SMART HEALTH AND WELLBEING

The Role of Basic Computing Research

Computing researchers throughout the country are enabling a transformation in how healthcare is delivered to patients. Their new approaches and technologies are preventing disease, improving care quality and lowering costs. Support from Federal funding agencies is critical to accelerating these advances in the coming years. | **Spring 2011**

What is "Smart Health"?

"Smart health" involves deploying computing, information, and networking technologies to aid in preventing disease, improving the quality of care and lowering overall cost.

Real-Time Monitoring

Sophisticated sensors and mobile devices can feed real-time medical data directly to patients and doctors via secure computing networks.

Computer-Aided Surgery

Advanced robotic devices make surgery more accurate and potentially less invasive.

Telemedicine

Automated tools in the home and on mobile devices are able help patients interact with providers remotely, enabling the patients to adjust their daily lives by better managing their own care.

Population-Based Care

Inexpensive monitoring devices enable collection of data from large populations with lower administrative and research costs than current methods.

Personalized Medicine

Machine learning and predictive modeling will identify trends and causal relationships in medical data – leading to improved understanding of disease, development of new cures, and more accurate treatments tailored to each patient's specific needs.

Ubiquitous Computing

Improved security and privacy ensure the integrity of data stored in the "cloud," allowing stakeholders – patients, providers, and relatives – to access the right information at the right time from anywhere in the world.

Decision Support

Computer systems offer possible diagnoses and recommend treatment approaches, allowing doctors to quickly assess situations and viable options.

Health 2.0

New Web-based tools such as wikis and social networks connect patients and clinicians to shared experiences, symptoms and treatments.

Preventative Medicine

Computing researchers are studying new ways to facilitate healthy living and prevent the onset of a variety of diseases.

Self-Monitoring – Software and hardware on mobile devices and smart phones make tracking one's own health a part of everyday life. At the same time, researchers can mine these data streams to preempt future health problems, incorporating flags into the software to make individuals aware of possible problems in real time – long before they manifest themselves.

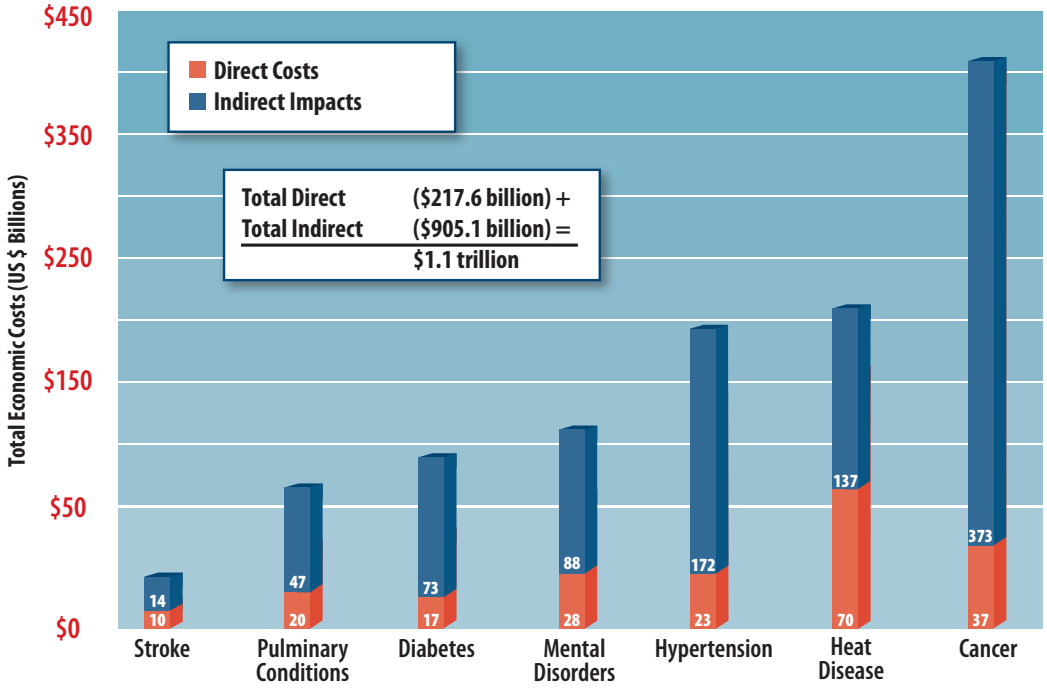
Identifying Causes of Disease – Data analytics, including machine learning and predictive modeling, can help researchers understand and mitigate the behavioral, genetic and environmental causes of disease.

Behavior Modification for Healthy Living – Self-monitoring applications combined with enhanced medical expertise help promote wellness through healthier diets, exercise patterns, and other health-related behaviors, such as mobile phone-based software that detects a nearby staircase and recommends that a user take that instead of the elevator.

Care Challenges Necessitating New Approaches

- 25 – The percentage of Americans that have at least two chronic conditions.[1]
- 75 – The percentage of healthcare expenditures that arise from chronic diseases.[2]
- 80 – The percentage of Americans that prefer that to spend money on preventive medicine as opposed to treating diseases after they arise.[3]
- 80 – The percentage of heart disease, stroke and type II diabetes cases that could be prevented through changes in people's behaviors.[4]

Projected Treatment Costs and Output Losses for Chronic Diseases in 2023



"An Unhealthy America: The Economic Burden of Chronic Disease - Charting a New Course to Save Lives and Increase Productivity and Economic Growth." Milken Institute. (October 2007).

Improving the Quality of Care

Computing research are helping to transforming America's healthcare system from one that is disease-centered to one that is much more patient-centered. The end result will be a healthcare system that is able to manage chronic disease more effectively, in turn offering much-improved quality of care.

Facilitating Patient-Centered Care – Doctors using new tools developed through basic computing research provide personalized treatments that consider genetic, environmental and behavioral factors.

Empowering Patients – Telemedicine – enabled by remote monitoring and secure data networks –allows patients to receive care when and where they need it.

Managing Chronic Disease – Computing technologies help individuals with chronic disease to much more effectively receive treatment and oversight while still pursuing the rigors of everyday life.

Effective Treatments – Computerized decision support systems can allow doctors to better diagnose and evaluate patients – reducing harmful drug reactions and unnecessary procedures.

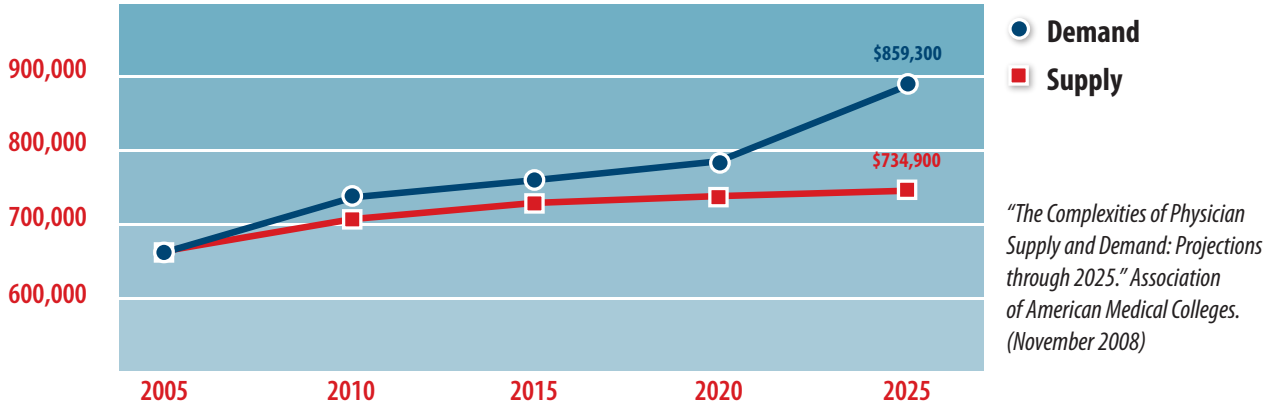
Safer Surgeries – Improved information flows and robotic-assisted devices can result in safer surgeries with fewer complications.

Independent Living – Automated care, assisted living robotics and mobile devices help the elderly and disabled live more independent lives without the need for assisted living homes.

Care Challenges Necessitating New Approaches

- 53 – The percentage of more trips to the doctor's office it is expected patients will make in 2020, as compared to 2000, due to the increasing average age of the population.[5]
- 56 – The percentage of adult patients that receive the appropriate preventive healthcare treatment each year.[6]
- 2,500 – The number of avoidable deaths that were a result of medical errors in 2008.[7]
- 6,000 – The number of medications doctors must consider when treating patients.[8]
- 68,000 – The number of known ailments doctors must choose from when diagnosing patients.[8]
- 125,000 – The number of known ailments doctors must choose from when diagnosing patients.[9]

Projected Physician Supply and Demand through 2025.



"The Complexities of Physician Supply and Demand: Projections through 2025." Association of American Medical Colleges. (November 2008)

Lowering Costs

Computing researchers are advancing new systems that lower costs for patients, doctors and taxpayers.

Eliminating Waste – Information management tools help hospitals and clinics identify and eliminate waste, thereby streamlining operations.

Preventing Costly Errors – Decision support systems that provide increased access to data and knowledge will enable patients and care providers to make the right decisions quickly and effortlessly, thereby reducing misdiagnoses and unnecessary or ineffective treatments.

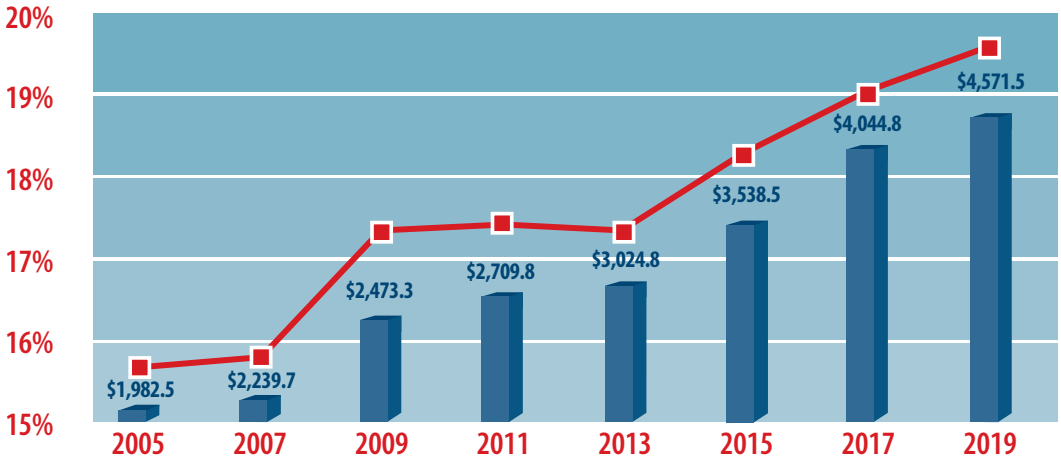
Home-Centered Care – Advances in telemedicine will empower individuals to manage care in the comfort and privacy of their own homes – freeing limited resources for other medical needs.

Optimizing Research & Development – Ubiquitous computing in the form of mobile devices coupled with improved data analytics approaches will allow medical researchers to analyze increasingly large, heterogeneous data sets to infer causal relationships – at a fraction of today's costs.

Care Challenges Necessitating New Approaches

- 15 – The number of years it can take to bring a new drug to market.[10]
- 17.6 – The percentage of the nation's GDP that was spent on healthcare in 2009.[11]
- 19.6 – The percentage of the U.S. GDP by 2019 that is expected to be spent on medical-related expenses.[12]
- $1 billion –The cost of completing research and development, including necessary clinical trials, to bring a new drug to market.[10]
- $19.5 billion – The cost of treating injuries caused by medical errors in 2008.[9]

Total Spending of Gross Domestic Production Healthcare 2005-2019 (In Billions and Percent Increase)



"NHE summary including share of GDP, CY 1960-2008." Department of Health and Human Services.

"National Health Expenditure Projections 2009-2019." Centers for Medicare & Medicaid. (September 2010).

Facilitating Improved Care Delivery through Federal Investment

Basic computing, information, and networking science and engineering stands to dramatically improve the healthcare enterprise – facilitating safer, cheaper, and more effective and reliable healthcare. Facilitating this research requires:

1. A multi-agency program comprising the National Science Foundation, National Institutes of Health and other Federal agencies dedicated to achieving technological advances in healthcare. This collaborative program would effectively marshal and coordinate Federal resources and encourage research communities to work together.
2. Increase overall funding for basic computing research that addresses healthcare needs. These resources will help researchers more quickly develop new technologies that provide a measurable return on investment.

Recent Healthcare Achievements from Computing Research

Behavioral Monitoring and Analysis

Computing researchers recently constructed systems for monitoring and behavior analysis at nursing homes and dementia wards. These systems transformed large amounts of data into a meaningful information resource for clinicians, allowing for more complete and accurate assessment, diagnosis, treatment, and evaluation of behavioral problems for the elderly. In short, the system enabled care providers to detect the likely onset of dementia and dementia-related effects in advance. This research benefited basic science and had a tremendous impact on care delivery for patients.

Advancing Computer-aided Surgery

Computing researchers developed modular, integrated systems to reduce the costs, risks and invasiveness for patients associated with modern surgeries. These systems use computer processing, sensors and robotic devices to perform a variety of surgical interventions in nearly every part of the human body. Compared with previous surgical robots, these systems are configured to progress more rapidly from one patient and procedure to another, and are less expensive and require less training for clinicians. As a result, computer-aided surgery allows doctors to combine the potential of machines with the experience of humans to change lives through procedures that could never be done before.

The Need for Computing Research

Computing research has led to breakthrough technologies that have solved some of the world's biggest challenges. Most of the revolutionary technological advances of the last 50 years were pioneered at U.S. universities through Federal research grants. We have a unique opportunity to enhance the way care is delivered – through additional Federal support in key areas of health information technology.

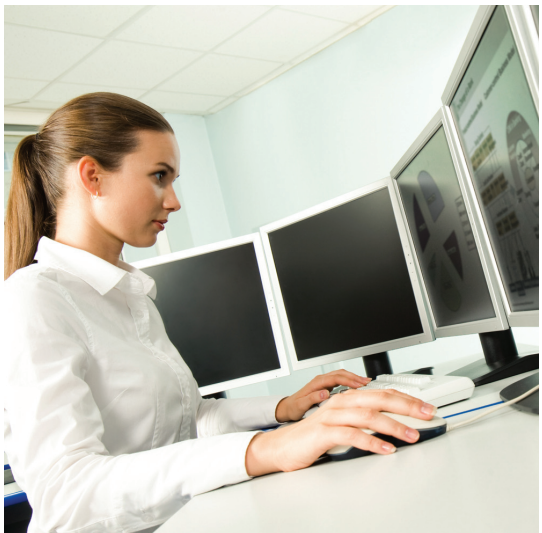
Economic Development –Every billion-dollar sub-sector of the IT industry bears the stamp of Federal support for research and development programs. U.S. preeminence in science and technology has long been the engine of job creation and the source of global economic leadership.

Scientific Advancement – Innovations in computing and networking technologies have led researchers to develop new tools that expand the breadth of many scientific disciplines – ranging from the mapping the human brain, to understanding issues of climate change, to analyzing massive amounts of astronomical data to better understand our universe.

Improve Daily Life – Computing research is improving areas as diverse as healthcare, transportation, energy and education. The development and distribution of these technologies will allow people to live safer lives, conserve natural resources, receive personalized education, and beyond.

Technologies Developed from Basic Computing Research

- The Internet
- Google
- Global Positioning Systems (GPS)
- Smart Phones
- Home Security Systems
- Doppler Weather Radar
- Health Monitoring Devices



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FOR MORE INFORMATION

Computing Community Consortium
Computing Research Association
1828 L Street, NW, Suite 800 | Washington, DC 20036-4632
(202) 234-2111 | www.cra.org/ccc

The Computing Community Consortium (CCC) is a standing committee of the Computing Research Association (CRA) funded through a cooperative agreement between CRA and the U.S. National Science Foundation. The CCC seeks to mobilize the computing research community to debate and articulate long-term research challenges.