Chapter 27
Engineering the Next Generation of Health Systems

John S. Silva and Marion J. Ball

"Insanity, doing the same thing and expecting different results"
Albert Einstein

Abstract This chapter focuses on three changes that will dramatically affect the rapidly evolving health ecosystem. It highlights today's high value/high usability computing paradigm, the explosion of information within the Web and the challenges for EHR systems as they try to face the data tsunami. The chapter proposes that a Complex Adaptive System (CAS) framework will be essential for an inclusive health ecosystem that meets the needs of clients, consumers and health workers. The authors suggest that a person-owned wellness-health record (POWR) will be required in the new ecosystem. It postulates that a Smart point of need system for all users should replace the current point of care systems that are limited to healthcare workers. The chapter concludes with a description of a community-based health ecosystem that adopts the behaviors of a CAS, incorporates continuous quality improvement and exploits new technologies to support decision-making for all individuals within the community.

Keywords Complex adaptive system • Health ecosystem • Person owned health/wellness record • Smart point of need support • Continuous quality improvement • Community-based health

J.S. Silva, MD FACMI (✉)
Chief Architect, Silva Consulting Services, 2055 Conan Doyle Way,
Eldersburg, MD 21784, USA
e-mail: Jc-silva-md@att.net

M.J. Ball, Ed.D
Healthcare and Life Sciences Institute, IBM Research, Johns Hopkins University,
5706 Coley Court, Baltimore, MD 21210, USA
e-mail: marionball@us.ibm.com

C.A. Weaver et al. (eds.), *Healthcare Information Management Systems: Cases, Strategies, and Solutions*, Health Informatics,
DOI 10.1007/978-3-319-20765-0_27

27.1 Introduction

This fourth edition of *HIMS* details many of the components of electronic health record (EHR) systems as they exist today, how an EHR and its components might evolve in the near future, and aspects of implementing and sustaining these systems at the local, regional and national levels. This chapter focuses on three changes that will dramatically alter current healthcare systems:

- The explosive move towards a "trillion sensor world… in which you'll be able to know anything you want, anytime, anywhere and query that data for answers and insights" [9]
- The move towards a more holistic, person-owned wellness-health record (POWR) that support the needs of all health workers, clients and consumers and away from today's sick care record systems [the EHRs of today] that support only the needs of healthcare workers, managers and payers
- The move towards vibrant health and wellness in the community and home and away from traditional healthcare in hospitals and other healthcare settings; i.e. towards the national "Triple Aim" of Better Care, Healthy People/Communities and Affordable Care but from individuals and their community [10].

27.2 The Future Is Here

The Internet and World Wide Web (Web) are disruptive technologies that have transformed the way we learn, work, play and even think. These technologies have evolved and expanded very rapidly from the 'read-only' Web 1.0 of the 1990s to the 'connected' Web 2.0 of the early 2000s. Crowdsourcing, social power [20] and user-generated content developed spontaneously and proliferated rapidly within the Web. It is estimated the Web handled 4 Zettabytes of data (4×10^{21}) in 2013 and is doubling every 2 years. By comparison, the healthcare ecosystem generated an estimated 150 Exabytes (1.5×10^{20}) in 2011 [29]. Individual patient home monitoring/rapid diagnostic test data and the Internet of Things (IoT) for health and wellness sensor data [5] will increase the total health data even more dramatically. Beecham Research has provided an early view of the potential transformations that will occur in all industrial sectors [6], Fig. 27.1.

These twenty-first century data sources already exceed the capacity of most systems to gather and analyze it, further exacerbating the ability of EHRs to provide relevant and usable information to health workers and consumers/clients. The next-generation Web 3.0, the Semantic Web, is just beginning to understand, link, and convert the Web's data tsunami into information so that we and technologies can rapidly co-evolve towards not-yet-imagined businesses, practices, and knowledge.

The Internet is a prime example of a complex adaptive system that has transformed nearly every sector of the global economy and introduced "social power" to industry and politics. Complex Adaptive Systems are characterized by a high degree

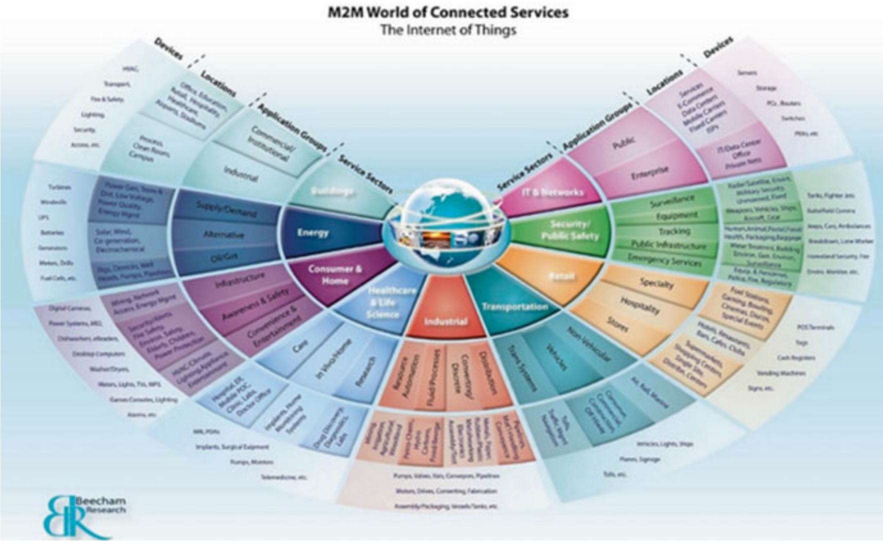

Fig. 27.1 M2M world of connected services (Reproduced with permission of Beecham Research Ltd)

of adaptive capacity, giving them the ability to succeed and flourish in the face of change. They are adaptive, communicative, cooperative, specialized, spatially and temporally organized, and reproduce, often with new parts that are more resilient and effective than earlier ones (Wikipedia, complex adaptive system, accessed 1/12/2015). One clear manifestation of the Web's adaptive behavior is the rapid emergence of cloud computing. These vast grids of always-on computing resources are fundamentally changing how companies purchase IT components and services. In many cases, fairly robust versions of software products are free, like Google Analytics, web conferencing systems, or the phone service Skype. As a result, today's users expect their "point of need" devices to access whatever information they need, wherever and whenever they need it, and conduct **useful** transactions **with no learning curve**; i.e., on Internet Time. For example, it is expected that a person can access their online banking services from their Smartphone or tablet, deposit checks, pay their bills and manage their finances in a completely transparent way, all without taking a single training class or having to change their behavior. This high user value for minimal user cost (high value/high usability) computing paradigm has enabled Smartphone and tablet computing to become the dominant model for user interactions with the Web. In fact, users expect these sorts of experience from their interactions with any IT. The health ecosystem must learn to play by these rules.

Twenty-first century manufacturing approaches have shrunk medical devices and their costs, making them significantly more affordable and pervasive. These devices, which require a fraction of the maintenance, supplies and technical support of their counterparts even a decade ago, are commonly available in doctor's offices.

In the home, a rapidly expanding set of inexpensive sensors of all kinds are monitoring diseases, medications, vital signs, saliva, urine and numerous other signals. Intel, Qualcomm, Freescale and many others have implemented unique solutions to collect and transmit home acquired sensor/diagnostic information to monitoring systems and/or physicians' mobile devices and office systems [31]. In addition to the mostly passive sensor data collection efforts described above, there are a few attempts to combine rapid diagnostic devices and linked Smartphone apps. One company has combined mobile technology, clinical and behavioral science and validated clinical outcomes to bring "mobile integrated therapy" to clients with Type 2 diabetes. They achieved very significant average decrease in A1c of 2 % [35]. These combined approaches start addressing the need for immediacy of actionable health and wellness to their clients. It certainly holds the promise to be an extraordinary game-changer for chronic disease management. In summary, these technologies are ushering in a new age that moves from receiving care in a doctor's office to the customer/client doing care themselves, at home or their workplace [22]. The critical question is: how can the health ecosystem adopt the behaviors of a CAS so as to exploit these new technologies and evolve toward 'health and wellness in the community' approaches that are more resilient and effective than earlier ones that were 'focused on sick care'? A recent National Research Council (NRC) report of a symposium honoring the 200th anniversary of Charles Darwin addressed this issue in the large: "Understanding and managing such complex systems requires ongoing adaptive cooperation and collaboration among disciplines and across jurisdictions, both public and private, as knowledge continues to evolve [26].

27.3 The Path Forward

At the turn of the twenty-first century, the IOM (Institute of Medicine) concluded that healthcare professionals needed to interact effectively with their EHRs to perform their daily tasks. At that time it was assumed that EHRs could effectively and efficiently support the needs of its users [13]. It was assumed that these systems of systems would result in significantly improved outcomes for patients and decreased healthcare costs. While there have been some isolated successes, these goals have not been realized in the large. A recent IOM report summarized it thusly:

> More than a decade since the Institute of Medicine's (IOM's) *To Err Is Human*: *Building a Safer Health System* was published, the U.S. healthcare system continues to fall far short of its potential. Although *To Err Is Human* and other IOM reports, including the *Crossing the Quality Chasm* series, have helped spark numerous efforts to improve practices, persistent health care underperformance and high costs highlight the considerable challenge of bringing isolated successes to scale. The nation has yet to see the broad improvements in safety, accessibility, quality, or efficiency that the American people need and deserve. [16]

A continuous learning systems approach was proposed to address the lack of success [16]. A follow-on IOM workshop on Integrating Research and Practice [17] has elaborated on requirements of a continuous learning system.

> In a continuously learning health system, data from sources such as electronic health record systems used to manage patient care, claims data necessary for billing purposes, and increasingly patient-generated sources of data such as patient portals, surveys, and online communities are used to inform questions of operations, to guide care, to further scientific understanding, and to power innovation. This approach differs from traditional approaches to clinical research, which are often removed from the clinical experience both in terms of the questions asked and the environment in which they are carried out, require large amounts of additional data collection, can take several years to complete, can be very expensive, and are often criticized for producing evidence that is not easily generalizable to broader populations or easily implementable in real-world settings.
>
> By realizing the potential of knowledge generation that is more closely integrated with the practice of care, it should be possible not only to produce more usable evidence to inform decisions, but also to increase the efficiency and decrease the costs of doing clinical research. Delivering on this promise will depend on certain technical capabilities, but, more importantly, **ensuring the sustainability of this approach will require the delivery of value to stakeholders who are engaged in these processes**. [17]

The important elements from the above IOM report drive home: (1) the need to provide relevant information at the points where health decisions are made; (2) the need to make "evidence" relevant to the specific contexts of client/health consumer and health worker; and (3) the need to significantly decrease the latency and costs of generating useful knowledge. The Roundtable on Value & Science-Driven Health Care clearly recognized the intimate relationship between providing value to the users and the sustainability of the infrastructure (bolded text above). These features are very similar to the characteristics of a CAS and the high value/high usability systems described above.

The failure to improve outcomes for patients and decreased healthcare costs may be related to the fact that the interactions between healthcare professionals and their EHRs may not be effective or efficient as previously believed. The authors have reported that the lack of adequate provisioning of healthcare professionals was a principal reason for the very slow adoption of EHRs [4]. The HIMSS EHR Usability Task Force reported that "Electronic medical record adoption rates have been slower than expected in the United States… A key reason is lack of efficiency and usability of EMRs currently available" [11]." A National Academy of Science report was more direct – current EHRs (in 2009) do not support clinical users, are not designed for usability and may even set back the vision of twenty-first century health care [34]. The lack of a usable point of care system for clinicians makes their work harder [4] and may actually introduce errors [3, 8, 36] (Authors note: Chaps. 8 and 9 in this book address these issues in detail.)

Realizing a system that provides utility and usability to clinicians, consumers and administrators is still an unfulfilled vision. Recognizing the importance of the "Cognitive Window" (*vide infra*), the Office of the National Coordinator, HHS, has funded projects that were focused on cognitive support issues. A recent report from one of these projects, SHARPC, detailed a number of features to make a better EHR [37]. However, efforts are focused primarily on users of EHRs and not the broad set of clients, health consumers or health workers outside of traditional health care settings. The authors suggest that failure to address the information needs of all health ecosystem users will not realize Triple Aim vision. We use the term point of need (PON) rather than point of care to emphasize this critical requirement.

In addition to the problems with usability, the lack of data interoperability amongst the myriad of data systems, both within and across health systems, continues to be one of the most vexing problems that negatively impacts usefulness [18, 28]. For clinicians, this lack translates into a less than complete picture of their patients who received health services in multiple settings. For clients and health consumers (aka patients), this necessitates collecting and maintaining copies of records, usually paper, from each health provider. This situation will continue to worsen as health services move more from hospital and clinic settings to community and home settings. Recent efforts by the Office of the National Coordinator (ONC) within the Department of Health and Human Services have focused on improving the interoperability of electronic health record systems and health information exchanges. ONC has released its 10 year vision for an interoperable health system [27]. In addition, the HL7 standards organization has released its Fast Healthcare Interoperability Resources (FHIR) specification to accelerate exchanging healthcare information electronically [12]. Taken together, funding from ONC and support for rapid standards evolution by HL7 will be a key factor in realizing data interoperability. It remains to be seen if and how these national efforts, focused on the current healthcare systems and associated EHRs, will be able to evolve towards the high value/high usability systems that today's users expect.

After all, high value/high usability systems do make it easier for us to accomplish our tasks. Thus, the authors believe that the major objective of health IT should be to subtract work not to add work or make our work harder. Clinicians, clients, consumers and health workers in general want systems that support and enhance their work – in short, that ease it, not complicate it" [4]. The next section describes the conceptual architecture for a Smart PON system that is designed to specifically address value and usability for all clients, consumers and health workers.

27.4 Vision and Value of Smart Point of Need Support System

Imagine a "clients, consumers and health workers support system" that: (1) knows and uses the PON user's context to increase the user's "cognitive window"; (2) supports the coordination and scheduling tasks – based on locally relevant outcomes and measures; (3) is customized based on what information is entered, what the user needs to see, what s/he does and closely replicates the way s/he thinks; (4) moves from device to device – installing automatically on whatever PON device is being used; (5) insulates the user from the quirks of systems, EHRs or person-owned wellness health record systems (POWR) to which the Smart PON sends or receives data; and (6) connects securely to whatever source of information is required by the user [32].

The client, consumer and health worker communities have the same need for relevant information, anywhere, anytime and on any device (Fig. 27.2). The Smart PON must support intelligent provision of data and information from a very diverse set of data sources, including:

- Traditional healthcare sources
- Home, personal and community medical or health sensors
- Rapid diagnostic devices
- Social media conduits, and
- The myriad of wearable/fixed devices via the IoT.

From these sources, it must enable the efficient fusion and analysis of continuously improved clinical, health and wellness practices (*vide infra* for feedback loops) and other relevant information to support a client, consumer or health worker's activities. The Smart PON expands its users' 'cognitive window' where the users will have more time to evaluate the relevant facts and analyses. Under explicit user controls, it purposefully exploits the power of social interactions, crowdsourcing, and collaboration to augment its users' decision-making by reaching out to others in the health ecosystem. The Smart PON produces required documentation and records of acquired data, analyses and decisions as a by-product of its use. It then distributes these user-owned artifacts to POWRs, EHRs and Payors, Public Health, and other entities and individuals, as appropriate. The anticipated result is better decisions across the entire spectrum from persons, healthcare and wellness workers, managers and policy-makers. It becomes an active CAS platform for engagement of individuals into the wellness, health and healthcare ecosystem as it evolves.

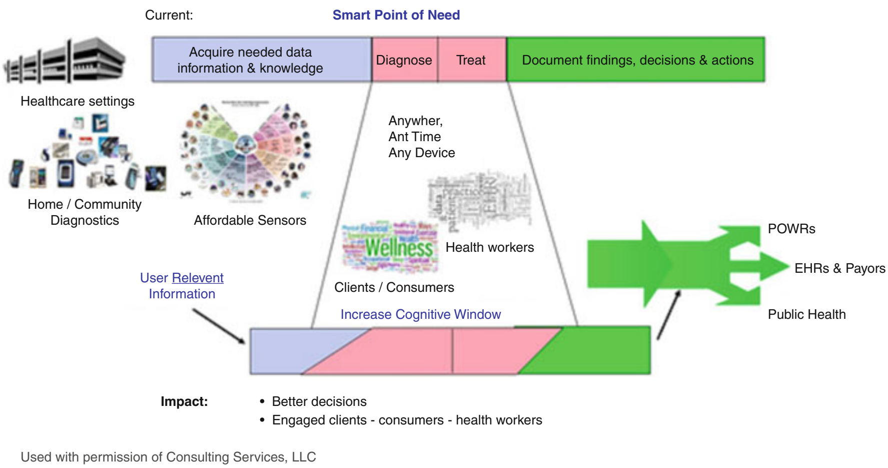

Fig. 27.2 Changing how clients, consumers and health workers work (Used with permission of Silva Consulting Services, LLC)

The Smart PON system described above has other key attributes, namely:

- It anticipates its user's needs – has data/information waiting for users
- It has a minimal learning curve as it continuously adapts to its user
- It hides all the complexity of underlying POWR and EHR systems with simplicity ('magical' IT), and
- It is built to bring immediate value to its user

A conceptual architecture for Smart PON support is shown below in Fig. 27.3 [30]. The three components operate within a services oriented architecture and exchange data within the Smart PON and to external information sources (such as local POWRs and EHRs, health information exchanges (HIE) and knowledge sources) using standardized messages.

The Context/Task Manager (C/TM) is the "heart" of the architecture. It monitors user's activity to determine context, uses models of user's tasks and current/expected context to anticipate activities, tasks and necessary data exchanges with the User Interface Manager (UIM) and the Information Broker (IB) components, and maps user activities and tasks to the most appropriate decision-support and analytic application for a true extensible software-as-a-service framework. The IB component is the data/information cache for its users as well as the connection point to external systems. The set of services required by the IB are available in many commercial HIE or SOA offerings from vendors. Exchanges between the IB and external systems should be mediated by HL7's FHIR [12]. Both the C/TM and IB are modeled from CAS design patterns and attributes. The C/TM and IB have analytic engines that monitor the efficacy and efficiency of user and system tasks versus

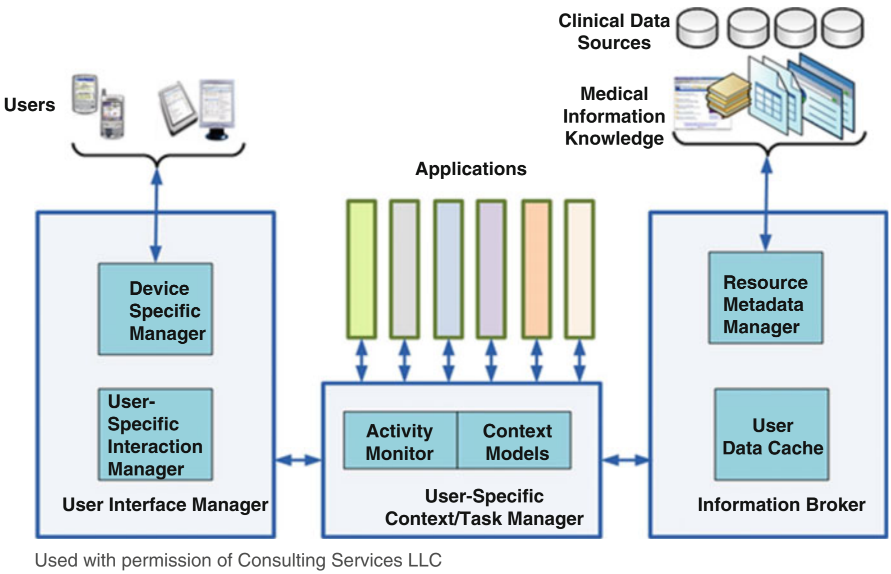

Fig. 27.3 Conceptual architecture of the smart PON environment (Used with permission of Silva Consulting Services, LLC)

outcomes to continuously enhance best practices and system performance by giving feedback directly to its users. The UIM component presents relevant data, information and health, wellness and clinical knowledge to users and gathers data from them. It has presentation strategies to achieve communication goals that depend upon current context, criticality of message and device being used, and adapts to the unique style of the user. It provides a consistent set of metaphors regardless of the user's location.

The Smart PON system is designed to:

- Automatically present relevant data and information via pre-filled "Health/Wellness/Care Widgets"
- Offer "Executable" care/health/wellness plans for its users
- Unobtrusively collect data from users
- Generate relevant POWR and/or EHR documentation as well as charge or billing information as a by-product
- Continuously adapts to the user's and their communities' best practices

The value proposition to users is that they have support system designed for them that implements a systems engineering approach, using CAS design patterns, for the collection, distribution and maintenance of best practices, health/wellness/clinical data and system performance. This context-aware Smart PON uses user-specific and continuously-adapting practice patterns that have the potential to dramatically enhance the quality and efficiency of all health, wellness and healthcare service delivery. The UIM component directly addresses issues of usability via its feedback systems to continuously evolve an efficient and effective interface. The Smart PON is specifically designed to meet requirements of high value/high utility. This approach addresses the very thorny and expensive issue of how to make practice guidelines/best practices relevant to local context and, at the same time, solves the "how can we maintain, sustain and evolve the practices that we have implemented" question [17]. The built-in business intelligence and analytic tools provide users and managers the "What's Been Done" versus "What Should be Done" based on context and outcomes. This near real-time feedback loop simultaneously provides analyses for informed decisions about:

- What is best for me – at the individual (client, consumer or health worker)
- What is best for our community, our state and our nation (population-level)
- Best practices that are adaptive to the unique context of the individual and their location

It is one path towards "realizing the potential of knowledge generation that is more closely integrated with the practice of care" [17].

27.5 A Bottom Up Model for the Health Ecosystem

Our health care system is a very large $2.9+ trillion enterprise with many diverse "business units". Each of these business units are firmly entrenched within the system and has a vested interest in ensuring that its portion of revenue increases or, at worst, does not change. There is significant pressure to keep the status quo and continue to focus on treating disease in patients.

Other industrialized countries have found that delivering a majority of health services through primary care physician practices, and focusing on health by keeping people healthy, work quite well [33]. These systems do not require over 17 % of their GDP as the U. S. healthcare system does. Since wholesale changes to our healthcare system are unlikely, is it possible to use the above principles, dramatic changes in technologies, and social power [20] to lead us to a "health and wellness Spring"? The authors believe we can. We need to use design principles of complex adaptive systems (*vide supra*) to enable an adaptive evolution from today's disparate healthcare systems towards a next-generation health ecosystem that embodies the Triple Aim of Better Care, Healthy People/Communities and Affordable Care [10]. These activities needs to begin at the grass roots, in communities that will partner with its citizens and health and public health workers. The partnership needs to nurture high levels of community and personal well-being via individual citizen participation, social power and transparent, continuous evaluation of the effectiveness, usefulness and efficiency of their entire community's ecosystem.

This evolution is already underway. The Patient-Centered Medical Home (PCMH) model, as defined by the "Joint Principles of the Patient-Centered Medical Home" [1], is a physician-directed practice that provides accessible, continuous, comprehensive and coordinated care that is delivered in the context of family and community [7]. Like systems in many other industrialized countries, the PCMH is based in primary care physician practices and focuses on keeping its participants healthy. The PCMH model has already developed substantial traction in both the private and public sectors, including support from a number of Fortune 100 companies and other organizations to promote and foster its implementation via Patient-Centered Primary Care Collaborative (www.pcpcc.org). The National Committee for Quality Assurance (NCQA) depicts the rapid growth of recognized PCMHs from 2008 when the first PCHM were established to January, 2015, when there were 8,828 – over 10 % of primary care practices in the US [24]. It recently summarized what a PCHM must do to meet receive NCQA recognition:

> …offering access afterhours and online so patients get care where and when they need it. PCMHs get to know patients in long-term partnerships, rather than hurried, sporadic visits. They make treatment decisions together with patients based on individual preferences. They help patients become better engaged in their own healthy behaviors and healthcare. Everyone in the practice – from clinicians to front desk staff – works as a team to coordinate care from other providers and community resources. [24].

Both organizations have recently summarized the success of the PCMH model and noted reductions in costs and in appropriate utilization, improved population health with more frequent use of preventative services, better access to and continuity of primary care, and improved patient and physician satisfaction [24].

In addition to PCMHs, Accountable Care Organizations (ACO) have emerged as key elements of the evolution of the healthcare landscape. The Affordable Care Act of 2010 introduced a series of incentives to pay for value rather than volume and reward organizations for realizing savings while improving quality. Under the Act, ACOs will be responsible for both the quality and cost across the entire spectrum of healthcare services for a defined population. The ACOs are often comprised of many primary care provider, PCMHs, hospitals, specialists and associated services; accountability and risk are shared among all its participants [23]. The Brookings Institute analyzed the results of the initial 2 years of the Pioneer ACO Model. The participating ACOs saved $96 million in the second year, shared savings of $68 million, and improved mean quality scores by 19 % [21].

It is important to note that for both PCMH and ACO's measuring and reporting quality is an essential component, as the Act mandated that HHS and stakeholders formulate a National Quality Strategy for quality improvement [2].

PCMHs and an ACO's primary care providers promote shared decision-making among its staff and the client. In this context, it is envisioned that the client will transition from a passive "patient" that is told what to do to an engaged client that is active in his/her care. There is a strong anticipation that a client's PCMH will be the connection point for all interactions between the client, their health workers and the 'medical neighborhood' [25]. Berenson described the implications of these relationships thusly: "It [a full-featured medical home] requires developing processes and systems (including IT) to support high levels of access for and communications with patients, coordination of patients' care within and outside the practice, capturing and using data for care of patients and populations and evaluation of performance, and support for evidence-based decision-making [7]."

The above discussions represent the traditional view of the healthcare system from those who provide, manage or pay for care; i.e., at the point of care where healthcare workers interact with their "patients". Certainly, many PCMHs and ACOs are moving towards patient engagement as an essential component of their practices. However, clients and health consumers use many other sources of information, including home, personal and community medical or health sensors, rapid diagnostic devices, social media conduits, and the myriad of wearable/fixed devices via the IoT (*vide supra*), hence the authors recommendation that individuals have and maintain their own holistic, person-owned wellness-health record (POWR) that is separate from, but interoperates with EHRs and other health data stores. From an individual's perspective, s/he needs relevant information anytime, anywhere **s/he** makes a decision about their wellness, their health, their prevention, or their social and personal activities; i.e., their point of need. The client's and health consumer's point of need is not limited to visits to a clinic or interactions with a health worker. Rather, their point of need is always with them and always on – wherever they are, whatever they are doing – to support their decisions and behaviors. They are active on Facebook, Twitter, Amazon and other Internet channels where they are able to conduct **useful** transactions **with no learning curve**. Interactions with their health worker or healthcare services are exceptions to their daily life; they seldom use a personal health record (PHR) system, if one is available. PCMHs and ACOs need to rethink the most effective way to provide their clients with access to clinical information and to support understanding the choices for therapeutic and preventative plans. After all, for PCMHs and ACO's to be successful, the client or health consumer must 'live' their specific therapeutic, preventative and/or wellness plans, taking the pills, modifying behaviors and lifestyle, and monitoring their outcomes.

The person-centric nature of these new business practices, POWRs that need be supported, the information exchanges that will be required, and the capabilities to support them are not well understood in the current healthcare system. Most of these capabilities do not exist in current EHR systems. Unfortunately, absent appropriate and useful IT support for these critical components, it is unlikely that PCMH or ACO efforts will achieve the anticipated benefits.

The last section in this chapter describes a possible pilot of a community-based, mesoscale version of a health ecosystem that adopts the behaviors of a CAS and exploits new technologies to support decision-making for all individuals within a community.

27.6 County/Community-Based Pilot Project

Our exemplar County Public Health Department (CPHD) is planning a new initiative they call "County 3.0" that will nurture high levels of community and personal well-being via individual citizen participation and social power. The County Public Health Officer and team decided to focus their efforts on the county's Federally Qualified Health Centers (FQHC). These FQHCs, community clinics and safety net clinics serve citizens of communities within the county who are near or below the poverty line, who have few resources and who have significant barriers to accessing healthcare services. Many must use public transportation to get to the clinic and other necessary health services, such as laboratories or pharmacies. Many are non-English speaking and are often unable to understand instructions in English. And, many have negative perceptions about their healthcare services. A key goal of the project is to improve the performance of the county's FQHCs by maximizing the time a patient is within the clinic – which the team has called the "Golden Hours". The FQHC staff plan to reengineer their workflows to build trust and optimize information about their clients conditions and associated treatments, in a culturally sensitive and effective manner.

A second key goal for the project is to ensure, within the "Golden Hours," that:

- Health workers have sufficient, relevant historical and diagnostic data they need for diagnosis and treatment planning
- Clients participate in decisions and receive all appropriate disease, treatment and medication information and training and any questions are answered
- Clients are interviewed prior to departure from the clinic to ensure that they participated and were successfully informed; and, if there are any identified problems, these are resolved prior to the client leaving the clinic
- Provide each client with their own POWR

Measuring progress and assessing how well the patient response system and reengineered clinic workflows have improved patient outcomes and clinic performance is fundamental to the approach. Results would be fed back frequently to all involved parties for their evaluation; successful ones would be accelerated and the FQHCs would adopt best clinical and management practices while avoiding IT solutions or practices that do not work.

The FQHC team, in collaboration with CPHD's obesity and diabetes awareness programs, has decided to start its efforts on reengineering its workflow for diabetic patients. It plans to provide FQHC staff with a Smart PON system to interface with their existing EHR and to incorporate practice guidelines and the results of rapid diagnostic tests. They intend to use the Smart PON to produce the set of clinical and patient measures they have selected as a by-product of using it for managing visits and interactions with their clients. They will incorporate rapid diagnostic testing, electronic capture of vital signs and a client response system (see Chap. 20 for more details on patient reporting) into the clinic workflow as shown in Fig. 27.4 below.

The team anticipates that the Smart PON system and the IT infrastructure will enable the FQHC to collect appropriate clinical, administrative, and client outcome information as a by-product of providing and orchestrating health services. At a later date, the IT infrastructure and Smart PON will ingest client-selected data from their POWR that has stored data from their home, other sources and self-entered information. As a result, best practices, local clinical guidelines and clinical decisions would be linked directly to patient outcomes. These data, the HIE infrastruc-

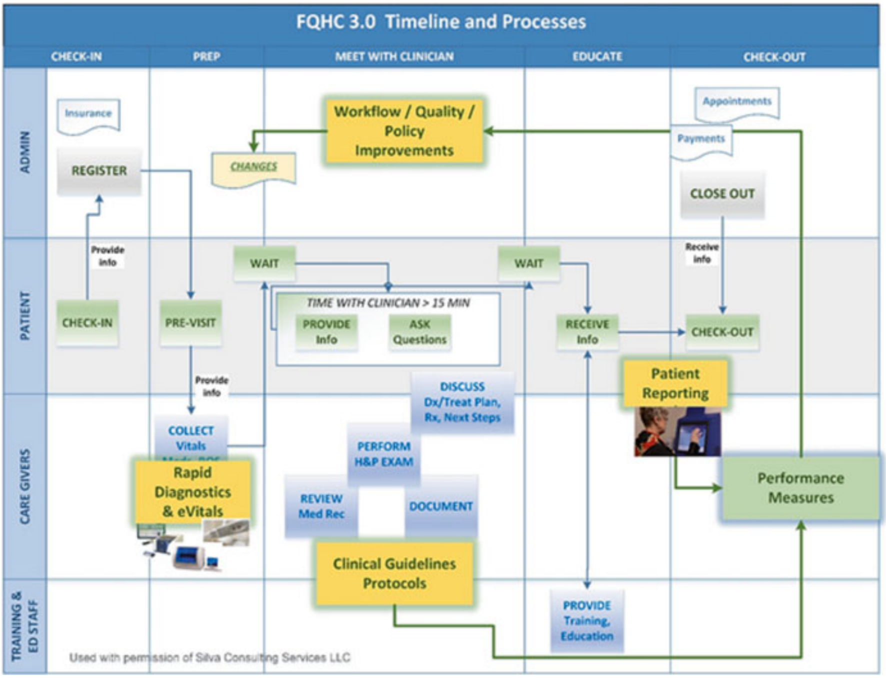

Fig. 27.4 FQHC 3.0 workflow and feedback (Used with permission of Silva Consulting Services, LLC)

ture and associated clinical and business intelligence tools come together as a disruptive technology platform that could revolutionize evaluation processes and research. FQHC and CPHD staff, management and clients will know – what are the best practices, what practices are not effective or not safe and what practices are more expensive without added value, all of which are continuously updated.

This approach seems to be just what the IOM has outlined in its report on comparative effectiveness research (CER):

> "CER is the generation and synthesis of evidence that compares the benefits and harms of alternative methods to prevent, diagnose, treat, and monitor a clinical condition or to improve the delivery of care. The purpose of CER is to assist consumers, clinicians, purchasers, and policy makers to make informed decisions that will improve health care at both the individual and population levels" and that "consumers, patients and caregivers as well as their health care providers must be involved in all aspects of CER to ensure its relevance to everyday health care delivery." [15]

The fully integrated evaluation framework is fundamental to the design of 'the community-based, mesoscale version of a health ecosystem that adopts the behaviors of a CAS and exploits new technologies to support decision-making for all individuals within a community.' That is, the county/community 3.0 system is designed to provide immediate feedback of performance, metrics, KPIs and other analyses, directly and transparently to local participants, clinicians and consumers and to record decisions about what changes need to be made. This information continuously informs decisions by all participants so they can adjust their local practices and behaviors to continuously improve their performance. Absent readily available CER data at the nexus of decision-making, the CER enterprise will not achieve its stated goal of "better decision making by patients and providers" [15].

Lastly, this approach for the county/community 3.0 is designed to address the maintainability and sustainability of guidelines. Guidelines are implemented within the Smart POC system, then continuously adapted, evolved and communicated to the local practice setting by feeding back the county/community outcomes, costs and utilization data and new biomedical knowledge onto the guideline itself. It should be a fascinating story for the science of CER to observe and analyze the time-oriented adaption and evolution of guidelines both within and across communities and special populations. After all, as Sir William Osler stated: "It is much more important to know what sort of patient has a disease than what sort of disease a patient has."

References

1. AAFP, American Academy of Pediatrics, American College of Physicians, and American Osteopathic Association. Joint principles of the patient-centered medical home. Mar 2007. http://www.medicalhomeinfo.org/Joint%20Statement.pdf.
2. AHQR. Accessed January 24, 2015 at http://www.ahrq.gov/workingforquality/agencyplans/ahrq-specific-plan-nqs2014.pdf

3. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. J Am Med Inform Assoc. 2004;11(2):104–12.
4. Ball MJ, Silva JS, Bierstock S. Failure to provide clinicians useful IT systems: opportunities to leapfrog current technologies. Methods Inf Med. 2008;47:4–7.
5. Booker, E. Can IoT slash healthcare costs? 22 Oct 2014. http://www.informationweek.com/healthcare/mobile-and-wireless/can-iot-slash-healthcare-costs/d/d-id/1316841.
6. Beecham Research Ltd. M2M sector map; 2011. http://www.beechamresearch.com/download.aspx?id=18. Accessed 29 Jan 2015.
7. Berenson RA, et al. A house is not a home: keeping patients at the center of practice redesign. Health Aff. 2008;27:1219–30.
8. Campbell EM, Sitting DF, Ash JS, et al. Types of unintended consequences relation to computerized provider order entry. JAMIA. 2006;13(5):547–56.
9. Diamandis P. Singularity hub; 2014. http://singularityhub.com/2014/12/23/know-anything-you-want-anytime-anywhere/.
10. Health and Human Services. National quality strategy; 2014. http://www.ahrq.gov/working-forquality/about.htm#aims. Accessed 8 Jan 2015.
11. HIMSS. Defining and testing EMR usability: principles and proposed methods of EMR usability evaluation and rating. Jun 2009. Available at: http://www.himss.org/content/files/HIMSS_DefiningandTestingEMRUsability.pdf. Accessed 10 Jul 2009.
12. HL7. FHIR, DSTU 1. http://www.hl7.org/implement/standards/fhir/overview.html. Accessed 30 Sep 2014.
13. IOM. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academy Press; 2001.
14. IOM. Knowing what works in healthcare: a roadmap for the nation. Washington, D.C.: National Academy Press; 2008.
15. IOM. Initial national priorities for comparative effectiveness research report brief. Washington, DC: National Academy Press; 2009.
16. IOM. Best care at lower cost: the path to continuously learning health care in America. Washington, DC: The National Academies Press; 2013.
17. IOM. Integrating research and practice: health system leaders working toward high-value care: workshop summary. Washington, DC: The National Academies Press; 2014.
18. JASON. A Robust health data infrastructure; 2013. http://healthit.ahrq.gov/sites/default/files/docs/publication/a-robust-health-data-infrastructure.pdf – 397k. Accessed 17 Apr 2014.
19. Jonsson A. How open source initiative can influence the internet of things; 2014. http://evothings.com/how-open-source-initiatives-can-influence-the-internet-of-things/. Accessed 29 Jan 2015.
20. Kirkpatrick D. Social power and the coming corporate revolution. Forbes, 26 Sep 2011, p. 74–81.
21. Kocot L, White R, Katikaneni P, et al. Blog: a more complete picture of pioneer ACO results. 13 Oct 2014 10:08am. http://www.brookings.edu/blogs/up-front/posts/2014/10/09-pioneer-aco-results-mcclellan. Accessed 30 Jan 2015.
22. Lefrak M. Diagnosing Disease from Home. InnovationHub December 12, 2014, accessed January 12, 2015 at http://blogs.wgbh.org/innovation-hub/2014/12/12/diagnosing-disease-home/>
23. McClellan M, McKethan A, Lewis J, et al. A national strategy to put accountable care into practice. Health Aff. 2010;29:982–90.
24. NCQA. Growth of medical homes. Accessed Jnauary 30, 2015 at http://www.ncqa.org/.
25. Nielsen M, Gibson L, Buelt L, et al. The Patient-Centered Medical Home's Impact on Cost and Quality, Review of Evidence, 2013–2014. Accessed January 13, 2015 at https://www.pcpcc.org/resource/patient-centered-medical-homes-impact-cost-and-quality.
26. NRC. Twenty-first century ecosystems: managing the living world two centuries after Darwin. Washington, DC: The National Academies Press; 2011.

27. ONC/HHS. Connecting health and care for the nation: a 10 year vision to achieve an interoperable health IT infrastructure. n.d. http://www.healthit.gov/sites/default/files/ONC10yearInteroperabilityConceptPaper.pdf.
28. PCAST. Realizing the full potential of health information technology to improve healthcare for all Americans; 2010. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf.
29. Raghupathi W, Raghupathi V. Big data analytics in healthcare: promise and potential. Health Information Science and Systems. 2014;2:3.
30. Silva J, Ball M. Next generation health professional workstations, Yearbook of Med Inform 1994: Advanced Communications in Health Care. Stuttgart: Schattauer; 1994. p. 78–84.
31. Silva JS, Ball MJ. Prognosis for year 2013. Int J Med Inform. 2002;66:45–9.
32. Silva JS, Seybold N, Ball MJ. Creating usable health IT for physicians – the smart point of care system. Healthcare informatics, July 2010. p. 40–3.
33. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. Milbank Q. 2005;83(3):457–502.
34. Stead W, Linn H. Computational technology for effective health care: immediate steps and strategic directions. Washington, DC: National Academies Press; 2009.
35. WellDoc. Accessed January 12, 2015 at http://www.welldoc.com/Clinical-Trials.aspx.
36. Weiner JP, Kfuri T, Chan K, Fowle JB. "e-Iatrogenesis": the most critical unintended consequence of CPOE and other HIT. JAMIA. 2007;14(3):387–8.
37. Zhang J, Walji M, editors. Better EHR. Usability, workflow and cognitive support in electronic health records. 2014. ISBN: 978-0-692-26296-2.