SmartAmerica Closed Loop Healthcare Team
Development & Demo at the MGH/MD PnP Lab, Cambridge, MA March 2014
Closed Loop HealthCare Team: Home to Hospital to Home

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Closed Loop HealthCare Team
Geographic Distribution
Fall Detected at home
Randall doesn't get up

Robot: Randall needs medical help alerts 911

Robot dispatch And 911

ER - Smart alarms utilize cloud data and EHR

Surgery – all data available

Pain meds: Reduce risk of injury and false alarms

Discharge

Device/Genomic Prescription CDS

NOTE: this graphic depicts a mix of current and planned capabilities.
Randall at Home

Depth camera for in-home fall detection so Randall gets help fast

Bed sensor logs sleep patterns.
Motion sensors log activity.
Real-Time Fall Detection

- Alert sent to caregivers with embedded link to depth video clip

Possible fall detected!

Fall confidence: 0.86
ID: 3012
IP: 10.0.1.200
Date: 12_04_2013
Time: 16_06_45_531
Another person was not detected walking in the room.
Video:
Fall Detection and analysis …
Can change the course and outcome of the event

More information about the fall can influence medical intervention
Randall’s data from home helps avoid un-necessary head CT scan
Nationally - $30B in wasted MRI/CT imaging
$2,000 each head scan. Radiation equivalent to 30 chest x-rays

1. Fall Detected at home Randall doesn’t get up

2. Robot dispatch performs triage alerts 911

3. 911 dispatch

Motion Sensors
Bed Sensor
Fall Detection – Kinect
Hospital will have standards-based “Integrated Clinical Environments”, for full data interchange, device coordination, closed-loop control, “black box recorder”, “IoT for Health Care”

In ED: Retrieving data from remote EHR
Then: Transfer all data and device settings from ED->OR
Integrated Clinical Environment - Simplified Architecture

From ASTM F2761-09

ICE Network Controller

Apps for PCA Safety, Smart Alarms, Remote Notification, Team coordination

ICE Supervisor (runs apps)

ICE Network Controller

ICE Data Logger

Medical Device or other equipment

Medical Device or other equipment

Medical Device or other equipment

Patient and Family

Standard recognized by FDA in August 2013
Patient-Controlled Analgesia (PCA) system safety concerns

- Patients can call to request more analgesia, but, cannot call for help when over-medicated.
- Over-medication can cause respiratory and cardiac arrest
- Comprehensive monitoring is not typically used due to high false and nuisance alarm rate
PCA Safety Issues continue ...

http://ppahs.wordpress.com/2012/02/01/guest-post-yes-real-time-monitoring-would-have-saved-leah-2/
This is the story of an 11 year old who died from narcotic-induced respiratory depression. "Ten years after my daughter's death, nothing has changed in the codes of monitoring post-op patients continuously, until they leave the hospital. Alive."

This is a statement from a multi-hospital coalition frustrated by ongoing adverse patient events:
"A closed-loop system, which stops or pauses opioid dosing if respiratory depression is detected, is desirable. Systems are most ideally centrally monitored. In any case, alarms should be audible or otherwise available to the primary caregiver, and a mechanism for prompt response should be in place."

http://ppahs.wordpress.com/about/
"Carly Ann Pritchard ... suffered an ankle injury and then underwent surgery to reduce lingering pain from her ankle injury. Unfortunately, although she survived surgery, she suffered brain damage because of an accidental overdose from a morphine-filled pain pump - after surgery. A California appeals court recently upheld a jury's award of about $9.9 million in damages."
OpenICE

ICE = Integrated Clinical Environment

- OpenICE encompasses
  - Medical Device Interfaces
  - Patient Simulation
  - HIS Connectivity
  - Safety Assurance
  - Validation and testing
  - Regulatory Pathway
  - ICE Application eXchange (ICE AX)
    - Med apps, device management

- Everything is open source

- OpenICE™ is a work in progress
  - Currently useful for clinical and CS research, prototyping, standards development/ref implementation, starting point for med device deployment, etc.

Bitly.com/open_ice
Implementing ASTM ICE Standard
Reducing false alarms will reduce alarm fatigue
Safer, more effective pain control
Real-time blue button data available to family and staff

Pain Medication-related injuries could be prevented with Medical CPS:
• Over 6000 patients severely injured/killed each year
• Up to $145M impact
• Untreated pain
• PREVENTABLE!

Safe Interoperability enabled by MCPS
Data Logger “Black Box Recorder” for the Integrated Clinical Environment (ICE)

- A Data Logger is a foundational component of MCPS clinical network. Required to improve forensic analysis of clinical adverse events and near misses.
- Required to address safety (Regulatory Science) and liability concerns of network medical systems.

- NIST Prototype Features:
  - Platform Independent, Plug-n-play & DDS compliant VM based Data Logger.
  - Browser based Playback: Intuitive Data Visualization with Annotation and Search capabilities (Mobile Compatible).
  - Modular Architecture (Loose Coupling).
Personalized Medicine: EMR data & Blood Pressure after Lopressor Administered
Randall’s Genomic Profile

A. Pt. 18 - Chromosome 9
   Avg. Signal Intensity
   Heterozygous calls

B. Pt. 38 - Chromosome 9
   Idiogram
   LOH Detection
   upd(9)(p21.2-pter)

C. Pt. 36 - Chromosome 9
   upd(9)(p21.3-pter)

Pt. 36 - Chromosome 12
   del(12)(p13.1-p13.31)
EMR Alert: Don’t use beta blockers
OpenICE + Analytics

IoT for Health Care benefits from information about users of each specific device.

SEMOSS is an open analytics technology that can find connections between data stored in multiple repositories.

DOCBOX’s ICE Manager integrates medical device data, clinical context, and IT data to enable real time decision support and analytics to occur for an individual patient, the point of care, or across the entire system.

Questions that could be answered:

a. How many times did this patient utilize this device?

b. Who are the various users working with this device?

c. How much time Nurse ABC spend providing direct patient care across the continuum of care (all patients all units)
Patient is discharged … to a smarter home

Bathroom/Toilet Floor Sensor
Motion Sensors
Bed Sensor
Fall Detection – Kinect
Auto Light Control
Capsule Robots
Real-time blue button
Wearable sensors
home Gait Analysis – Kinect

Motion Sensors
Bathroom/Toilet Floor Sensor
Home Again
Sensors & Health Alerts Prevent Re-Hospitalization

in-home fall detection and gait analysis

Bed sensor under the mattress logs pulse, respiration & restlessness
Capsule Robots for Non Invasive Healthcare Monitoring and Localized Drug Delivery

Painless Diagnosis & Automated Therapy

Controllable Capsule for Localized Drug Delivery
On Display at the Closed Loop Healthcare Booth

L: 25 mm, Ø:14 mm

http://my.vanderbilt.edu/stormlab/