

# Strengthening Health Systems in Resource-Poor Settings through the Application of the Sana Wireless Technology

Leo Anthony Celi MD MS MPH

Harvard-MIT Division of Health Sciences & Technology  
Division of Pulmonary, Critical Care & Sleep Medicine  
Beth Israel Deaconess Medical Center

A **lack of trained physicians** is one of the largest issues facing healthcare in the developing world.

Patients often make long journeys to clinics, only to be referred to **expensive and far away** medical centers for a diagnosis.

**Paper based medical records** further contribute to inefficiencies.

# Bigger Systems Problems

- Care provision is fragmented: providers work independently
- Absence of or inadequate documentation of care (paper-based)
- Lack of process standardization and outcomes tracking – “ad hoc” care -> care variability
- Weak system for quality assurance and improvement

# Traditional Approach

- Focus on short-term vertical programs rather than longer-term capacity building

World Health Organization and Bill and Melinda Gates Foundation logos have been removed due to copyright restrictions.

# Sana

- Volunteer organization hosted by the Computer Science and Artificial Intelligence Laboratory consisting of students and alumni of MIT, Harvard School of Public Health and Harvard Business School
- Offers a mobile tele-health platform for resource-poor settings

# Why Mobile Health?

# Traditional Tele-Medicine

- Scalability an issue
- Reliance on fixed and expensive infrastructure
- Limited broadband connectivity

# mHealth

Two graphics removed due to copyright restrictions. "Between 80 and 90 percent of the world's population live within range of a cellphone tower. Now, care can be in range for them too."

## Cloud Computing



# Sana Technology

- Interfaces with point-of-care diagnostic tools and a back-end EMR
- Allows guidelines, checklists and protocols to be hardcoded onto phones bringing EBM into the hands of CHWs
- Streamlines triage and referral system
- Facilitates coordination of care, care standardization, quality assurance and improvement

# Sana Technology

- Facilitates real-time decision support for CHWs from remote experts
- Enables development of clinical database to build customized medical AI

# Sana Vision

- Apply artificial intelligence (image analysis, machine learning, search algorithms) to database to develop population-specific decision support tools

# Capacity Building

- Promote a collaborative ecosystem to incubate, deploy and scale mHealth solutions
- Advocate grassroots project support and accountability
- Share what we learn at MIT, HSPH and HBS to our counterparts in developing countries

# Sana India

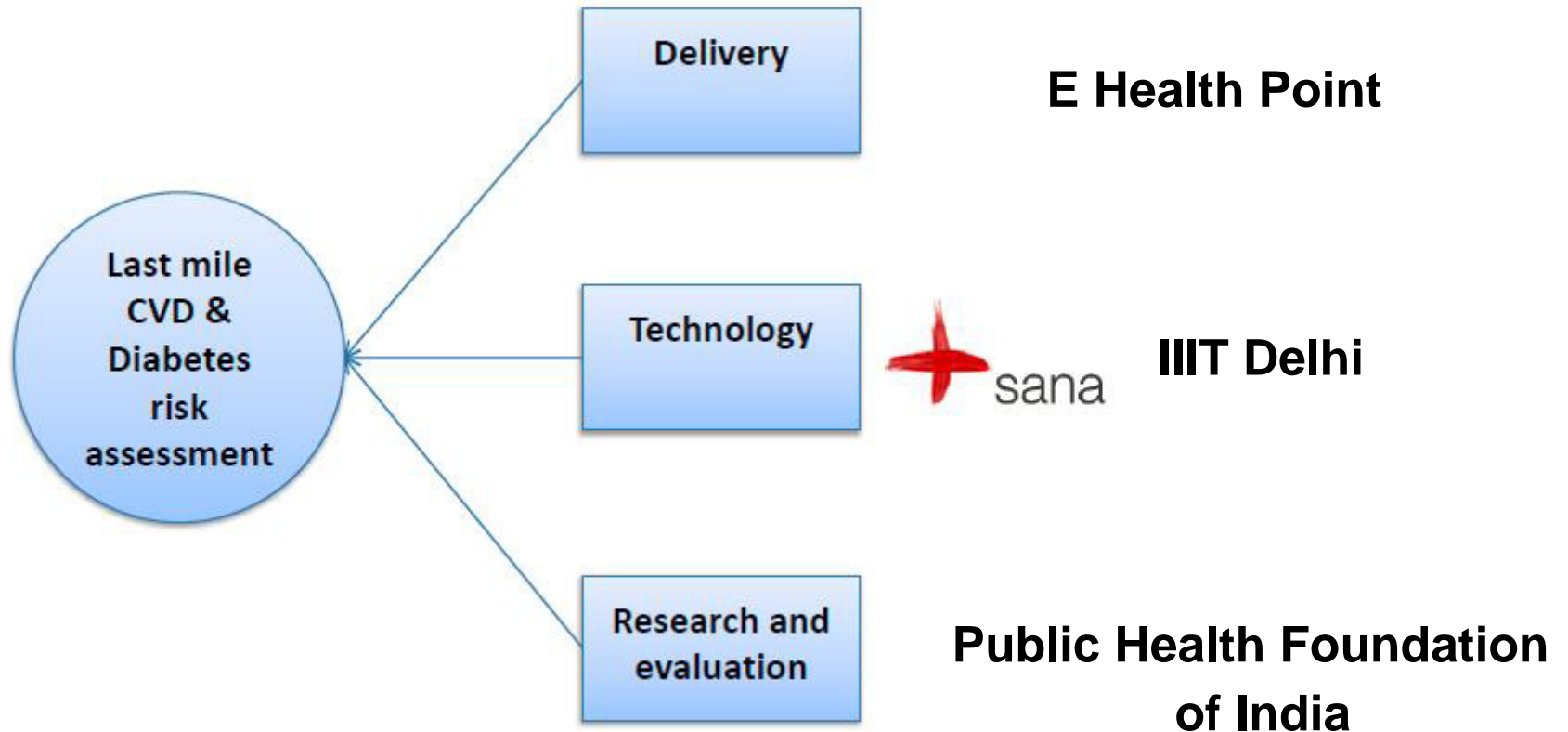
- Screening of cancer and chronic diseases (heart disease, diabetes) – 20% of disease burden, 40% by 2016
- Early detection: less costly care, better outcomes







# Sana Delhi











# Sana Brazil

- Screening for common eye conditions
  - Error of refraction
  - Cataract
  - Trachoma
  - Retinal disease

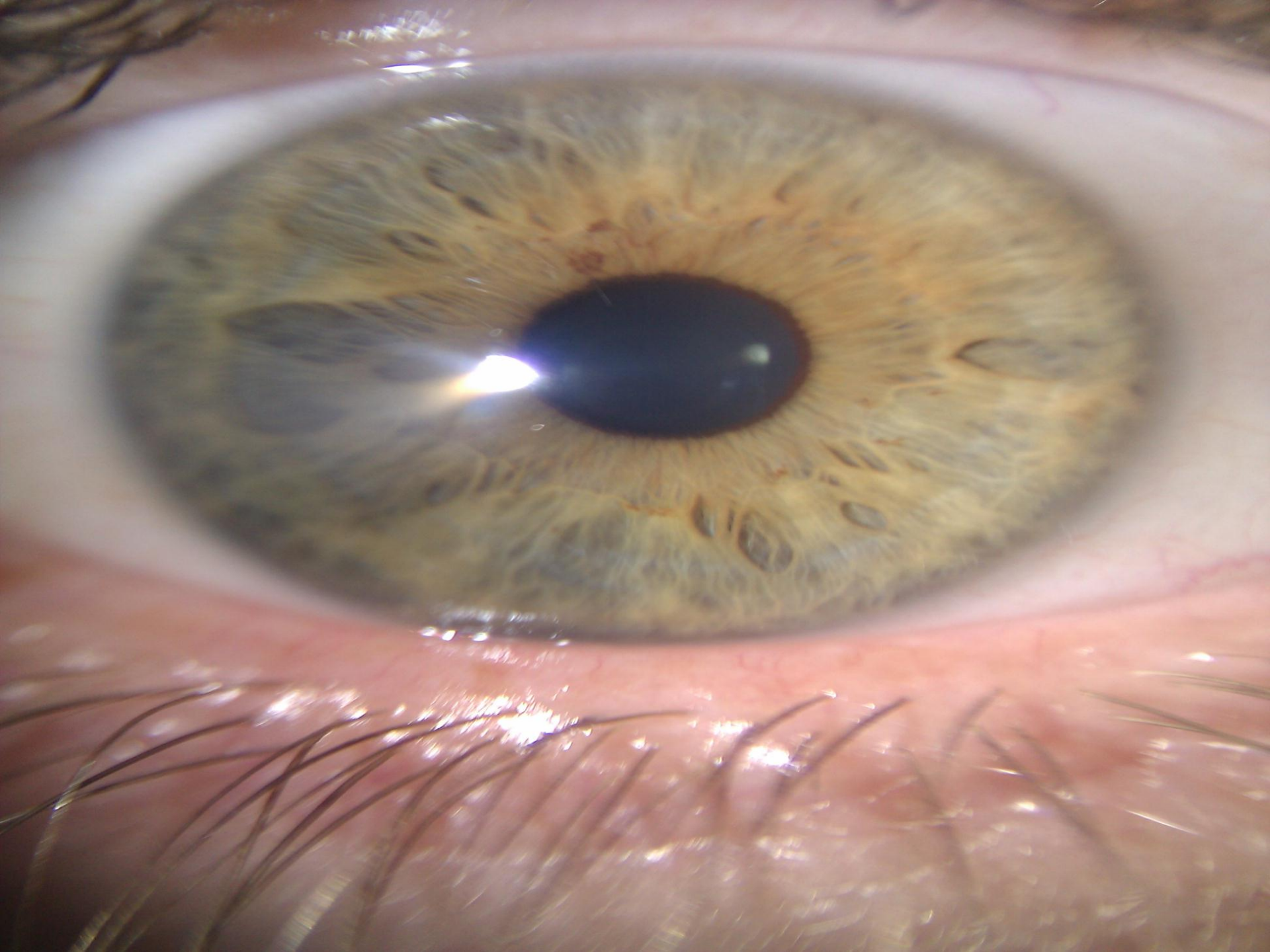
# Sana Brazil

- Partners:
  - Prof. Raskar's group at MIT Media Lab
  - Instituto Nacional de Telecomunicações
  - Universidade Federal de Sao Paolo









# Sana Philippines

- Primary care application
- Partners:
  - National Telehealth Center
  - University of the Philippines
  - Integrated Open Source Solutions
  - Department of Health DTTB Program









# Sana Taiwan

- Assist Taipei Medical University to implement mHealth in Swaziland as part of Taiwan Medical Mission, established in 2008

# Sana Taiwan

- Pilot project: Surgery follow-up of patients from Mbabane General Hospital





# Postnatal System to Address MDG4 and MDG5

- Provide care to mother and infant during the critical period of 1 hour to 1 week after delivery
- Hardcode WHO recommendations into the phones of birth attendants and CHWs





sana

care, anywhere: e-health solutions  
+ education for the developing  
world

Crystal Mao, Sept. 2010



# eHealth Lab Course

- World Bank alone is investing \$500M on health information systems in developing countries.
- Low return-on-investment unless the right organizational and cultural healthcare infrastructure exists to maximize the value of these systems

# eHealth Lab Course

- Sana, Partners in Health, IHI and MIT Open Courseware
- Bring together students from different disciplines interested in mHealth technologies
- Connect students to local health organizations to identify problems and needs
- Design, deploy and assess solutions with mentorship from mHealth experts



# eHealth Lab Course

- Best practices in implementation
- Value chain analysis and value-stream mapping
- Data-driven learning system
  - Track, evaluate and improve outcomes
  - Analyze, streamline and standardize processes

# eHealth Lab Course

- Quality improvement concepts
  - Positive Deviance
  - Lean
  - Teamwork and collaborative change
  - Checklists
  - Systems approach to errors

# eHealth Lab Course

- For capacity-building
- Strengthen existing healthcare infrastructure
- Provide students opportunity for experiential learning
- Promote cross-pollination between students of partners countries
- Sets the stage for a collaborative ecosystem

**about**

[visiting](#) | [maps](#) | [offices+services](#)

**admissions**

[undergrad](#) | [graduate](#) | [financial aid](#)

**education**

[schools+courses](#) | [OpenCourseWare](#)

**research**

[labs+centers](#) | [lincoln lab](#) | [libraries](#)

**community**

[students](#) | [faculty](#) | [staff](#) | [alumni](#)

**life@MIT**

[arts](#) | [athletics](#) | [video](#)

**initiatives**

[energy](#) | [cancer](#) | [diversity](#) | [global](#)

**impact**

[industry](#) | [public service](#)

*today's spotlight*

**Mobile health care**

Software aims to increase health care access in developing countries



**news**

[Unexpected finding at the Large Hadron Collider](#)

[Explained: How recessions are really identified](#)

[Study ties airplane emissions to deaths on the ground](#)

[NRC rankings reaffirm MIT's leadership role in science, technology](#)

[research](#) | [campus](#) | [press](#)

**events**

[State of the Institute, community social \(today\)](#)

[Of Note: MIT VPF Provider Fair \(tomorrow\)](#)

[Join MIT Entrepreneurship Review's Board of Topic Experts](#)

*today's image:*

RJ Ryan

## In The World: Health care in the palm of a hand

MIT-led student team develops mobile-device software to help improve health-care accessibility in remote regions.

Morgan Bettex, MIT News Office

### today's news

#### First improvement of fundamental algorithm in 10 years



Graphic: Christine Daniloff

The max-flow problem, which is ubiquitous in

September 27, 2010

[email](#) [comment](#)  
[print](#) [share](#)

According to the United Nations Foundation, there are about 5 billion mobile-device subscribers worldwide. Two-thirds of those are in low- and middle-income countries, many of whose citizens lack easy access to health care and must travel great distances — often



Using Sana, health-care workers take photos of precancerous lesions inside a patient's mouth in India. Those images were then transmitted to an oncologist for diagnosis.

### multimedia



Sana's open-source software system relies on smart phones running Google's Android operating system to connect health-care workers in rural regions with physicians in urban areas.



# Cisco to pay \$2.9b for Starent Networks

Deal for cellular data firm highlights growing demand for mobile Internet services

By Elizabeth Stone  
The third data networking company to be acquired by Cisco, Starent Networks, a cellular data firm, is being bought for \$2.9 billion, a deal that highlights the growing demand for mobile Internet services.

Starent Networks, a cellular data firm, is being bought for \$2.9 billion, a deal that highlights the growing demand for mobile Internet services.

Starent Networks Corp. is being bought for \$2.9 billion, a deal that highlights the growing demand for mobile Internet services.



A general practitioner in Batanes, in the Philippines, uses a cellphone with Moca software to transmit an X-ray to a radiologist in Manila.

# Using cellphones to change the world

MIT project leads to programs that help health workers, farmers in developing countries

By D.C. Denison  
CLOSE STAFF  
It's an unlikely medical device: a sleek smartphone more suited to a nightclub than a rural health clinic. But it's loaded with software that allows health workers in the remote northernmost Philippines province of Batanes to dramatically reduce the time it takes to get X-rays to a radiologist — and to get a diagnosis for a patient being tested for tuberculosis.

nology to the "90 percent of people" who fall outside of the marketing plans of most phone companies. Talking about his Telmex job, Rotberg made a peak with his hands. "We were dealing with the very top of the pyramid," he said as he sat in his office at MIT. "We spent most of our time trying to sell more phones and products to the middle class and the upper middle class."

In Mexico and illiterate women in India. "Cellphones are inexpensive, personal, connected, and everywhere," he said. "They are also a perfect Trojan horse for social development, because you don't have to convince anyone to buy one."

The software, created by a nonprofit organization called Moca, is one of nearly two dozen cellphone-based projects that have sprung from NextLab, a course at the Massachusetts Institute of Technology. It's taught by Jhonatan Rotberg, who was sent to MIT by Telmex, one of Latin America's largest telecommunications companies, to bring cellular tech-

And when Rotberg settled into his research and teaching position at the Media Lab, he made a discovery: The same device that powers teenage texting in the United States can be adapted to help farmers

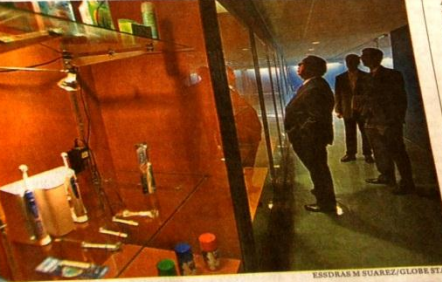
"It really kind of jumps out at you, the positive impact you can have with cellphone technology," said Zack Anderson, a recent MIT graduate who was on a team that started Moca, a nonprofit that is developing mobile software to improve health care

CELLPHONES, Page B10

# New headquarters about the best Gillette can get

Gillette, the Boston shaving giant, yesterday unveiled its \$50 million renovation and expansion of the World Shaving Headquarters in South Boston. The manufacturing and research complex, totaling more than 1.65 million square feet, will soon accommodate between 400 and 500 employees who previously worked at the Prudential Center corporate headquarters. The 44-acre site features perks including a convenience store, coffee bar, and an "Art of Shaving" shop that with an onsite barber.

complete their move by Nov. 1, trading large offices and views of the Charles River for the more low-key South Boston digs. The new offices feature open layouts, and even top executives will have offices without doors, similar to the design at Gillette's parent company, Procter & Gamble Co.



Mayor Thomas M. Menino and Gillette executives toured the company's renovated world headquarters in South Boston yesterday. It has a store, coffee shop, and onsite barber, as well as a 9,000-square-foot fitness center.

ESDRAS M. SUAREZ/GLOBE STAFF

CELLPHONES, Page B10

# Investors stuck in Big Dig bonds

Treasurer letting auction-rate notes remain in limbo

By Seth Maehr  
Treasurer Thomas H. Cahill has been stuck for nearly two months with \$75 million in frozen Big Dig bonds. The state's investment firm, the Massachusetts Bond Finance Authority, is stuck with the bonds because they were sold at a high interest rate, and investors are reluctant to buy them at the current market rate.

# 'It's Kafkaesque'

ALEX NEHAUS, a frustrated investor from Southborough with \$75,000 in frozen Big Dig bonds

caught in a netherworld in which neither the state nor the Wall Street investment firms that sold the bonds will claim responsibility for refunding them. "It's Kafkaesque," fumed Alex Nehaus, a Southborough resident who holds \$75,000 in frozen Big Dig bonds.

Cahill's staff said the state hasn't refunded the bonds because it would have to do so at a much higher, fixed interest rate, which would be costly. Also, a refunding would largely benefit the investment banks that underwrote the bonds, because they have bought back billions of dollars of the investments under pressure from state and federal regulators.

BONDS, Page B10

Various images of news articles removed due to copyright restrictions: "Cancer centre, SANA to launch healthcare project" from The Hindu, "City doctors help distant patients" from The Epoch Times, "Mobile phones used to boost health outcomes in Asia" from Radio Australia, story in "Tech Universe: Monday 11 October" from The New Zealand Herald, "Mobile health: Access for the world's poor" from Asia Society, and "More about Sana and mobile health" from Americas Quarterly.



National Design Triennial

# WHY DESIGN NOW?

MAY 14, 2010-JANUARY 9, 2011



Highman  
Globe-Horn, National Design Museum



# Sana

- Academic Research & Development group
  - Works with local multi-disciplinary implementers
  - Offers an open source mHealth platform customizable to any clinical application
  - Focuses on capacity-building by providing educational tools to strengthen healthcare infrastructure, including health information systems
  - Provides students an environment for experiential learning

# Sana Approach

- Multidisciplinary and collaborative to enable
  - Technical innovation (based on an open source platform)
  - Business innovation (based on models being designed and tested with partner organizations)
  - Development of value-creating networks by building coalitions of local and international academic and provider organizations to identify and share examples of best practice and to pool resources



MIT OpenCourseWare  
<http://ocw.mit.edu>

HST.950J / 6.872 Biomedical Computing  
Fall 2010

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.