used primarily for initiating a relationship, for those who do not feel comfortable with technology and in those instances where a hands-on examination is needed.
4. The office knowledge ecosystem helps us efficiently manage customer access and flow, while ensuring optimal use of resources and gathering a plethora of data for quality, outcomes and process improvement endeavors. Now that we get a significant part of our revenue in the form of bonuses for documented outcomes, resource effectiveness and continuous improvement this capability is a godsend.
5. Anonymized clinical data from our customers is married with most other health homes in the country in a collaborative best practices data network that provides real-time primary care evidence-base treatment guidelines and country-wide innovative best practices recommendations.

The Health Center

I am involved in a regional high-tech health center for some client care, but usually refer to others in the vertical network for specialty services. There are things that must be done in a

special facility with inpatient capacity, but the number of hospitals has dropped by 25% and only 38% of clients stay more than a day. It is the venue for complex diagnostics and procedures requiring expensive equipment or expertise, severe trauma care, and the management of severely ill individuals needing intensive support. Services such as these need a robust backbone knowledge ecosystem to manage complexity and huge amounts of data.

Global competition on price and quality resulted in successful health centers fundamentally reinventing themselves with lean process engineering over the past decade, and reducing costs by about 50% in the process. This endeavor eliminated waste and redundancies, dramatically improving customer service and permitting successful operations with the elimination of about 40% of staff members who were no longer necessary. These efforts succeeded in part because of ubiquitous monitoring of customers and processes while amassing and assessing massive amounts of data.

The health center of today is an efficient vertically and horizontally integrated system with high capacity and streamlined operations. Smart systems manage emergency department flow, resource utilization and even the ongoing monitoring and adjustments of the physical plant for optimal comfort and efficiency. The knowledge necessary for continuous quality and process improvement is instantly available, and a new staff culture of continuously engineering optimal performance and safety has achieved world-class outcomes. The resultant automatically generated reports are key for receiving incentive bonuses for customer satisfaction, disease outcomes and value that make up about 25% of total revenue.

New imaging technologies and genetic profiling are very data intensive. Robotically guided minimally invasive 'surgery' also requires high bandwidth. The physical facility is very adaptive to client needs and most care is brought to the 'patient,' who stays in the same set of rooms during the stay. Most of the staff and even family member interactions are through holographic visits that are convenient for the client and staff.

Lastly, all the data generated are anonymized and provided to national consortium databases for sophisticated data mining to provide evidence-based best practices and knowledge for national public health surveillance.

Community Public Health

Community and country-wide public health knowledge ecosystems make a big difference in proactively improving the health of my community. The Public Health Department monitors a large amount of anonymized health data on our citizens and the many types of wireless environmental biosensors giving input on air and water quality, toxins and so on. Automatic mining of real-time data can spot a health outbreak or the onset of a national epidemic for rapid intervention. But the biggest challenge is monitoring chronic disease problems and finding ways to modify behavior to reduce the risk. Needless to say, obesity is this community's biggest problem. Anybody can go to the public health web site to see maps and trending along with report cards of what businesses, schools and governmental agencies are doing about obesity with numerical outcomes. There is easy access to advice of proven interventions and information about various community based coaching and intervention services for individuals and institutions. Our Health Home works closely with public health professionals in supporting community efforts and helping particular clients.

As you can see, knowledge technologies have an impact on all aspects of health in my community and have been an important catalyst for changing our minds and practices over the past decade.

Yours truly,

DR. BETH CARPENTER