Chapter 6: Personalized Medicine and Public Health

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Abstract—While popular media may suggest that scientific experts are generating new medical breakthroughs by the week, the inescapable truth is that the foundational health in communities is markedly eroding. Illnesses, once seen almost exclusively in old age, are now increasingly occurring in young people. Could it be that traditional, centuries-old medical models and economic systems are keeping people trapped in an underperforming paradigm? Once upon a time, this paradigm may have been the inescapable driver of civilization; and simply lacked the tools to make it perform better. But today, new tools exist, including wireless value exchange systems to create optimal social, scientific, technological, economic and medical paradigms. These tools, incidentally, all share a common element: crowd-sourced, ultra-high yield, high-volume insights that will lay new groundwork for defining what is reachable within free-living systems.

This chapter explains how Wireless Health is poised to overhaul our access to optimal health outcomes and restore mankind’s ability to reach its full health potential.

Learning Objectives—Studying this chapter, the reader will:

• Become familiar with ‘Personalized Medicine’ and ‘Public Health’ as they are currently known and practiced today, as well as appreciate the underlying assumptions that beg reassessment

• Be able to use a basic modern health landscape to help contextualize strategic advances of Personalized Medicine and Public health

• Recognize why we need other people’s data

• Recognize the urgent need to enable cross-generational collaboration models similar to the National Oceanic Atmospheric Administration (NOAA)

• Be able to describe concrete case examples using community data commons (see side bar) as a foundation for monetization alliances and innovative business models;

• See the Open Source culture as a successful leader of the fundamental principles governing rapidly-adjusting complex systems

• Be able to articulate how regulatory agencies such as the FDA will transform from approving static intended-use, to approving dynamic, community co-produced intended-use

• See the obvious benefits of this approach in significantly lowering the barriers to achieving ongoing effective privacy and security practices
• Be able to summarize the key value of Wireless Health in *Personal Medicine* and *Public Health* and offer strategic next steps for stakeholders.

**Sidebar:** the term “data commons” captures the key product of this chapter, however the definition of a “commons” may not be universally known in today’s world. (Having its roots in medieval England may have something to do with its obliqueness, as does America’s hyper-emphasis on both the individual and the bottom line that may limit thinking about freely shared resources.) Wikipedia neatly defines it:

“The commons were traditionally defined as the elements of the environment - forests, atmosphere, rivers, fisheries or grazing land - that are shared, used and enjoyed by all.

“Today, the commons are also understood within a cultural sphere. These commons include literature, music, arts, design, film, video, television, radio, information, software and sites of heritage. The commons can also include public goods such as public space, public education, health and the infrastructure that allows our society to function (such as electricity or water delivery systems). There also exists the ‘life commons’, e.g. the human genome.

“Peter Barnes describes commons as a set of assets that have two characteristics: they are all gifts, and they are all shared. A shared gift is one we receive as members of a community, as opposed to individually. Examples of such gifts include air, water, ecosystems, languages, music, holidays, money, law, mathematics, parks and the Internet.”

“There are a number of important aspects that can be used to describe true commons. The first is that the commons cannot be commodified – if they are, they cease to be commons. The second aspect is that unlike private property, the commons are inclusive rather than exclusive — their nature is to share ownership as widely, rather than as narrowly, as possible. The third aspect is that the assets in commons are meant to be preserved regardless of their return of capital. Just as we receive them as shared gifts, so we have a duty to pass them on to future generations in at least the same condition as we received them. If we can add to their value, so much the better, but at a minimum we must not degrade them, and we certainly have no right to destroy them.

“The Public commons is commonly referred to as a place in our world that has a public good that is free for people to view and enjoy and owned by everyone who wants to be a part of it. Something as simple as water and grass that you see in the park everyday is a public common. Most times people don’t even realize that when they’re in a park that it is free. However usually in these commons it is patrolled by other people in the area and if someone were to violate the commons in anyway by littering or dumping then it would be up to people in the area to control what happens to their own place.”

1 **Introduction and Overview**

The US is about to lose a national treasure. Within a few decades, we will lose the ‘last of the accidentally well’ – a large population that acquired a level of health, fitness and cognitive performance that they did not expressly set about to earn. What they acquired came to them by virtue of the time in which they were born. At that time, parents had no need to understand what refined carbohydrates and trans-fatty acids were, or to worry about their children getting
sufficient levels of activity. High calorie fast food was not yet ubiquitous, and children tended to play outdoors, rather than plunk themselves down in front of TV sets, computer keyboards or game consoles. During the heyday of accidental wellness, prior to the 1980s, type II diabetes was relatively rare in the US population. By 2010 it had risen to more than 8%, and may continue to climb.[6-1] Likewise, US students were once consistently ranked in the top third, globally, in math and science. Now, there is grim evidence that US students are losing significant ground academically.


What does all that mean? It means the fast paced, ever-advancing modernization may inadvertently steer complex biological systems in undesirable directions. The current method of tracking and effectively managing human performance across large diverse complex systems has failed to adjust with the pace of change. Perhaps current business models, some of which are underpinned by the narrow pursuit of profit alone, may be woefully missing the broader societal impact they generate. If society is no longer accidentally well, the traditional ways of gathering and disseminating health, academic and other information may be primed for a serious upgrade to ensure society accurately predicts and prevents impending, but avoidable, population trends. Society is primed to advance beyond the industrial era, through the information era, to embark on a new and prosperous future. Wireless health is a key foundational element of the fabric supporting this future.

This chapter begins by walking the reader through 'personalized medicine' and 'public health' as currently known and practiced. Underlying assumptions are examined and a basic modern health landscape is proposed to help contextualize strategic advances to traditional personalized medicine and public health. With this foundation in place, the chapter goes on to propose a cross-generational collaboration model as a fundamental requirement of sustainable societies. The logical technical framework for this is introduced and illustrated with examples. The merits of this model extend to improving the regulatory responsibilities for groups such as the FDA, as well as reducing privacy and security challenges. The chapter ends with a brief summary and important suggestions regarding the possible next steps for the motivated reader.

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1.1 Personalized Medicine and Public Health as They are Currently Known and Practiced

In 2012, personalized medicine holds the promise to better tailor medical interventions to individual needs as defined by genomic and other types of data. In this way, medical practice goes beyond the days of treating everyone as a population or treating failing organ systems as if they were under identical influences in each patient. This approach takes advantage of predictive models that have grown out of previous health experiences and over time have an improved ability to separate out the prognosis and therapeutic benefit of alternative medical management. The examples cited often include tailored cancer treatment protocols based on genomic-derived predictions of whether or not an individual is more or less likely to respond favorably to a particular therapeutic option. Thus, patients avoid unnecessary exposure to the hazards of harmful agents with little or no therapeutic potential.

In addition, cost savings from avoiding unnecessary treatment can be important. The total global economic burden of cancer is estimated at approximately $900 billion.

http://www.aicr.org/learn-more-about-cancer/infographics-economics.html?gclid=CPPQ8rjR77ECFWk0Qgod3WEA0w

However, there is strong evidence suggesting a large portion of this cancer burden (at least one in three cases) appears preventable (see previous link). More tailored and more effective cancer therapies are likely to have a modest cost saving effect when compared to the real potential of carving $300 billion out of the cancer bill through effective prevention strategies. In short, the overwhelming emphasis on personalized medicine as a route to more precise and thus, more effective health care will do little to advance effective prevention strategies.

Similarly, the traditional population health approach has merit, but is failing to keep up with the modern pace of avoidable adverse community health. Wikipedia expresses it well: “Population health refers to the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals.”

http://en.wikipedia.org/wiki/Public_health

However gallant the traditional approaches to optimizing population health have been, the data suggests continued fail in protecting the health outcomes of groups. There is a struggle to adequately and timely predict gross adjustments in adverse health trends, and incessantly fall desperately short in redirecting adverse health trends while they remain reversible. Around the 1980s, for instance, health experts recommended the US population adopt a ‘low fat’ diet. This was a simplistic notion, well received by the general population. For most, it seemed reasonable to assume that less fat in the diet would result in less fat in the body. A few decades later, it became clear that the US population failed to reap the intended health benefits. Each decade we saw rates of obesity and type II diabetes climb across all states in the US.

http://www.cdc.gov/obesity/data/adult.html

Obesity experts such as David Ludwig, of Boston Children’s Hospital, now suggest that offering no recommendation at all may have resulted in better health outcomes than this well-
intended, ‘low fat’ message. Evidently, people in the US found plenty of high-calorie, low-nutrition substitutes for fat.

Decades later, it became clear that a ‘good fat’ message would have been the preferred approach; but at the time, the US lacked a wireless health ecosystem that would have made rapid access to the relevant evidence feasible. [6-2] Clearly, US obesity maps http://www.ehd.org/health_obesity.php are an ominous reminder of that lack. Communities have enabled passive development of obesity along with the secondary adverse health outcomes such as type II diabetes associated with obesity. The genetically stable population has adjusted the phenotype from low rates of overweight and obesity to more than 67% overweight and obese within four decades. This is cause for alarm. Clearly, traditional public health approaches are struggling to protect public health amidst a growing plethora of poor health choices. It may not be overstating the case to suggest the desperate need of more effective tools in the US.

Today’s concepts of personalized medicine and public health came about before there was Internet to make globally widespread interconnections possible. Previously, mobile communications made it possible for everybody to be in touch – anytime, anywhere. Thus, while some might say medicine has come a long way, others might argue that it is only now, through widespread connectivity and rapid emergence of wireless health, that the US is in a position to harness the full power of personalized medicine and public health.

Purposeful strategies using wireless approaches (such as using wearable sensors) can, and likely will, move people beyond tinkering with the course of disease (and tinkering with costs of care), to dramatically lowering the collective burden of disease among large populations. Discussed later in this chapter are wireless health cancer prevention strategies. These are good examples of how the data from large groups can deliver the scientific truths needed to eliminate unnecessary suffering and shrink the future burden of modifiable poor health outcomes. Wireless health will enable ‘high definition’ living - the ability to see at the pace of change relevant and hopefully correctable co-occurrences that are culminating towards future health experiences. With the robust ability to map event streams to future health outcomes, society will be able to proactively design optimal health journeys.

Until recently, it was assumed that an individual’s genetic disposition was largely responsible for oncological outcomes. The average person believed cancer “fell from the sky” and “afflicted” the unsuspecting victim. Increasingly, studies confirm that unhealthy behaviors may drive the prevalence of many cancers. For example, the cumulative burden of breast cancer in a population appears to be significantly driven by environmental factors.[6-3]-[6-7] Lifestyle choices, such as activity levels and nutrition can either ‘dial up’ or ‘dial down’ the future burden of breast cancer. Communities going about their business of living without the benefits of wireless health approaches may be blindly ‘dialing in’ unnecessarily excessive future rates of heart disease, diabetes, strokes, and many cancers.

The great promise of the innovative approaches by means of wireless health is the possibility to reduce the disease burden within populations, in order to obtain the lowest achievable rates of disease within a free-living system. However, the move from tinkering with disease
outcomes to drastically reducing disease prevalence will require new societal, cultural and economic approaches to personalized both medicine and public health.

In short, the traditional medical model of reactive care is a relic. Transforming the health outcomes of crowds in the modern era of rapid change will require ultra-efficient means of avoiding the avoidable. It will require the task be spread beyond the health experts to the general citizens. Everyone will need to roll up their sleeves and participate in the quest to grasp reachable health outcomes. Wireless health will be the workhorse for teaching and supporting this new skill. Simple distributed sensors, lightly instrumenting the communities, will advance personalized medicine beyond reactive care toward pro-active, preventive personalized health. In this way, Public Health strategies will be able to advance rapidly. With citizens capable of co-locating the things that really matter throughout the decades of their lives, some may advance beyond being accidentally well to achieving levels of “super wellness” and “super cognitive” capacity respectively. Before promising the moon, it will be necessary to lay out a reasonable path towards this future. The rest of this chapter seeks to effectively provide this pathway.

- We are no longer accidentally well...
- Altered living conditions alter gene expression and ultimately, health outcomes
- This is NOT a failure of gene disposition. 3-4 decades is a blink of the eye in terms of evolution and thus, far too short to lay blame on the gene disposition of communities
- Universal response across the globe...not isolated to the US
- No continent has received a new shipment of genes

2 The Modern Health Landscape: Disappearance of The Accidentally Well

The traditional medical model assumed all people were well until diagnosed ill. In other words, individuals were free to exist within their communities, and as long as the basics (clean air, portable water and wholesome food) were available, individuals could expect to achieve their full potential in the form of academic achievement, suitable employment, social position, longevity and so on. Parents were not required to know how much exercise or what types of nutrition their children needed to reach their full potential (e.g. an ‘accidentally well’ society, Fig. 6-1). Those were blissful days of low definition living: no data to track, no devices to wear, and little progress to chart. Going along with that model, the underlying assumption was that everyone got more or less what he or she needed, and that living blindly (without actively gathering data or wearing simple devices) would make little or no difference to outcome of a persons life. It seemed reasonable to assume that the incoming younger generation would access at a minimum the same outcomes. In fact, with modernization, one might assume the younger generation would likely be smarter, stronger and faster than the preceding generation.
Fig. 6-1: A Society No Longer Accidentally Well - Modified from the Economist 2003

The rapid pace of progress and the pure pursuit of profit may actually have made it possible to modernize large nations in such ways that future generations would fair considerably less well across many measures of human performance. Today in fact, modern societies are plagued with increasing levels of poor health that outpace advances in medical technology. The rates of diabetes, obesity, heart disease, stroke and cognitive declines are growing (some even doubling and tripling) within genetically stable populations.

Children are bearing the unintended burden of teaching parents that their generation has been ineffectual at generating and sustaining optimal prosperity for mankind. For centuries, the chronic diseases of aging occurred, by definition, in the aged. Now, many chronic diseases occur prematurely, not by weeks or months, but by decades. Type II diabetes, once called “adult onset diabetes,” increasingly accounts for more than 50% of pediatric diabetes [6-8]-[6-11]

By mapping out the landscape of modern health journeys, effective strategies become more obvious and easier to visualize. This next section walks through a series of graphics designed to help orient the reader to the concepts that underpin new approaches to transforming the health of crowds. Fig. 6-2 proposes the route of an optimal health journey.
Fig. 6-2: Ideal Crowd Health Landscape

- This is the presumed health journey of the accidentally well, an ideal population arriving in good health and remaining in good health throughout the decades of their lives.
- Rapid drop off to death in the end.
- In modern times, persons following the green path are becoming vanishingly few. More common instances can be seen in Fig. 6-3.

Fig. 6-3: An Illness Episode

- In the traditional medical model, if an individual experienced illness, it would be identified; medical care would come to the rescue and rapidly return the individual to good health.
- However, this is not the view of our modern society.
- Very little of medical practice is rescue medicine. The majority of medical work is chronic care management, which is demonstrated by the orange lines in Fig 6-4

Fig. 6-4: Chronic Care Management

The reasons the orange lines start near the bottom third of the page (in Fig. 6-4) is to highlight that this is where we begin documenting the health journey.

- Persons in the top 2/3 of the Fig 6-4, are undocumented, in the dark, living blindly
- Only upon the individual being sufficiently ill to meet diagnostic cut offs, is the health journey (regular office visits, medication refills and so on) effectively tracked
- The domain of claims data are the people in the bottom third of Fig. 6-4. Claims data does not teach us about the preclinical journey (the top 2/3 of the landscape)
- Note the lack of return to good health... most of modern medicine is chronic care and very little of it is rescue medicine
• The reversibility potential is greatest at the top of the page, but the crowd is comfortably blind until there is a hit to the bottom of the page
  o Imagine if Google maps provided the bubble “you are here”, but did not include any of the context around there...how useful would that be?
• Knowing that the green route is “reachable” and what it would take to follow this route is information that would be best available while still in the top 2/3 of the chart (Fig. 6-4)
• If the avoidable cases of breast cancer are avoidable through active lifestyles and good nutrition, it would be prudent to quantify cumulative activity and cumulative exposure to nutrition

In reference to the model in Fig. 6-5, individuals who remain not-yet-chronically-ill, know little to nothing in regards to their current health position and how it will affect their future path. Only upon entering the bottom 2/3 of the page, where turning back is not an option, does it become clear they may be tracking towards routes B, C or D.

**Fig. 6-5: Early Health Journey**

Dropping down from perfect health to illness appears unreasonable. Folks that are 100 pounds overweight did not generate this outcome over a few weeks or months. This took years if not decades to achieve. The relevant health adjustments likely occurred while the individual was still within the ‘normal’ weight category. Likewise, the regulatory elements that drive diabetes, heart disease, stroke, cognitive decline and many common cancers to arrive decades earlier, are likely occurring under the radar for years before the scientific community is able to detect them. In a world that is no longer accidentally well, there is a need to harness the power of large data to define the co-occurrences that combine effectively to create the outcomes people wish to pursue. Life is short. There is too much to figure out. The current methods of seeking out scientific truths are desperately and unacceptably slow. Communities are losing ground. Advancing current approaches by harnessing the power of connecting hundreds of thousands of health experiences is outlined below.

3 Why There Is a Need for Other People’s Data
Imagine Susan completes her annual physical. Her values are ‘normal’. Previously, it was assumed that “normal” was the target. If values are normal, that implied a ‘clean bill of health’, ‘no work to be done’. In such situation, the care provider would probably tell Susan to carry on, check back in a suitable period of time and show up for preventive screening as indicated by age and gender. This approach assumes that the individual is free to carry on as before and their accesses to a full academic, full health future and full general performance would, by default, remain intact. Today, this a flawed assumption and 'normal' must been redefined as simply 'prevalent' and not necessarily optimal or the desired target.

Many contributors to poor health expression have been covered in detail in various articles and documentaries. The 2011 US and EU collaborative technical report, “Nudging lifestyles for better health outcomes: crowdsourced data and persuasive technologies for behavior change” Piniewski et al. EUR 24785 EN – 2011 also does a good job of organizing the evidence base for promoting prevention strategies.

However, preventive health screening practices today do little to prevent the onset of premature adverse health outcomes. For example, the common preventive screening for diabetes and lipid disorders depend upon sufficient prevalence of disease in the population before screening can be justified. As this model is dependent upon prevalence, it acts as a ‘case finding’. Make no mistake, case finding approaches to prevention merely prevent the delayed onset of care and do little to prevent the co-occurrences that enabled the health journey to prematurely arrive at the point of needing care.

The dichotomous approach to evaluating health as a ‘normal’ or ‘not normal’ state is an artifact of grey matter, also known as human intelligence. Mentally managing a lot of moving parts is not easy even for the most gifted people. Thus, even in complex disciplines such as medicine, experts consider remarkably few variables when determining if a prescription is warranted or not. In fact, the medical industry still treats individuals as if they were a population. Eric Topol, M.D., expertly outlines this topic in his recent book, The Creative Destruction of Medicine. While medicine holds onto practices that can be managed by trained individuals, other industries have yielded to and accepted business intelligence and complex computing. Machines capable of managing large volumes of co-occurrence data continuously analyze the data to pullout the inter-dependencies that drive desired outcomes. Transforming the health of crowds through the effective management of pre-clinical health journeys will also depend upon the deliberate processing of data representing alternative pre-clinical health journeys.

Why is there a need to use simple sensors to track passive and often involuntary event streams? Because modern technology is changing the environment in profound ways:

- Nations once flush with activity-based employment must now cope with far-reaching dislocations caused by the shift to knowledge-based employment and the health implications of having employees spend long hours sitting in front of computer screens
- Factory-manufactured food is ubiquitous, cheaper, has a long shelf life and often displaces farm food from many a toddler’s diet, leading to health outcomes related to poor nutrition
• People are bombarded in all media with health information that can be reassuring, alarming and contradictory (e.g. should I drink a glass of wine a day? Is 20 minutes of walking enough daily exercise? Is coffee good for me, or bad for me?)

Make no mistake, such events are life altering. In the US, a group of 300 million or more people is the constant reminder of how modernization carries a disturbing price. At the end of the day, everyone is but a biological agent. The basic expectations of human genetic material – a daily minimum of healthy movement and wholesome, naturally-sourced foods (to name a few) – may be violated by profitable business models. In a world in which society is no longer accidentally well, there is a need to rely on the intelligence gathered by many to deliver scientific truths to guide humans ability to play an active part in their own health futures.

Here is a simple example:

An individual sees her doctor for a regular visit and part of the visit includes laboratory testing. The Low Density Lipoprotein level is 70 mg/dl. Currently, said information tells someone they do not qualify for medication, and provides no other use. It does not tell her an optimal value for her circumstances, or whether this value of 70 means she is on track for a positive or negative health journey. In general, the specific health journey will not be exposed until the individual is well on her way to an irreversible chronic care management event stream. A more useful method of presentation can be seen in Fig. 6-6.

“Normal” means prevalent not “Optimal”

Fig. 6-6: Location on Health Journey

Through the mass sharing of simple lifestyle markers, crowds will be able to define both what is reasonable and what value is optimal at various times for various segments of the community.

Clay Shirky, an NYU professor who studies how communications networks shape culture and vice versa, has begun to define the science of mass participation in such works as Here Comes Everybody and Cognitive Surplus. Fundamentally, Shirky’s work provides clues from non-health-related, crowd-based examples that point to participatory models for total health transformation.

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As highlighted above, the term “normal” is of little value in a world where the majority (66%) is overweight or obese. The traditional medical model looked for prevalence in the community to define “normal”. Clearly, that which is prevalent may have little to do with that which is optimal. Defining “optimal” will depend upon linking clinically relevant, high yield health data across crowds, the workhorse of wireless health. In isolation, personal data alone, especially during periods before overt illness may be of little value. But when this personal data is superimposed on data from large groups whose eventual outcomes have been tracked over time, the individual may be able to see where they are in relation to others tracking with alternative health journeys.

Health is a process. One can spend decades getting the process right and reaping its benefits (better education, mental acuity, employment and physical and mental health), or one can accept the current system as the default and continue to see large portions of communities underperform in many crucial areas of human functioning.

Wireless Health is not about life-logging... but about enabling crowds to proactively co-produce their own health futures.

Modernization has brought container-loads of poor choices, from cheeseburgers dripping with fat, to supersized fast-food meals; from near-quart-sized bottles of soda, to doughnuts so laden with fat and sugar that they might better be called “aortic clamps”. Does that mean humans are going to have to start using sensors and other devices that track their every move and guide them to smart health choices? Let’s hope not, because if wireless health becomes synonymous with ‘life-logging’, most people will opt out.

The medical industry is often plagued by negative assumptions about people making changes:

- Change is too hard for people; they may start to make healthy lifestyle changes but their efforts will never be sustainable
- Privacy is a deal breaker; people will not share their health data
- People are inherently selfish and will not see the value in providing information to help future generations

Assumptions such as these raise unnecessary objections to a truly liberating use of wireless technologies. Wireless health could eliminate repeated mistakes by giving valuable alternatives to ensure individuals remain in charge of their health and performance futures. Increasingly, sustainable societies will require the older generation to pass on high yield health data to the younger generation, to free all future generations from repeating the health-related mistakes of the past.

3.1 What Data are High Yield Data?

High yield health data implies data that most accurately predicts health futures, or accounts for the majority share of health futures for different groups. If the US had a do-over of the last
forty years, using a wireless health infrastructure to both predict and prevent modern day epidemic of obesity, it would be a relatively trivial technological task. A small number of parameters account for the greatest portion of preventable poor health outcomes. Quantifying avoidable or modifiable health may be achieved through tracking a few simple parameters: amount of physical activity, body weight change, and the body’s response to foods ingested. The dramatic shifts in food consumption, from highly nutritional farmed foods to less nutritional factory foods while becoming increasingly sedentary may be tracked through simple home testing of insulin resistance or Triglyceride over High Density lipoprotein ratio (TG/HDL). [6-12]

One cannot undo the past, but one may prevent an even worse obesity epidemic by acting now. It is dire to contemplate the consequences of not acting: In a 2008 paper in the research journal Obesity, Youfa Wang, of the Johns Hopkins Global Center on Childhood Obesity, projects that if the overweight and obesity trends from 1970 to 2004 are projected forward, 86.3% of adults in the US will be overweight or obese by 2030. The title of his paper, “Will All Americans Become Overweight or Obese? Estimating the Progression and Cost of the US Obesity Epidemic”.

Physical health is only one domain of human performance that appears desperately dependent upon optimal living environments. Cognitive performance may also be very dependent upon similar environmental co-occurrences. Think about declining test scores in schools and universities, the usual assumption is that the problems lie in education issues, such as class size or teacher quality. But is that really so?

Imagine a crowd-based wireless health ecosystem in which simple sensors track the activity levels and response to nutritional intake of families. It might turn out that the growing deficit in cognitive capacity might be entirely explained by the dramatic violation of certain basic requirements of the evolving human central nervous system. The human brain is expected to mature into a complex, neuro-circuitry system capable of high-level computational math and science. Maturing brains, like all physical products, likely require basic structural elements, presumably found in food. Historically, since medieval times at least, each subsequent generation appears to have been somewhat stronger, smarter, faster and better able to survive than the generation before.

Although there is little support for the "Aquatic Ape Hypothesis" (that humans primarily evolved alongside lakes, rivers and ocean shores), it is reasonable to assume that early humans stayed close to water and likely included fish and other seafood in their diets. Those foods, along with fresh vegetables, provided the all the complex nutrients needed for human brains to evolve the capacity for complex, abstract thought. Furthermore, the central nervous system is tightly regulated regarding glucose and insulin balance.[6-13]-[6-18] Hence, a lifestyle pattern of little activity coupled with significant refined carbohydrate loads may wreak havoc for a developing nervous system.

Now look at the food tray of a modern toddler. Rather than a tray of fish or vegetables, it is far more likely to be covered with energy-dense, nutrient-poor (EDNP) foods –highly processed carbohydrates in the form of juice, crackers, and cold cereals. http://theweightofthenation.hbo.com/ In this way, important structural elements may be
missing from the toddler’s diet and perhaps responsible for less-than-expected cognitive performance a few years later. Early data from the UK suggests toddlers diets may have irreversible effects on their IQ by the time they reach 10-12 years of age. According to the report, "Young children eating a diet packed with fats, sugar and processed foods consume too few vitamins and nutrients, which means their brains never grow to optimal levels."

(Read more at: [http://www.dailymail.co.uk/health/article-1354683/Junk-food-diet-hits-childs-IQ-reveals-major-UK-study.html#ixzz23FWeBBaS]Ref[3])

It is not far-fetched to conjure a restaurant scene that has a group of well educated, professional parents enjoying Mahi-mahi and arugula, while their kids are in booster seats eating French fries. Expecting the younger generation to develop complex grey matter in their central nervous systems without consuming the right nutrients may be unrealistic. Is it possible that the silent and insidious effects of modernization on nutrition and activity are robbing the younger generation of their full cognitive potential endowed upon them originally by their genes?

Had humans the insight to foresee the hidden challenges of unbridled modernization, the population might be living in a vastly different world. Currently people seem satisfied to wait, passively, for experts to direct their health and nutrition choices. Communities may wrongly assume they can do no harm. This top-down approach does not encourage people to develop the skills to figure out for themselves in a timely manner what the current prevailing poor health pressures are and how best to actively avoid them. Neither does the bottom-up approach, in which people, willy-nilly, try every new health fad, no matter what the source. But the transparent sharing of large numbers of similar health-related experiences could help people develop the skills and knowledge to choose better health outcomes. Some of the major goals of mobile health are to promote active participation in data-gathering, to instill habits of questioning hand-me-down or hand-me-up health information, and to rapidly learn the real, useful health insights that large-scale data sharing makes available.

Legacy data-gathering models, including randomized clinical trials, may be under-performing. Today, the education debate suggests experts might be generating tighter confidence intervals around wrong answers. This type of faulty intelligence was once excusable, only because connecting large numbers of people was not realistically possible. But there is hope. By using simple, wearable sensors and other tools to capture high yield data from the older generation, the younger generation could have the information they need to avoid the faulty assumptions and patchy data that has guided us thus far.
In a Connected world, we are no longer responsible for what is reasonably known, we become responsible for what could have been reasonably known had we collected and organized the data appropriately.

4 The Solution: Cross-Generational Collaboration

What if wireless health was the participatory mechanism by which communities collectively gathered and disseminated health and wellness data that is both highly accurate and locally relevant? Had society or communities started with this vision earlier, they might already be in a position to define basic knowledge such as:

1. How much activity a group ought to accumulate by the time they are 10, 20, 30 years old, to avoid making lifestyle contributions to poor health outcomes such as the early onset of chronic diseases, cognitive difficulties and excessive incidences of largely preventable diseases

2. How much insulin resistance burden has the group accumulated over time and what are the most effective steps to reversing anticipated adverse health effects in the shortest period of time?

The organized collective health experiences of the older generation become an invaluable asset for the younger generation that missed the period of the ‘accidentally well’. Life is too short and too much must be known to expect the young folks might reasonably and efficiently figure out all the mistakes that have already been made. Sustainable societies will depend upon the handing down of this organized data asset. The motivation and the basic operation of accomplishing this cross-generational hand-off will be explained in the following sections. The opportunity takes advantage of two parallel events: seniors needing help using simple devices to manage daily health challenges and young folks needing help with tuition fees.

Because of age-related decline, the older generation is not simply the last of the accidentally well; this generation also houses the bulk of chronic disease management challenges. More than half of those aged 65 or older are at high risk of developing, or are already suffering from, chronic diseases such as diabetes mellitus, cardiovascular disease and arthritis. Data from 2002 confirms that more than half of the Medicare population was treated for five or more chronic conditions.

http://assets.aarp.org/rgcenter/health/fs149_medicare.pdf

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These folks are immigrants to the digital world (digital immigrants), many of whom recall phones with rotary dials that were wired to the wall. They are often not skilled in using simple medical monitoring devices. Figuring out how to turn a device on, how to charge it, how to synchronize and present data can be overwhelming for an older person.

By contrast, modern students have an almost instinctive ability to figure out how to power up any device, sync data and make a variety of user-preference adjustments to the device. These are the digital natives. They share this talent for all things digital with most students across the globe. Another issue common to students almost everywhere is a relentless climbing of the tuition fees they are expected to pay. Furthermore, these large sums of money offer few guarantees that graduates will enjoy lasting value from their educations or enjoy fulfilling employment.

These two parallel events (i.e. older folks who would benefit from devices if they knew how to properly use them and younger folks who have the skills but really need financial help with higher education) open the very real possibility of establishing a strong and effective cross-generational monetization alliance. The skill set most students already have with electronic devices are monetize by rewarding them for helping seniors use the latest mobile health tools and the most suitable applications for self-managing and optimizing health behaviors. Far from being an expensive undertaking, such alliances could be scalable low-cost solutions to the high-cost problems.

In this alliance model, the health care industry remains, as always, the custodian of community illness, while the academic campus becomes custodian of community and human performance.

Such an innovative approach to wireless health can unite the two generations in a value exchange system that enables both generations to protect themselves from preventable, poor-health outcomes. The same wireless health infrastructure can also be used to collect and track other non-health data, such as carbon footprints, exposure to toxins and other human ecosystem concerns. Monetizing this alliance is deliberate. The expressed intent is to direct at least some of the resulting funds towards reducing ever-rising tuition fees.

One early task will be to design and implement a standard technology infrastructure in the form of a Campus-Led Community Data Commons. This form of commons will be the foundation for monetized alliance. Students, professors and the community will be connected with the expressed intent of creating health value. Civic-minded student groups skilled in using social media will actively recruit their grandparents, grandparents’ friends and other senior citizens to engage in innovative ways to optimize their long-term health behaviors. An interoperable system of light instrumentation (low-cost, wearable, easy-to-use sensor devices) will enable the collection of high yield, low risk data to track different standard units of health value. The ease with which this happens will depend, in part, on establishing a practical set of standards to assure the inter-compatibility of data gathering and data transmitting devices, such as blood-pressure cuffs and cell phones.
At the highest level, the cross-generational monetization alliance has three main components:

1. **Open ecosystem platform**: a standard community data commons framework with interoperable low-cost sensors and technical support for student-led solution mash-ups over the course of a few semesters

2. **Rapid prototyping innovation engine**: Multi-disciplinary student teams will design, mash-up and rapidly deploy a series of locally relevant trial solution sets, which will be just as rapidly evaluated in the field. These solutions can target any area the community is interested in and range from the usual apps to increase activity to other specifics such as reducing the amount of soda consumed. This approach favors highly innovative solutions with rapid prototype cycling. This is in contrast to models major health companies still use. A large player may typically spend upwards of $100,000 or more to develop a single app that should be all things for all members. At this level of investment, failure is viewed as unacceptable. Instead of risking failure, the industry tends to play it safe, inventing and re-inventing the wheel – and missing opportunities to truly innovate. The mobile health model will benefit from a steady supply of new options and applications to keep both students and seniors engaged by avoiding boredom.

   Through constant variety, student innovators will also be able to attract not just seniors, but other community and family members to road- and stress-test their solutions. In this model, failure is not frowned upon, but is a necessary ingredient for attaining success quickly. Many proposed solutions, perhaps most, will fail, with only a few having elements of success. But the failures are valuable, because they will generate key learnings that result in sub-optimal solutions being abandoned before they eat up too much time and money. Those with elements of success will be incrementally improved upon as new student teams rotate in every few semesters.

3. **Health Data Transaction Transparency and Informatics Engine**: The donor data transactions can be tracked via a value exchange platform. As transactions grow and data commons’ data volume increases, the health value reaches a point that entices industry to purchase access to the commons. An example already in use is the Targeted Currencies Network, founded by Arthur Brock, which uses a process it calls FlowSpace™ to “…increase the flow of resources within a community. These are specifically designed for each community and their specific problems, as opposed to ‘one size fits all’ solutions.” ([http://www.targetedcurrencies.net/](http://www.targetedcurrencies.net/)).

### 4.1 Technical Framework Overview

Technical Framework - Campus-led crowd based sensor economy solutions are based on an extensible standards-based technical framework for collecting personal connected sensor data and generating evidence-based outcome centric informatics services.
Fig. 6-7: Long-term Architecture

4.2 Design Goals

- **Standards**: Code reuse, simple extension and less development time and costs
- **Extensible**: 3rd party vendor-specific extensions
- **Data portability**: Users and/or caretaker can obtain different informatics services from their single data store that they can collect over time
- **Ease-of-use Spectrum**: Application developers with limited programming skills can build engagement solutions utilizing sensor metrics
- **Data differentiation**: Data from numerous regulated and unregulated sources
- **Provisioning**: Simplify provisioning of sensor devices to particular users and allow applications to use the data from those provisioned devices
- **Normalization**: Applications utilize a single data format for that data which is shared between sensors of different device manufacturers
• **Identity:** Identity of a user is authenticated outside the system allowing solution partners to own the end-user account relationships

• **Authorization:** Access to sensor data shall be authorized by the end-user or their duly appointed caretaker

### 4.3 System Components

• **Gateway:** Provides an easy to setup platform with numerous radio technologies

• **Client:** Implements both sensor and WAN network protocols and data structures. It securely captures data from sensors and reliably delivers this data to the web service

• **Web Service:** Receives and normalizes sensor data from numerous sources. Evaluates trigger conditions in the context of groups and historical data. It multiplexes data to authorized back-end services and end-user applications

• **Universal Pedometer:** User application engine that allows a user to authorize access to their data, provision new sensors and receive offers based on user metrics

### 4.4 Third Party Extension Points

1. A functional API as part of the Client SDK that provides access to current data from sensors and generates alerts when triggers are met. This is used if the SDK is on a mobile phone or tablet or an appliance device.

2. A RESTful network API from Web Service that provides pull and push (alert) access to current, historical data from friends/family/team sensor data and sensor data thresholds.

3. A modular sensor extension mechanism that allows developers to add new sensor support to the Client SDK. They provide a .jar file that meets a specific interface specification. The .jar file basically handles data layer communications with the external (or internal) sensor and converts it into the IEEE 11073-10201 Domain Information Model. The .jar gets loaded onto the SDK and the SDK will support the new sensor. This mechanism can also be used by 3rd parties to create innovative derivation algorithms that take data from one or more sensors and generates new data (e.g. accelerometer to steps, gps to speed, etc).

4. A modular PHR service extension mechanism that allows developers to add new 3rd party web service support to the Web Service. They provide a .jar file that meets a specific interface specification. The .jar basically handles communications with external web service allowing read of sensor data and write of sensor data. The .jar gets loaded onto the Web Service and the 3rd party web service is supported. This is to support web services like QualcommLife 2Net, FitLinxx, BodyMedia, RunKeeper, FitBit, etc.

5. A data extension mechanism allowing 3rd parties to define metric thresholds and actions to take on those thresholds resulting in delivery of virtual or real rewards
6. A data extension mechanism allowing 3rd parties to define metric threshold triggers and audio/visual/textual user interaction allowing the creation of themed games using a game engine pre-built into Universal Pedometer.

7. An Electronic Medical record (EMR) extension mechanism allowing 3rd parties to define protocols and data formats that are non-standard.

In the data commons model, the host organization such as the university, will track data transactions and offer data donors their share of the “money”, as well as the opportunity to “click here” and donate all or part of their share toward reducing tuition fees. Over time, tracking clinically relevant occurrences, such as those that drive the ebb and flow of community insulin resistance, will serve as a standard currency of health value efficiency and allow communities to compare approaches and discover best practices. In this way, each community can benefit from the activities and solutions tried out in other communities. Campuses need not re-invent the wheel if another campus has already demonstrated the clinical utility, or lack thereof, of a particular approach. Hence, an open-source platform will provide continuous outcomes analysis, thereby supporting rapid iterations of improvements. This approach has already been proven to work in the weather reporting industry.

### 4.5 The National Oceanic Atmospheric Administration (NOAA) Model

Most technologists and scientists are familiar with how the NOAA disseminates a valuable substrate of rich weather data, enabling a wide range of industries: weather reporting services, TV channels, economic forecasters and others in order to generate their own business models. The NOAA’s task is simple: drop a few sensors into the environment, collect the rich flow of synchronous data about many different weather and climatic parameters, stream the data into a data commons and thus provide the fuel to power predictive modeling engines and to support a variety of different business models. The NOAA shares its sensor data freely with many users, who comb through the high yield data and compare the weather outcomes of previous parameter co-occurrences, to better predict significant weather events and patterns. In this way, the ability to predict high-risk outcomes such as tornadoes, droughts and mass flooding is improved by all previous events. Old weather provides the insight to predict new weather.

In health, the task of predicting is more challenging. High yield sensor data (activity, sleep, nutrition) are not currently being seamlessly streamed into a community data commons. Nor is there a shared expectation of standard approaches to de-identification and privacy protection for low risk data that can inform people in preparation for sharing higher risk data. However, in the era of wireless health, students can provide the much-needed resource to both start the data flow, and then ensure the flow is sustained. Students everywhere are a uniquely scalable resource, able to handhold the older generation while they gather and transmit low risk, high yield health data. The drive for students to participate goes beyond tuition fee reduction (a later reward perhaps) to more immediate rewards such as gaining a grade advantage or improving their resumes. This is detailed in the following example. The example is hypothetical, but is based on recent early efforts.
5 Case Example: Students Make the NOAA Model Work in Digital Health

Years ago, students used to exit society and enter their institutes of higher learning to be trained, often in a narrow field of expertise, with little guarantee of employment in that field. Learning how to survive or even thrive during periods of unemployment was not part of the curriculum. Cross-disciplinary training may have been minimal.

Now, meet Jack, one of many students at a University. He did not exit society; he brought society into the classroom. He arrived on campus with a crowd in his pocket - a social network on his smart phone. With support from the campus Leadership Institute, he joined a multidisciplinary team to take part in designing a locally relevant solution for a community obesity challenge. He actively expanded his social network to include the young and the old, urban and the rural dwellers, in an effort to secure a grade advantage for his team. They visited local bridge clubs, alumni meetings, and other groups to pitch their project, unite the community against tuition fees and recruit participants. Jack did not ask for dollars. Instead his team asked for data and stated upfront that the data would be housed in a community data commons with the expressed intent of monetizing that common’s help reduce tuition fees. Many seniors were excited to participate and support their local students and university. Most however were unsure of how to use unfamiliar devices so they started with a simple a sleep patch to measure sleep. The students demonstrated the correct use of the patch over and over again without fatigue or frustration. They communicated with their participants through text messages, YouTube video instructions, and face-to-face visits. The students taught each other “best practices” on how to get participants to “get it” or how to “make it stick”.

Students did not send any health instructions to participants at any time. There were no recommendations as to whether the sleep data suggested good or bad sleep patterns. They just sent simple and timely thank-you notes when the data arrived successfully in the data commons, or short nudging requests if the data failed to flow.

Soon, Dan, one of the seniors donating data, had three months of sleep data in the community data commons. His student team was able to show him where it was and where it fell within the entire group of seniors also sharing their sleep data. Right away, Dan became interested in tracking his activity levels, as well. He was suspicious that walking had a strong effect on sleep quality. Dan’s student team was able to “hook him up” with a wireless accelerometer and off he went. In this way, the students not only lifted their collective talents; they also simultaneously lifted the collective talents of the community.

The student teams launched 20 different trial solutions that year and as always at least 18 of them were expected to fail, while just two were likely to “work.” Nevertheless, all 20 had to be deployed to find the two that worked. It is just as important to figure out what does not work as it is, in order to figure out what does.

Over time, the data volume and diversity began to grow substantially (just as with the NOAA). Multiple monetization approaches began to be proposed by the student teams; many that could not have been anticipated at the outset of the community data commons. The three...
stakeholders: students, expert professors and the community, weighed in on authorizing different forms of monetization. Older models, such as having a member of the pharmaceutical industry pay to troll the data commons, were approved early on.

Alternative currencies are not so difficult to grasp. People playing Farmville on Facebook earn alternative currency as they gather food for their farm animals. There are many other examples in online games where points are cashed in for virtual goods. In fact, the virtual goods industry is already a multibillion-dollar industry. In an extreme example, prisoners have been known to actually play games to get “goods” for people on “the outside” who don’t have enough time to devote to gaming, but are willing to pay prisoners to put in the time instead, to advance their positions in virtual gaming environments. In the case of our senior, Dan, he donated sleep and activity to the data commons. As a result, he received an email noting that, because industry purchased a view of the data commons, and his data contribution was a small part of the commons, he was now entitled to a dollar value of $200. The e-message offered Dan an option to “cash out” or, if he felt like it, to “click here to contribute to tuition fees”.

The community culture soon became one in which the generation ahead expected their data to always go to the data commons first, not directly to industry. In this way, the senior was not burdened with the need to assess or navigate the different security and privacy practices of various industries. Dan was free to have a single relationship to navigate. He was confident and trusted the University to uphold his standard social contract regarding privacy and security. Dan was pleased that the students would be siphoning value from his data before others had access to it. He liked the frequent simple communications between his generation and the student’s. He was proud to be connected with the University, although he did not have a chance to study there himself.

Soon the University seemed to be attracting not only the best students but the best researchers, eager to work with the community data commons.

Jack’s team went on to attract some seed funding from industry to advance their solution to the next level. He left campus with more than just a talent for good ideas. His experience with this multidisciplinary project gave his résumé a substantial boost. Clearly, Jack does not simply have bright ideas and a university degree. Through the community data commons project he has also demonstrated his ability to take a bright idea, create a working model or application, deploy it in the community and follow up on the data his idea collected. In addition, his team became proficient at using alternative currencies to track how value is generated. These skills meant they, too, were in a much better position to survive, or even thrive, in almost any economy (See Fig 6-8 for related visual).
This is a modification of the National Oceanic Atmospheric Administration (NOAA) model. The commons depends upon a strong foundation of older folks using simple sensors to capture their “digital debris”. They do this using the social and technical surplus of the young folks constantly helping the older folks with the use of sensors and social networks. Thus the data is proactively enabled to flow up (this is the work to be done: actively capture digital debris and transport it into the cloud). As the commons increases in data volume and diversity the value and crowd-relevant insights inform industry and innovative business models. The value from these is pre-designed to flow “spontaneously” to the data donors and the student custodians in a transparent and relatively effortless manner.

In this way, each out-going generation harbors the final truths and passes the course-correcting insights onto the incoming generation to ensure each generation has full unobstructed access to their full human potential.
6 Open Source Culture: A Sustainable Approach to Supporting Complex Systems

Ensuring optimal performance from highly dynamic, complex systems is not a simple task. Assuming that a group of pre-trained experts will endurably have the skillset to ensure optimal performance over time has become unrealistic. Too many elements are drastically changing at an exceedingly fast pace. Traditional quests to safeguard business models underpinned by intellectual property rights may stagnate the evolution of more and better functioning solutions. With the current pace of change, it is a need to find ways to spread the work-to-be-done beyond narrow expert groups to the wider skill set within the non-expert general community; the deeply entrenched on-the-ground folks.

Large Software systems may teach the common principles for optimizing free-living biological systems. Software evolves as code is updated and functionality is improved and the software takes on “life” of its own. Software of low utility is dropped as users select higher utility and deliberately advance functionality for new use cases. The open source culture demonstrates how a transparent approach to sharing software practices enables problem areas to be identified and corrected accurately, cost-effectively and at the pace of change.

The term "crowdsourcing" was introduced by Jeff Howe in WIRED magazine in 2006 (http://www.wired.com/wired/archive/14.06/crowds.html) and later became the title of a popular book by Howe. The idea of information sharing goes back to ancient times, through maxims such as "Who is wise? He who listens to everyone". But the power of the Internet and collaboration among volunteers to vastly increase the value of information was really revealed by the open source or free software movement.

Many computer programmers have shared their code freely from earliest times, passing it around on tape or whatever other low-cost, portable media were popular. Part of their motivation was simply that selling code was logistically more trouble than the proceeds would be worth: it would require setting up a company, creating a complicated licensing scheme, policing usage and so forth. But more fundamentally, programmers realized that sharing the code was of benefit to them. Those who took the code would submit bug fixes, improve the code and add new features. To this day, most functioning computer systems are mash-ups of different cooperating programs from different developers, often open source.

Proponents of the open source movement include Yochai Benkler, whose book Wealth of Networks is probably the best-known research on the topic, Eric Raymond, who in The Cathedral and the Bazaar wrote many popular aphorisms of the movement, such as "given enough eyeballs, all bugs are shallow," and Eric von Hippel, whose research at MIT showed that even in commercial industry, companies have taken many of their innovations from customers.

Open data is now a rallying cry for advocates of public information and more effective governments, but the lesson of the open source movement is that the mathematics and algorithms used to process data should be open as well. This applies to healthcare because data is inert in itself. Some kind of processing must be applied to extract useful information, and if it takes the form of open source code, many people can check it for accuracy, reuse it,
and upgrade it. It is this continuous activity of sharing and upgrading that drives and defines quality and value over time.

In other words, the community is the purveyor of value. In order to think this way in health one can look at a simple example of a knee replacement operation. The individual undergoes the procedure and then relatively blindly enters the post-op recovery period. Is the patient experiencing optimal or sub-optimal recovery? What is reachable in terms of recovery given the patient’s age, gender, pre-op conditions and so on? Answering the question regarding the quality of the post-op event stream will depend upon many folks sharing their experience in a timely manner such that patches or improvements can be uncovered while there is still enough time to implement them. A good example of open sharing to nudge health event streams in optimal directions is Patientslikeme http://www.patientslikeme.com/. However, this sharing behavior need not be limited to folks with chronic diseases.

Currently in health, there is no way of knowing if a person’s post-op course or health journey is “on track”. Is society reaching what is reasonably ‘reachable’?

Many conventions supporting self-organization developed in the open source and free software movement. Although a key principle is that anyone can offer software code updates (no contribution is too small), members of a team accept the need for a central authority or group of experts to keep malicious or poorly designed changes out. The term "benevolent dictator" often applies to the person or people whose authority to approve code is broadly accepted. Linus Torvalds, who invented Linux, now maintains it in consultation with many advisors. As many elements change rapidly, the work to be done must spread to a wider base of experts.

Innovations in health care are often controversial at first, and an open source attitude toward experimentation seems inconceivably reckless especially in cases where the therapeutic window is narrow. In these cases the cost for error is high. However, lifestyle management recommendations often enjoy a wide therapeutic window such that adjustments in one direction or another is less likely to be dangerous. Evidence-based lifestyle management as learned through an open source attitude towards experimentation might be an ideal way to teach free-living communities the skills they need to protect against evolving threats. In this way the self-organized group becomes the trusted entity. Perhaps the media may suggest a cold cereal has the power to reduce cholesterol. Using an open source attitude armed with wireless health devices enabling home testing of cholesterol levels, the crowd can test this claim themselves. Social networking enables a few hundred friends to unite the quest of testing the “lowers cholesterol” claim. After 6-8 weeks of cereal ingestion and sharing pre and post cholesterol levels, this group can determine if the claim is valid when applied to their free-living community. Of course the validity of group-self-investigation insights will depend upon the number of participants. Simple open-source tools can be built to estimate confidence intervals as a function of the numbers participating.

6.1 Innovative Business Models

Although open source goods are usually distributed over the Internet for no cost, they can be the center of a rich commercial environment.
Linux, for instance, lies at the center of many company offerings. Red Hat, whose offerings are entirely based on Linux and a lot of free software built to work with it, earned nearly three hundred million dollars in one quarter of 2012. Open source data and software are also used to develop non-free offerings. Likewise, the community data commons modeled after the NOAA example can be the basis for a number of innovative business models.

The university case example previously described is not entirely hypothetical. The University of Mississippi launched similar work with their MBA class in the summer of 2010. Seventy-five MBA students with diverse backgrounds split into 8 teams to tackle the obesity challenge in Mississippi. What was remarkable about their work was not only how different the 8 proposals were, but also how much effort and enthusiasm went into their work. Many were disappointed to have simply developed their projects on paper, in the form of power point slides and white papers. Unfortunately, the technology industry in 2010 had not yet matured to the point where it would be relatively easy and affordable for this group of students to mash up a solution and actually deploy it to their community.

The NOAA framework in the above scenario has been introduced to a number of campuses in the US, UK and Europe. The hope is that each university will adopt a minimal technical framework for the data commons, such that the raw data (about sleep, physical activity, diets, medication effects and more) moves relatively freely across campuses. Each campus is then able to build its own intellectual property on that data substrate. Early examples might include the advancing tools to mine ultra large data sets or advancing privacy-preserving layers for networked data, which is beyond the needs for un-networked data. In this way, each campus is expected to use the commons to mature their own unique areas of expertise.

There are at least four key ways of enabling innovative business models:

1. Generating unique campus Intellectual Property (IP) and licensing that to outside parties as the NOAA model
2. Attracting technology industries to fund campus projects to cost effectively test the efficacy of integrated sensor solutions
3. Charging 3rd parties (Pharmaceutical industry, Health care Payers and others) for trolling the data commons for valuable health forecasting
4. Enabling small and medium businesses to launch innovative apps after paying a subscription fee to use the data commons for a much richer data flow

In the leadoff example, Dan could pay for a subscription to a hypertension service or app to help manage his blood pressure. The app, in turn, pays the commons to pull not just his blood pressure, but also his sleep and activity levels, enabling a much richer, more personal “recommendation” engine. In this model, the blood pressure app service provider does not need to have a business relationship with the specific blood pressure cuff that Dan uses. This is a clear benefit, as Dan is likely to go through a number of different blood pressure cuffs during his lifetime. Likewise, the blood pressure app service provider need not have any relationship with the various vendors of sleep and activity monitoring. The data commons, through the use
of standards, takes care of generating and sustaining a rich and usable collection of personally relevant data.

In this way, just as in the NOAA example, value in the form of reliable data volume, is created first; then, after a critical mass of data has accumulated, various business cases are enabled.

Another parallel with the NOAA model is that this commons approach to collocating data is inherently light on assumptions or rules. With weather, people rely on historical data patterns to drive the predictive power of future patterns. As patterns change and new co-occurrences of events are added to the mix (for instance, humans have gone from having just a few markers of weather to over 60 now), one can rely on the past to help make unbiased predictions as to what future weather will look like. As history has taught, one cannot predict now what will be the health challenges of the future. In time, however, a solution will be found in order to solve the problems with poor nutritional value of factory food and deplorable sedentary behavior.

What will follow? Mankind is certain to encounter new pressures that negatively influence their health and prosperity. Clearly, rebuilding a new data architecture for future human challenges might be required if the current one was inappropriately burdened with assumption rich rules that no longer apply in future societies. Thus, to effectively future-proof the data commons, one must resist the urge to insert or apply excessive “intelligence” that may prevent underlying truths from surfacing. Sticking to the simple NOAA model will allow the collection of co-occurrences in increasingly complex combinations, without bias, to ensure that new relationships are forever exposed through large numbers.

Recall that no ability to tinker with the ‘inputs’ of the weather model is in existence. There is no real chance of affecting wind velocity or direction, temperatures, or rainfall. Unlike the weather, communities are free-living biological units. They have the ability to alter inputs and tinker in ways that can alter health outcomes. Tinkering blindly in the past has generated the dismal health profiles seen today. The burden of avoidable health outcomes continues to grow in the US. However, the US is now in a real position to organize the relevant co-occurrences to make health behaviors much more transparent. Only through a clear vision of how current health behaviors are limiting future health outcomes, is it possible to build the skill set to adjust in a timely manner. By sharing across communities, it is possible to collectively define “what is reachable” by any free-living system and thereby provide evidence-based benchmarking to more rapidly achieve what is realistically achievable by the community.

6.2 More is Different...

The constant referral to ‘community and groups’ in this chapter is intentional. Wireless health approaches will be best at predicting group or public health outcomes, and less effective in predicting individual health outcomes. Human knowledge will always be provisional, and one can never know everything about an individual. A person may have a “wild card” that trumps other knowledge known about them -- like the marathon runner who by all accounts appears well until he drops dead of a heart attack. Within large groups however, individual variability is diluted. Placing a bet on whether individual A or B will get breast cancer may be difficult, but when A and B are entire populations and the activity and nutrition characteristics of each are
exposed by simple sensors, placing the right bet (which group will have the most cancers) approaches a sure bet.

Similarly, as the percentage of diabetes rises in a particular group, as in the US population, it quantifies the size of the opportunity for improvement for the group. With heart health, for example, if medical did nothing, developed not one new drug, not one new procedure, but instead shifted collective activity levels in a community such that the average HDL level rose by 10 mg/dl, the rate of future cardiovascular events would drop by 50% [6-19]-[24]. Clearly the power to alter future health outcomes to this degree does not reside within the expert community. This power resides in the free-living community itself. Just as communities can “dial in” excessive poor health outcomes by making poor food and exercise choices, so too can communities “dial in” the lowest possible rates of adverse health outcomes.

Parents may need to go well beyond teaching their children to look both ways before crossing the street. Dangers impairing a young child’s access to the full spectrum of their human potential may lurk in unsuspecting locations. These younger, “no-longer-accidentally well” cohorts will need to actively consider the things that really matter throughout the decades of their lives to ensure they have reasonable access to the health performance, cognitive performance and social performance that was encoded within their genome long ago.

### 6.3 Household Data Trumps Institutional data

If given the chance to do the last few decades over again, the technology requirement would be very small. The previous decade did not achieve 66% overweight or obese because of a profound failure of medical records to connect with each other, nor was it a failure of patient portals, or medication compliance and so on. Most of the current feverish activity in health IT involves complex areas unlikely to affect the onset or progression of population-wide avoidable health outcomes. Data from hospitals and clinics, otherwise known as institutional data, suffers from this problem as well. There is little ability to take institutional data and extrapolate backwards to gain insight into the co-occurrences that drove the premature onset of illness in the first place.

Here, household data accumulated by a simple tracking of activity and response to nutritional intake will generate more reliable predictive capacity regarding future adverse health outcomes.

The World Health Organization (WHO) confirms two simple factors are largely responsible for the recent dramatic shift in phenotype: a profound drop in daily physical activity, along with, as noted previously, a significant switch from farm foods to factory foods. Furthermore, these shifts appear to be consistent regardless of which population on the planet this pattern of modernization reaches.

Said another way, the potent biological mechanism behind the common evolution of premature poor health profiles is the same mechanism whether the group is American, Asian, German, Canadian, Australian, South Asian, Russian, or any other genetic group or mixture. No matter which group one belongs to, smoking, not exercising regularly and eating poorly may ultimately manifest as a blocked coronary artery, gripping chest pain and the beginning of many visits to Emergency.
6.4 What Ails the World Today is Not that which Makes Mankind Different, but that which Makes Us the Same.

Ironically the rampant spread of preventable poor health across the globe has delivered an unthinkable truth, a silver lining. If the same factors generate the same effects on most populations, one should be able to design a universal wireless health solution that optimizes public health everywhere. Furthermore, the widespread commonalities make data tracking on the ebb and flow of lifestyle effects on health relatively easy. It can be done through low-cost, easy-to-use sensors, such as activity trackers, wireless weight scales and simple home biometric-testing devices. In general, these are low-risk data elements and once gathered, in large volume, will give us a robust ability to “stress” the data commons, to determine where “cracks” or data breaches might occur. Such testing will be crucial to reassuring and readying the public to share more sensitive data such as medications, diagnosis and others.

7 Advancing the FDA and Regulatory Framework

The Food and Drug Administration (FDA) has a formidable task. They are expected to separate what might be safe for public use from that which might generate significant risk, before the public has access to it. The public, for their part, must wait, on standby, while this solitary agency figures things out. Even as more and more technology is used to help with health management solutions, the FDA struggles to act, efficiently, in the public’s best interest. How can they assure minimal harm, while avoiding unnecessary delays in making innovative solutions available to the public? With Wireless Health approaches, the campus model can be used to approach the problem with a shared responsibility that will improve how well the FDA functions. It could work as follows:

Historically, the FDA’s task was to approve a chemical agent (a drug) to alleviate some human disease or frailty. Let’s use the example of a drug used to lower glucose in diabetics. Typically, this drug would have been tested in study populations and, if the evidence were sufficient, the drug would be “FDA approved” for this specific purpose.

Now, when a patient takes this drug, the first thing his physiology does is mount a compensatory response. That’s why the size of the beneficial effect – the potency of the drug – tends to decrease over time, leaving no choice but to increase the dose, add other medications or change medications altogether. Contrast the foregoing example with the use of a non-chemical agent, such as software. WellDoc (www.welldoc.com) has developed software that helps diabetic patients track high yield contributors to their blood sugar readings: meal carbohydrates, medications, and exercise to name a few. A new patient with no previous experience with the software would start at zero or no-benefit because they are not familiar with the solution. Over time, the software teaches them to understand which activities and foods have the greatest effect on blood sugar readings. Thus, unlike the declining potency of a chemical agent, a software-based treatment can be expected to have dynamic and increasing potency as the user learns from previous experience. Furthermore, learning can grow exponentially as groups share their experiences through crowd-based collaboration models.
Campus-based Wireless Health approaches can be used in advancing community resilience in the face of future epidemics through the use of community-based wireless health data. Consider the influenza example below:

Periodically, throughout history and into modern times, communities experienced flu epidemics. Large numbers of people become ill and some eventually require extensive medical care. The H1N1 epidemic in 2009-10 was remarkable, as it seemed to be randomly fatal among otherwise young, healthy individuals. As of today there is no test or technology that can help families determine if any of his or her flu-afflicted members are likely to need expert care, or if they are safe to “wait it out” at home.

During the last H1N1 epidemic, too many young people showed up at hospitals and clinics too late for treatment to avert their deaths. There were simply no means for predicting fatal outcomes. This happened despite the fact that the wireless health community was perfectly capable of building a ‘fix.’ The fix would be a small suite of wearable sensors that could notify someone when their symptoms (such as temperature, heart rate and blood oxygenation levels) indicated an urgent need for medical intervention. The trouble with the existing regulatory rules is that there is no reasonable or cost-effective way to “prove” sensor collection would prevent deaths from flu. Beyond the wireless sensors, you also need large volumes of health-data from which to match patterns with outcomes. Only then could you deliver evidence-based recommendations to future users of these technological fixes.

At the outset, the fixes have zero predictive capacity. They are used simply to illuminate and share the pre-clinical courses of many people with flu-like illnesses. In the campus model, the community is already pre-registered with the community data commons and they expect to participate in creating intelligence around health outcomes. They have already been donating sleep data, activity data, physiological data, and more. Students follow-up by sending out messages to confirm each participant’s desire to track the next flu season with new sensors; further instructions are provided regarding their pick up of a 10-pack of sensor patches designed specifically for monitoring the flu. Participating members in the community put on new patches each day to track their heart rates, temperatures and oxygen levels. Local hospitals send admission and outcome data to the commons to match pre-clinical patterns against post-admission results.

As the flu season evolves and eventually peters out, the insights gained through the data commons can be made rapidly available, enabling analysis to identify suspicious patterns of symptoms that may lead to fatalities. Subsequent advances to the patch may be suggested, such as switching out heart rate sensors for ones that measure heart rate variability.

In this way, the pre-clinical course of the community is not lost but purposefully captured, leading to the possibility of incrementally enhanced resilience each flu season. Eventually the patch goes from being a simple gatherer of data, to being a diagnostic tool. At this point, the patch would instruct symptomatic individuals or parents of symptomatic children, when their symptom co-occurrence pattern should be treated with a simple rest at home, or treated with expert medical attention because the risk of deteriorating pulmonary function has been identified.
The cost to run randomized control trials often reaches many thousands of dollars per participant. The flu patch example would not be unreasonably expensive, but it might be operationally infeasible. It is simply unreasonable to expect to be able to register large numbers of participants at the moment they experience the onset of illness. Pre-registration is also not an option, since there is no reasonable way of determining in advance who will get flu.

It is unlikely therefore, given the current regulatory environment, that a flu patch would be approved during this lifetime. By sharing the approval process with the community and using the power of mass participation, important evidence may arise showing that certain combinations of sensors provide reliable differentiations between benign and malignant patterns. Now it can be know who needs to get to a hospital and who can safely remain at home. What’s more, this valuable information can be accumulated in the space of a single flu season. The burden of proof is shared with the FDA and the community for which the technology is intended. Those unlucky enough to suffer the flu will not do so in vain. They will be important change agents helping to educate and better protect others who may become victims during the next epidemic.

There is simply too much to learn to allow old regulatory models to delay the advance of wireless health. The information wireless health provides can incrementally improve knowledge affecting health outcomes. Wireless Health technologies can become an indispensable foundation for the health of future generations.

8 Safety and Security

8.1 The Many Eyes Transparency Model; Supporting Dynamic Privacy and Security

Imagine experts crafted a superb document safeguarding the privacy and security of health data. Now imagine a 65-75 year-old woman at home with diabetes and hypertension. The reality is that no matter how good the rules are, if she doesn’t comprehend who might be looking at her data or how they might be using it, she effectively not able to steward her own privacy or security.

Now imagine this person knowing her data is always going to the campus data commons. In this setting, there are student groups and professors as well as savvy community members with keen and knowledgeable eyes watching whoever is viewing the data and monitoring how it is being used. With many eyes watching as multi-disciplinary/talented stewards, wrongful or malicious use of her data may be far less likely.

This culture is already in place in the open-source software industry. In that culture, people are expected to behave properly and use open source products responsibly. Recently, a large industry player was identified as behaving otherwise. In short order, the open source community became aware and the market adjusted unfavorably for this large player. Thus, it can be increasingly seen that there are other ways to ensure optimal practices, other than legal threats. In this example, no lawsuit was required. The action was corrected promptly and the large industry player expressly hired personnel familiar with open source to help ensure its errors were not repeated. A “data is safe if everything is transparent” model will likely be
sufficient for low risk data such as activity or sleep. However, moving to higher risk data such as medication use and diagnostic labeling will require extra effort such as automated de-identification prior to analysis.

Data donors within the campus model are likely to adopt locally relevant open-source-like cultures regarding the expectations of privacy and security. See Appendix A for a suggested approach to the social contract between participants and the data commons.

8.2 Principles of Reachability Management

Thanks to a plethora of technologies and media, people are more connected now in the first decades of the 21st Century than at any previous time in history. Any given individual may be connected through landlines and cellular phones, through email, text messages and instant messaging, through Skype, Facebook™, twitter™ and numerous other social media. Add lightweight, wearable sensors to the mix, and significant health information about those individuals could also be easily and widely shared to create new insights and drive new economies.

Had such health information been available and reachable during the 1970s (the heyday of accidental wellness), society might now possess a wealth of detailed information. This wealth might have exposed some of the real reasons why the rates of obesity, type II diabetes and breast cancer have doubled or tripled over the last 20 to 30 years.

Still today, many assume the states with the highest rates of obesity are the same states that gained too much weight per capita. In reality, wireless approaches to health intelligence may effectively confirm the key event was in fact losing too much weight. Through centuries of exposure to long periods of extreme hardships in finding enough food, human physiology has generated relatively robust protection against weight loss. This recent phenomenon of excess nutrition, excess may have occurred too rapidly and as a species, humans have yet to develop any effective protective mechanisms against weight gain. Patients commonly complain that they cannot lose weight and the expert community usually assumes noncompliance with recommendations.

Perhaps not all weight loss is created equal. Some weight loss may not be health promoting but in fact profoundly dis-regulatory, setting up the individual for future weight gain. Imagine a motivated woman aggressively restricting calories so that over time her body “learns” to store any available calories in anticipation for the next "life threatening" fasting event. As weight loss is achieved through profound calorie restriction, gene expression may be shifting towards hyper-efficient calorie storage; a storage that will set humans up for future weight gains. Clearly, these physiologically distinct forms of weight should have been distinguished loss by now, because they have plagued communities for decades. However, the annual measure of weight taken in a medical clinic is almost worthless. Without access to accumulated weight loss through a wireless weight scale at home there is no insight into the ebb and flow of weight in response to repeat dieting and extremes of consumption. The path to being a hundred pounds overweight likely started years ago. The individual would likely have been assumed to be risk free, with good weight, good blood pressure, good exercise tolerance... but in reality, the individual is silently on the way to a very different future.
Thus, fundamentally understanding “what is reachable” by a free-living system will depend in large part on the infrastructure as well as the social contract enabling the sharing upon which defining ‘reachability’ depends. For example: What is ‘reachable’ in terms of insulin resistance burden for San Diego, California? What is reasonably reachable in terms of HDL (high density lipoprotein) for this city? How does one arrive at the best group HDL and how much of an effect will this community adjustment have on the future cardiovascular event rates? If a significant portion of the adverse health events on the books of any health delivery system are in fact avoidable...what is reachable in terms of effective avoidance? These and many more questions like these will depend upon the effective sharing of data. The only way a 20 year old knows what is reachable in terms of their HDL is if many 20 year olds share their HDL and informatics experts rack forward to then define optimal HDL for 20 year old males in a given geography.

In short, society has been operating within a framework that provides little to no insight during the crucial time of a person’s health journey, when flexibility and reversibility are maximally available. Society has continued to struggle with legacy approaches to gathering intelligence. Yet these approaches have produced only partial insights after much use of human and cost resources. Now through the connectivity of crowds, more complex questions can be asked, and answers can be proposed at a level of granularity that dwarfs previous approaches, and at a cost of pennies compared to thousands of dollars. See side bar:

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Journal of Medical Internet Research: Jan 2011 Frost et al.

Patient-reported Outcomes as a Source of Evidence in Off-Label Prescribing: Analysis of Data From PatientsLikeMe Off-Label Practice

In this paper over 3,000 patients shared data to provide crowd-based insights for almost zero cost over a remarkably short period of time. Contrast this to the average cost per patient for phase III trials which at the time was estimated to be $26,000!

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http://www.slideshare.net/nrcpara/cdc-obesity-maps

Figure 6-9: The National Health and Nutrition Examination Survey (NHANES) 2007–2008 data for US adults aged 20 and over, suggested an increase in obesity between the late 1980s and
today, with the estimated age-adjusted prevalence moving upward from a previous level of 23% in NHANES III (1988–1994) to approximately 34% in 2007–2008.

http://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.pdf

- Breast cancer 1980’s 1:9 women, 2010 1:3 (tripling or 200% increase)
- Diabetes II 1980 near zero in pediatric population, now DMII is 50% or more of pediatric diabetes
- Diabetes II in 1980 3% and in 2010 8% (almost tripling, 200% increase)

In the recent book by Dr. Eric Topol, M.D., The Creative Destruction of Medicine, Topol describes a super-convergence and maturation of digital technologies, which together hold the promise of transforming medicine. He goes on to confirm that the usual incumbents are not going to be the change agents.

“...it is vital for consumers to be fully engaged. Without the active participation of consumers in this revolution, the process will be inexorably slowed. All the other forces that could come to bear—doctors, the life science industry, government, and health insurers—are incapable of catalyzing this transformation.” Eric Topol, M.D.

Achieving Topol’s transformation will depend upon instilling people with new expectations and giving them new information- and technology-based skills. This chapter provides a logical and practical approach to advancing the collective, non-expert community beyond their current passive, “stand-by” roles. Individuals who were once simply waiting for experts to sort out what they should do, will become pro-active participants in co-generating community health intelligence through cross-generational collaboration that advances us toward the ultimate, full functionality of Wireless Health.

9

Summary

This dramatic transformation towards health in the developed world occurred in such a short time – within one generation’s lifetime. Advancing poor health outcomes was never the intent nor desired by neither the patient nor the medical and scientific community. This transformation lacked deliberate design. If it is possible to create such dramatic shifts in health without intentional design, imagine what might be possible with intentional, data-driven design of our environment.

Clinically relevant co-occurrences of activity levels, diet and other lifestyle effects are now well documented in medical literature to have contributed significantly to widespread shifts in obesity and type II diabetes across the US. Recall that the 1980s versions of activity and nutrition enabled by today’s standards record low rates of diabetes and obesity. These record low rates were “accidentally reachable” by every community. Since that time, unbridled modernization has delivered suboptimal human performance at increasing rates. And that is a fact that ought to be ignored no longer.
It remains important to point out that whatever drove this daunting increase in poor health had little to do with the many areas health IT is currently working feverishly on to deliver. In other words, soaring rates of obesity, diabetes, cognitive decline and many cancers (to mention a few) are not due to a failure to connect medical records, or to medication compliance issues, or to a failure to provide patient health portals on the Internet. Likewise, those soaring rates had nothing to do with visits or otherwise to clinics and hospitals. Staying locked into an obsession of analyzing claims data is a reminder of the lamppost paradox...look under the lamppost for keys not because they were lost there, but because it is where there is light. Going to where data is plentiful, such as in claims, data fails to provide valuable insight into the event stream that generated the claims data in the first place. For this, there is a need to tap into community household data. Before doing so, one must figure out how to operationalize the flow of household data to analytic engines. Low risk requests such as activity and sleep data may be the best way to learn how to accomplish this task. In short, the medical community cannot be directly blamed for recent soaring rates of adverse health outcomes; they are simply the unintended consequences of modernization proceeding without protective oversight.

Since it is clear that the US population is inherently capable of achieving more desired rates of obesity, type II diabetes, cognitive achievement and many cancers, it would be prudent to have the older, accidentally well generation demonstrate how to reach what was clearly reachable for their cohort. This task is urgent. The US is about to lose their accidentally well folks. Without a huge technology ‘ask’, seniors could pass on valuable benchmarking insights using light wearable instrumentation. Much of that instrumentation is already available today. The greater challenge lies in designing the eco-systems that will result in widespread scalable use of sensors couched in supportive regulatory oversight. Other instrumentation has yet to be designed, yet will be, once the creative energies of the university-age generation are unleashed and pointed effectively at the problem. It is urgent to do so while the older generation is still alive. If this is not done, that generation is likely to be the last of the highest achievers in collective health, cognition, and social capital ever to live in the US. If it is done, the US may finally replace accidental wellness with pro-active, intentionally optimized, collective health. Such is the promise of the coming era of wireless health. It is a new era that can not only equal the era of accidental wellness, it can take us to an era of ‘super wellness,’ in which rates obesity and type II diabetes and many cancers are even lower than the historic record lows of the days before the 1980s.

Side bar: How do we achieve the promises of wireless health in reducing breast cancer rates?
Consider a university breast cancer project. By tracking accumulated activity (in steps per day) and tracking cancer outcomes, the women of this community will learn over time how many steps they must collectively generate to correlate with the lowest possible breast cancer rate. By comparing with other cities through the community data commons, residents can also gain insights into the per capita frequency of farmer’s markets and other healthy lifestyle elements that collectively keep health outcomes optimized. Getting the basics right (shifting communities to optimal activity levels and so on) most of the time will have the greatest health yield across the free-living system. Complex correlations and splitting hairs between the multitude of minor contributors is likely to generate much smaller gains.
The role of students in this would be to mash up simple, low cost, solutions to provide a multitude of different user scenarios. Those would help quickly show what types of activities and data work well for this study, weeding out those that may not work well, or at all, for specific groups. This way, students become a priceless asset – an innovation engine, capable of launching 20 or more health-related solutions each semester.

9.1 Next Steps for Students, Administrators, Governments, Industry and Others

Work must begin towards freer, more open communications between governments, educational institutions, health care institutions, students, ordinary citizens, entrepreneurs, technology incubators and commercialization centers, wireless carriers and other technology companies (large and small). Gone are the days when communities are expected to wait passively, “on standby” while the institutes of higher learning and the scientific experts sort out what they should know and do. This approach is unacceptable. Society can no longer tolerate the snail pace of new insights given the current ability to re-invent environments. Modern man’s ability to shift widespread co-occurrences is guaranteed to out-pace the inherent physiological ability to adapt. The citizenry must be able to roll up their sleeves and contribute effectively to pro-actively co-produce the optimal health outcomes they seek.

Governments need to re-look at their regulatory functions, giving people a more free hand to use wearable devices to collect and use data within a set of interconnected data commons. Because this type of ‘deregulation’ will be overseen by thousands of multidisciplinary eyes, the new, freer processes for collecting and co-locating health data are unlikely to be abused, co-opted for selfish reasons, or derailed by incautious participants. It may also prove much easier to integrate the collection of useful health information into the fabric of society.

The technology industry has seen a rapid increase in the numbers of incubators for start-ups in digital health. Rock Health in San Francisco, HealthBox in Chicago, Sanotron in Canada and BluePrint Health in New York City are just four incubators with ambitious plans for nurturing start ups and enabling them to bring their innovative ideas and products to market.

Digital health innovation is the key to solving the health industry’s main challenges of cost reduction, improved quality of healthcare delivery, increased revenues and sustainability. Because digital health is still a new industry, which some observers feel is about to undergo explosive growth, demand for incubators is high. In fact, incubators are perceived by the private and public sectors as one of the most important drivers of innovation and economic development. Students of digital health are encouraged to take a closer look at how the incubators do what they do.

Modern campuses will see the benefit of this approach and early adopters are likely to reap the greatest benefit. These campuses will prepare themselves to become more accountable to both heir students and social communities. Students will no longer passively hand over tuition fees in exchange for knowledge and opportunity. The general community will not be waiting patiently (and passively) for institutes of higher learning to endow them with better lives. As a matter of course, the value generated by this modern campus model will be evaluated.
regularly, and one may discover that high value campuses may not be the same as the traditional big name campuses. Campuses with the greatest community connectivity, the most social capital and dynamic social contracts supporting evolving security and privacy will likely be in high demand. These will succeed in attracting the most data from local and remote participants, respectively. Such modern campuses may also be the ones attracting the best students, the best researchers, the most industry funding and more. Because of data donation tracking systems, these modern campuses are also destined to become the least expensive – possibly free. Deliberate design enabling maximal transparency to all stakeholders will underpin a value exchange distribution model. In this model, the data donor is the data owner and the monetization value goes first to the donor and then directly to tuition fees.

Enabling students to harness the ‘hand–off’ of high yield information from the older generation will be a fundamental element of sustainable societies. Capturing and documenting “what is reachable” will be an enduring requirement. The only constant in a free-living system is CHANGE.

“In a time of drastic change it is the learners who inherit the future...while the learned find themselves beautifully equipped to live in a world that no longer exists.” Eric Hoffer
Appendix A

DATA BILL OF RIGHTS

The experience of the younger generation is in large measure forged by the contributions of the older generations. Core to such contributions is the older generation being enabled to provide enhancement of life, liberty, and pursuit of happiness to the both their own generation as well as the younger generation.

Every person has the inalienable right to have and share health data based on the following principles:

I. My health data is my valuable property.

II. I have right to commensurate value if I lend my data to a third party.

III. If such data is lost or misused by a third party, I should be offered reasonable compensation.

IV. We espouse the Declaration of Health Data Rights that reads as follows:

a. In an era when technology allows personal health information to be more easily stored, updated, accessed and exchanged, the following rights should be self-evident and inalienable. We the people:

i. Have the right to our own health data

ii. Have the right to know the source of each health data element

iii. Have the right to take possession of a complete copy of our individual health data, without delay, at minimal or no cost; If data exist in any form, they must be also made available in that form.

iv. Have the right to share our health data with others as we see fit

b. These principles express basic human rights as well as essential elements of a health care that is participatory, appropriate, and in the interests of each person. No law or policy should abridge these rights.

We further espouse the Consumer Privacy Bill of Rights as recently promulgated by the White House [http://money.cnn.com/2012/02/22/technology/bill_of_rights_privacy/index.htm](http://money.cnn.com/2012/02/22/technology/bill_of_rights_privacy/index.htm)

The following schematic shows the relationships of each of the four parties whom this Bill of Rights affects: Student, University, Industry, Community.
The following conditions shall apply to the relationship of the four parties.

**NO MEDICAL ADVICE**

If you have a medical question, you should contact your physician. If you think you have a medical emergency, call 911 (or the equivalent country emergency number if outside the USA) or your physician immediately. The Data Bill of Rights was not intended to replace your physician for medical advice, nor is it intended to address medical emergencies. Always seek the advice of Your physician or other qualified healthcare provider for answers to any questions You may have regarding a medical condition requiring prescription medication. Neither the Content nor any other service offered is intended to be relied upon for medical diagnosis or treatment. Never disregard medical advice or delay in seeking it because of something You have read on the website.

**AGE REQUIREMENTS**

You must be at least 18 years of age to participate.

**USER IDS AND PASSWORDS**

Access may be limited by a user identifier ("User ID") and password, which are selected and/or supplied as part of registering for a service account. By registering, You represent, warrant and covenant that: (i) You are at least 18 years of age; (ii) You are using Your actual identity; (iii) You have provided only true, accurate, current and complete information about Yourself during the registration process; and (iv) You will maintain and promptly update the information that You provide to keep it true, accurate, current and complete.

**PRIVACY POLICY**

We recognize the importance of protecting the privacy of visitors to the website. Please click here to view the Privacy Statement.
ACCEPTABLE USE POLICY

This Acceptable Use Policy (the “AUP”), including the following list of Prohibited Activities, is an integral part of these Terms and Conditions. This AUP is designed to help protect users and the community in general from irresponsible and/or illegal activities.

Prohibited Activities include the following:

1. Sending Unsolicited Bulk Email (“UBE” or “spam”). The sending of any form of UBE through the website systems is prohibited. Likewise, the sending of UBE from another service provider advertising a website, landing page, email address or utilizing any of the website’s resources, is prohibited. The website’s accounts or services may not be used to solicit customers from, or collect replies to messages sent from, another Internet Service Provider where those messages violate this AUP or the AUP of another Internet Service Provider.

2. Running Unconfirmed Mailing Lists. Subscribing email addresses to any mailing list without the express and verifiable permission of the email address owner is prohibited. All mailing lists run by the website’s customers must be Closed-loop (“Confirmed Opt-in”). The subscription confirmation message received from each address owner must be kept on file for the duration of the existence of the mailing list. Advertising, transmitting, or otherwise making available any software, program, product, or service that is designed to violate this AUP or the AUP of any other Internet Service Provider. This prohibition, includes, but is not limited to, the facilitation of the means to send UBE, initiation of pinging, flooding, mail-bombing and denial of service attacks.

3. Operating an account on behalf of, or in connection with, or reselling a service to persons or firms listed in the Spamhaus Register of Known Spam Operations (ROKSO) database at www.spamhaus.org or accessing networks that appear on commonly used blacklisted networks including, but not limited to, Don't Route or Peer ("DROP") list at www.spamhaus.org. Simply Smarter Rx reserves the right to restrict or deny access to all such networks.

4. Unauthorized attempts by a user to gain access to any account or computer resource not belonging to that user (e.g., "hacking" and/or "cracking" and/or “password mining”).

5. Obtaining or attempting to obtain service by any means or device with the intent to avoid or reduce payment.

6. Unauthorized access, alteration, destruction, or any attempt thereof, of any information of any of the website members and users by any means or device.

7. Knowingly engaging in any activities designed to harass, harm, overburden or cause damage to the system, any content included on the website or a third-party, including, but not limited to, denial-of-service (e.g., synchronized number sequence) attacks.
directed at any other user, whether on the website network or on another provider's network.

8. Using the website's Services to interfere with the use of the website's network by other customers or authorized users.

9. Engaging your account or service for any other illegal or harmful activity including but not limited to child pornography or terrorism.
References


