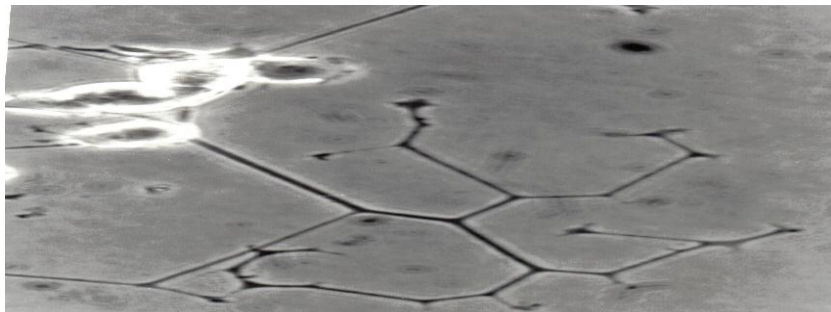


# Future of Health Technology Journal™

Produced by the Future of Health Technology Institute  
*Happier, Longer Lives™* - [www.fhti.org](http://www.fhti.org)



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**The Future of Health Technology Journal™** is an interdisciplinary renaissance-like publication that reveals and debates ideas about cutting-edge medical technologies, methodologies and products to make lives happier and longer in a way that fosters creativity, innovation and personal growth.

Each issue consists of Inspiration, Incubation and Insight segments (*FHTI's 3I™ Method*). "Inspiration" segment covers selected health technology strategies, discoveries, and products; Incubation segment features innovation tools and entertainment (e.g. art, music, nutrition). "Insight" section covers future research ideas and strategic direction: unsolved problems, unanswered questions and uncovered territories.

You are invited to contribute if you want to present your vision of the future, reveal new strategies, and showcase health, wellness, fitness and innovation technologies, methodologies and products to make lives happier and longer. Please send proposals to [Bushko@fhti.org](mailto:Bushko@fhti.org).

***About The Future of Health Technology Institute - Happier, Longer Lives™***

*The Future of Health Technology Institute in Hopkinton, Mass., is the health technology think tank dedicated to defining the health technology agenda for the 21st century. The institute was established to identify the most promising technologies to improve the quality of health care and to define promising health technology research areas needed to meet future health challenges. Renata Bushko ([Bushko@fhti.org](mailto:Bushko@fhti.org)) has chaired annual Future of Health Technology summits since founding the institute in 1996. These summits engage creative minds from the technology and healthcare fields in envisioning the future of technology for healthier, longer and happier lives. For further information, visit the Web site at [www.fhti.org](http://www.fhti.org).*

## Inspiration

### Big Questions

Renata Bushko, Future of Health Technology Institute (FHTI)

In 1956 a diverse group of scientists consolidated various studies into a new field of science: Artificial Intelligence. They aimed to discover the unknown and mysterious machinery of the mind. Future of Health Technology Institute considers their efforts a model of leadership and innovation, representing skills essential in facing the problems of the 21st century.

How can we use this successful example to address emerging complexities that lie ahead? The world has changed in fifty five years since Marvin Minsky, John McCarthy, Allen Newell, Herbert Simon and other inquisitive minds met to design the field of Artificial Intelligence. In the same fifty five years the world of biology and medicine faced equally radical changes. Future of Health Technology Summits address achievements of the last fifty five years in both medicine and technology, trying to map out how those fields might come closer and merge in the future.

With the development of new technological innovations, people naturally fear that increased costs are inevitable. FHTI, however, believes that increased expenses can be stopped or even reversed. For example, while computer technology continues to expand, computer costs have decreased exponentially. Why should technological improvements in healthcare not follow the same progression? How can we take advantage of new technologies to improve the quality of life and simultaneously reduce procedure and treatment costs? Perhaps it is a matter of vision and leadership.

### Future of Health Technology Award Lecture 2011

[Link to audio file: Professor Benjamin L. Miller Ph.D.  
University of Rochester Medical Center 2010 Future of Health Technology](#)



Future of Health technology Award Dinner 2010, Benjamin Miller Ph.D.– FHT Award Honoree and Renata Bushko, Founder, Future of Health Technology Institute

## Incubation

Sunset, Laguna Beach, CA



## Insights

### Network

Jim Karkanias, Senior Director, Applied Research and Technology, Microsoft (from the presentation at FHT2010)

One of the most powerful achievement engines on the planet is the Network. Whether it is a group of people acting together on a small team, an entire company of people, a country or a social network spanning all of these things, the power of the network is apparent in the activity of these individual units acting towards some set of goals; even if the goals they achieve are sometimes in conflict with one another!

This nature of the network is present at even smaller scales, in biological systems and the biochemical components that compose them. We are already building databases that operate as a network of data, and reasoning engines that depend on this network of data. Both are able to achieve things that their classical counterparts cannot.

Much as a recognition of the dynamics of social networks ushered in a revolution in human interactions, the recognition of the network contained in biology, marks the beginning of *systems medicine* where a fundamental understanding of the inherent networked nature of biology will permit an unparalleled capability to achieve what by today's standards would appear miraculous. In this new world, *Healthcare would be as effective and predictable as software programming is today.*

### Unsolved Problems

Renata Bushko, Future of Health Technology Institute

## Unsolved Health Problems

By analogy to mathematics where there is always a list of unsolved problems to guide the young generation of mathematicians, Future of Health Technology Institute conducted an “unsolved health problems” survey. The results are listed in the table below. All survey participants were also asked to state what will we gain if we solve that problem and what will we lose if we do not solve it. We need to generate questions and extend this list in the quest for happier and longer lives.

Unsolved Health Problems – Based on HFTI’s Unsolved Problems Survey

Unsolved Problem	What will we gain if we solve this problem?	What will we lose if we do not solve this problem?
Lack of clean water in much of developing world.	Reduced (especially child) mortality rates.	Lives
Lack of drugs resulting from human genome.	Cures for previously untreatable, fatal illnesses.	Funding for genetic research
Really effective interfaces with human users.	Efficiency	Usability
Significant (in magnitude) replacement of human professionals by machines.	Enormous increase in efficacy/productivity and better "results"/outcomes.	Status quo
Translation from the Laboratory to the Bedside: many innovations seem to never to get past the “proof of concept demo” phase.	We may see more of these projects make a difference in clinical treatment.	We will waste a lot of our intellectual capital on projects that don’t make it to the bedside.
Lack of tools to build causal models that integrate all pieces of medical and process information; information systems that can help us to integrate all information into causal models, test the models against available information, and help us do thought experiments to devise new hypothesis to test.	If we are able to overcome the problems of how to build, interpret and validate what will often be massively underspecified models of physiological systems, then we will be able to accelerate the process of discovery.	We will continue to build an increasingly fragmented knowledge base and many important discoveries will not get translated into useful understanding.
Independent nanorobots with smart software controls.	Stop disease before it develops.	Lives.
Anticipating human and system failures so that processes can be devised to prevent these failures.	We will be better able to optimize the care we can give with the clinical advances we have in hand.	Medical errors will continue to limit our ability to give the best care possible with the current clinical knowledge.
Structured capture of clinical data (history, physical examination, progress notes, procedure reports, discharge summaries).	Increased formal encoding of phenotype information to enable research, clinical care, decision support, etc.	We will continue the present process of having this information unavailable. Some could be captured through natural language processing techniques, but structured data capture also encourages more discipline and thoroughness in recording, and provides more opportunity for timely decision support.
Personal longitudinal integrated health record.	This will foster improved continuity of care, access to relevant information to care	We will continue the present process of fragmented, incomplete, inefficient

	providers, better decision making, decreased errors (e.g., overlooking an allergy or ordering of a medication conflicting with another), and the ability to track a patient's care over time, issue reminders, recommendations for improved health, etc.	management of episodes of care without ever having a complete picture of the health status of a patient.
Comprehensive structured population health data bases.	This will provide the ability to do analyses of screening tests, genome-phenotype correlation, outcomes analyses, technology assessments, and clinical prediction/prognosis.	Continued current state of limited comparability and size of datasets.
Application of cutting edge technologies for Primary Prevention i.e. implanted calorie counter/blood sugar monitor with beeper or such for weight loss, nicotine or drug aversion implants etc to give ongoing feedback and stimulus for behavior change. The simple low cost pedometer is a good example, but perhaps taken to a higher level or personalized monitoring.	Decrease in incidence of chronic illness and money spend for chronic illness, care and improved quality of life.	Individual quality of life and economic stability in health care costs as current population ages with chronic illnesses due to behavior factors.
Cost benefit ratio analysis of health technologies.	Truly beneficial and cost effective health technology applications.	Increasing personal and 3rd party costs for marginal efficacy - "technology for technology sake".
Inadequate distribution of current technologies, based on geography, income etc.	Equity in world health.	Continued Inequitable distribution which may eventually be the death of us all i.e. SARS AIDS etc. spreading world wide without available monitoring and prevention measure
Lack of coordination. This problem crosses all applications of technology, whether business, aerospace, or medical. In medicine, the cost of mistakes is already too high.	A specific example of positive coordination among medical systems includes the sharing of patient information among pharmaceutical and patient records so that errors in prescriptions, both in hospital and out of hospital are reduced, if not eliminated. But also that same mechanism of sharing, can provide a uniform source of information across many platforms, many software systems, so that validation and cross checking among the different systems may be simplified and when errors are detected, more easily tracked.	If we do not attack the problem of coordination, we risk additional sources of error, loss of our ability to track errors, and loss of time, not to mention increases in medical error and possible law suits.
Lack of recognition that not all medical problems can be solved	Reduce patient load, empower patients, create first steps in the	Continuing on the path we are on is no longer an option.

with "more technology"... sometimes, "LO TECH", is a more cost effective and patient friendly. E.g., providing access to meditation classes can reduce the cost of medication for chronic medical conditions such as high blood pressure and pain management.	cultural shift to one where patients begin to take an ACTIVE rather than PASSIVE role in their own health.	Health insurance costs are not going down. Not only are Americans uninsured they are also underinsured.
Effective use of media such as TV and the internet to raise awareness and engage the average consumer into healthcare. Make being healthy "trendy"; make it "attractive". This requires administrators to make this a line item in the budgets, a non-technical issue, but implementation is technical.	It will take time to help consumers reach for self care in their medicine cabinets rather than pills, but eventually we can hope to see an improvement in the overall health of human race reducing the costs of chronic conditions and the incidence of health problems.	We will continue to see the deterioration of health status. The cost of insurance, and the cost of Hi-tech healthcare need to be offset by low tech, such as dietary habits, practice of meditation, and so on.
Regenerative Medicine: ability to apply stem cells to address regenerative medicine.	Find cures for millions that suffer and sometimes die prematurely from degenerative illnesses.	Billions of dollars spent on unpromising therapy as well as incalculable human misery.
Background noise in biological agent detection system.	Ability to rapidly detect pathogens to isolate populations from further exposure.	Millions of lives lost to infectious disease epidemics that may be able to be curbed with early detection.
Growing new Telomeres from stem cells.	Potentially slow down the aging process.	Immortality
100% Electronic infrastructure for medical records.	Greater portability of data, greater collation of data for research, longitudinal tracking of health information, and potential reduction in medical errors.	Privacy lapses, consumer apprehension.
Wide-spread mobile computing in medical care.	Instant access to reference and clinical information, greater evidence-based healthcare.	Fragmentation of technological application in well-funded vs. poorly-funded settings; physician resistance and lack of acceptance of new computing technology.
Personal understanding of preventative health lifestyles.	Lower health costs and better quality of life.	Unbounded cost of health care.
Adequate pricing of health care	Reduction of serious ethical problems in health care pricing.	Lost market pressure for improved health care costs with monies being extracted for drugs and procedures no care and health.
Inpatient medical error as the third leading cause of death. Medication error is the largest subcomponent and by itself is the fourth leading cause of death. 60% of medication error is caused by physician ordering and 30% is caused by nurse administration.	Eliminate of a substantial portion of 220,000 unnecessary inpatient deaths per year and millions of persons maimed or incapacitated in some way. Elimination of a portion of about 1M unnecessary outpatient deaths. Elimination of about half of patient visits and hospitalization by proper disease management.	220,000 unnecessary inpatients deaths and millions of outpatient deaths and disabilities. About \$500 Billion in unnecessary healthcare costs.
Outpatient medical error (even	Human Lives	See Above

higher than inpatient error, perhaps by an order of magnitude)		
Disease management errors - the iceberg of which medical error is the visible tip. E.g., many unnecessary amputations on diabetics performed every year in the U.S., caused by improper follow-up.	Human Lives	See Above
Bringing the bio-med hypothesis builders and the tech developers closer (educational challenge).	Fast progress and better penetration of innovations into practice.	Slow progress
A reliable protein/proteomics database for NORMAL human serum. (Surprisingly, from the many decades doctors have looked for signs of disease in the blood, the normal constituents--proteins-in blood are very poorly known, both qualitatively and quantitatively. Before we can exploit nanotech & high throughput methods, we really must get a handle on what the range of normal proteins is in peripheral blood).	Human Lives – Reduction in unnecessary anxiety about “symptoms” that are part of normal variation not a sign of disease.	Lack of individualized biochemistry understanding and treatment.
Expediting tech transfer from lab to clinic (administrative, governmental challenge).	Reduction in suffering.	Wasted human effort.
Finding the genetic basis of the telomerase-independent telomere extension seen in about 10% of human cancers.	We'll be able to control telomerase-independent cancers (including half of all sarcomas, for example) by gene therapy in the same way that we will be able to control telomerase-dependent cancers by gene therapy against the telomerase genes.	We will fail to give people longer healthy life spans and reverse aging in order to reverse aging comprehensively enough to keep people alive and healthy for a few decades more than now, which will be enough to let us improve the therapies further and keep us alive indefinitely.
Making the 13 protein-coding mitochondrial genes work when placed in the nucleus.	We'll be able to ignore the accumulation of mitochondrial mutations during aging, because they will be harmless -- the proteins that are made from the mitochondrial DNA will be made from nuclear copies of the genes so the mitochondria will still work.	We will fail to give people longer healthy life spans. See Above
Finding microbial enzymes to break down the cholesterol analogues that cause atherosclerosis and maybe Alzheimer's disease.	We'll be able to treat all major diseases that are caused by the accumulation of garbage inside cells. That includes atherosclerosis, macular degeneration and probably most types of neurodegeneration.	We will fail to give people longer healthy life spans. See Above.
Lack of machines with common sense that could take care of us	Well cared for population. Increased health status of the population.	Worldwide healthcare crisis due to lack of care givers. Unnecessary suffering.
Lack of comprehensive working	Faster progress towards errorless	Slow progress towards errorless

easy to use framework for performance evaluation of adaptive complex systems.	healthcare.	healthcare.
Maintaining long-term engagement between users and health dialog systems (caring machines), especially crucial for chronic disease management systems in which we need people to use the system regularly for the rest of their lives.	Increased speed of acceptance of caring machines.	No good communication between people and caring machines.
Encoding of behavioral medicine concepts and theories into shareable computational ontologies, to support information sharing and re-use.	Exponential growth of the use and utilization of the caring machines.	Limited use of caring machines.