THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®

CYCORE:

CYber-infrastructure to Support COmparative Effectiveness REsearch in Cancer

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CYCORE | THE UNIVERSITY OF TEXAS MD Anderson Cancer Center | UC San Diego | UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

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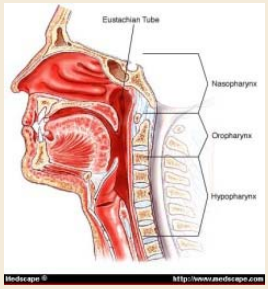
Head and Neck Cancer

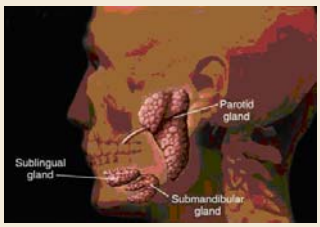
- **Diverse Set of Diseases**
- **27,000 Pharynx or Oral Cancer/ yr, primarily men in their late 50s**
- **Increasing incidence of oropharyngeal (tonsil / base of tongue) cancer due to the HPV virus**
- **Oropharyngeal cancer is highly curable, 87% 7-yr survival rate (R03 data)**



Oropharyngeal Cancer Treatment

- Large Field High Dose Radiati
- Every day for 6 wks
- With or Without Chemotherap

- Damage of key salivary swallowing structures



Temporary Radiation Side Effects:

Skin burn

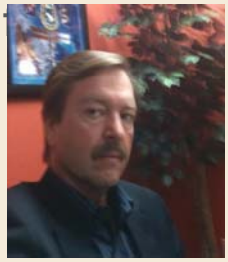
mucositis

Photos courtesy of Drs. Beadle and Morrison

Radiation and Hospitalization

- ER/ Hospitalization admission rate is 30-40%
- 98% require pain control with morphine-level palliation
- Average weight l ng
  weeks: 25 lbs

Before cancer diagnosis



after cancer treatment

Why aren't more Hospitalization Events Prevented with Usual Care?

- **Ability to assess patient only once/week at clinic visit**
- **Rapid physiological changes can occur between visits**
- **Home assessment limited to self-report**

H&N use case: opportunities for clinical and behavioral assessment

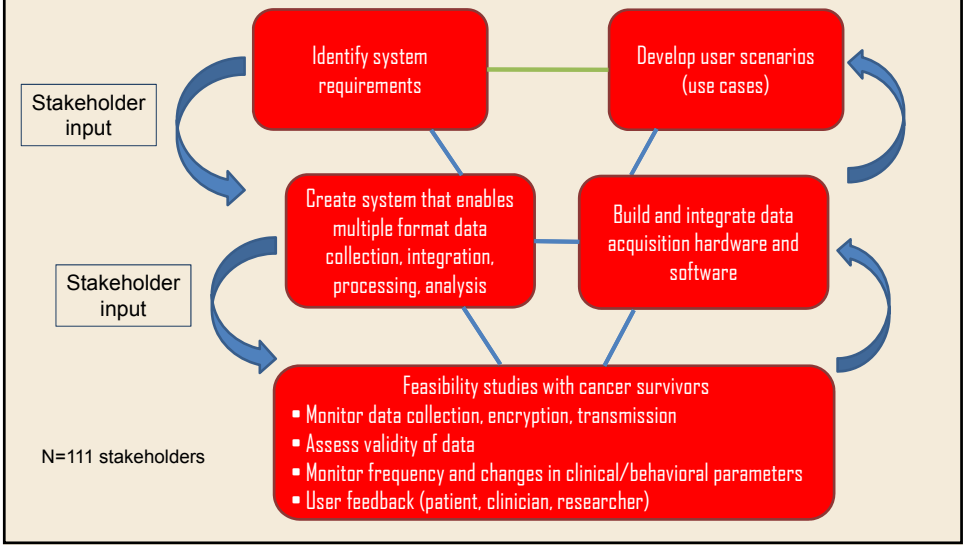
- **IV hydration**
- **Nutritional support**
- **Pain management**

Sensor Technology Research Advantages

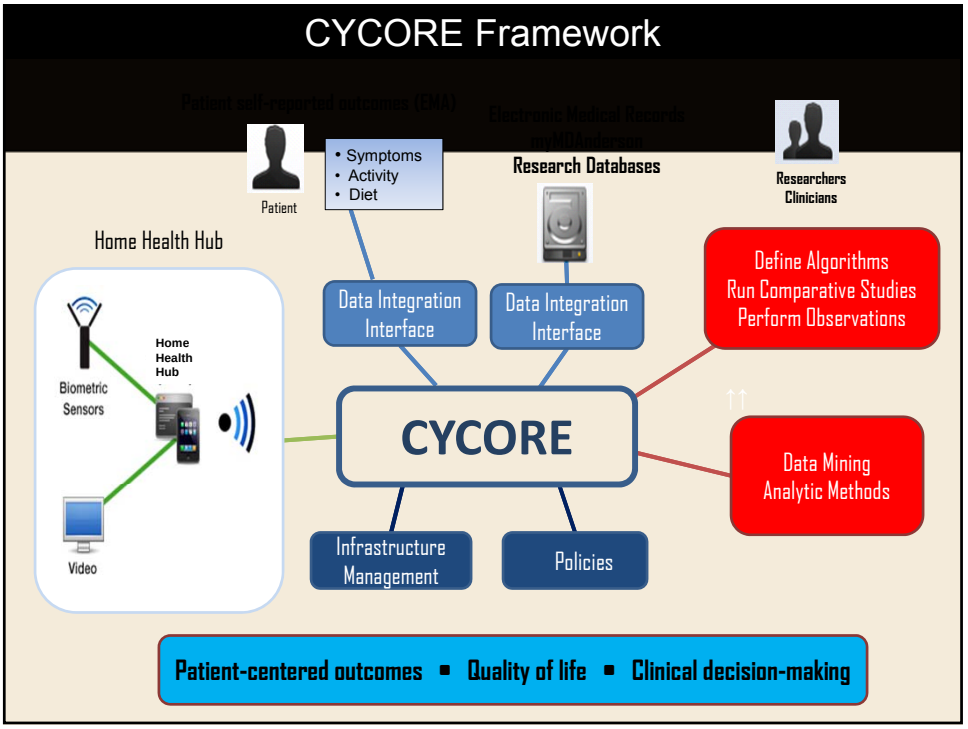
- Objective vs subjective self-report
- Real-time data collection vs retrospective
- Multiple data source integration

Report to the President and the Congress on CER, 2009

CYCORE Prototype Development and Testing



CYCORE Framework



Patient monitoring through sensor-based data collection

Build primary interface between patients and CI for data collection away from the clinic setting

- Data transmits from biometric and environmental sensors to Intelligent Home Health Hub
- HHH relays data from patient's home to CI via web- service interface

H&N Dehydration Use Case: CYCORE goals

- **Maximize capability for home-based data collection during critical treatment periods on key physiological and behavioral outcomes**
  - Weight, BP, pulse, food/fluid intake, activity levels, adherence to swallowing exercises
- **Integrate with other data sources**
  - Patient medical history, treatment information, prescribed medication
- **Integrate and analyze data to identify high risk patients**
  - Intervene to reduce hospitalization, ER visits
  - Reduce complications from non-adherence to swallowing exercises
- **Decision support for clinician/researcher through availability of objective, timely, home-based data**
  - Optimizing chances for rapid intervention, support

CYCORE Dehydration Sensor

Blood pressure + pulse to assess dehydration risk

Smart phone to provide self-reported outcomes (EMA)

Scale to monitor weight loss

Data transmission to Home Health Hub

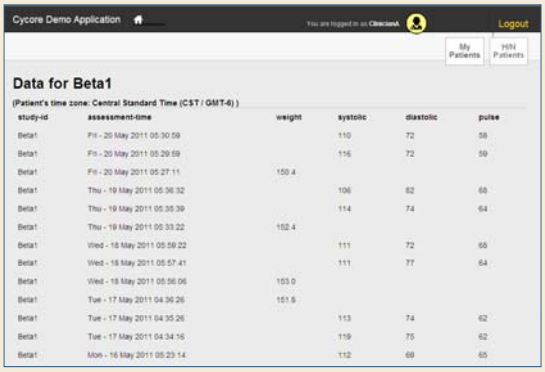
Accelerometer to assess activity

Interface with CI

Data available to researchers, clinicians

Clinician and Researcher Interface

Clinician/researcher views data; tracks trends in weight, pulse, BP



Alternate views available

Orthostatic Hypotension + ↑Pulse

Dehydration risk

Early identification via CYCORE

Earlier IV fluid therapy

Improved outcome: reduction in ER visits, hospitalizations

Clinician Interface

Enables clinician/researcher to view data on daily patient-reported outcomes via EMA

			0 = none; 10 = worst, extreme, or as bad as you can imagine											
Date/Time of Survey	Last Urine Dark Yellow	Dizzy Last 24 Hours	Fatigue Now	Weakness Now	Pain Now	Swallowing Difficulty Now	Thirst Now	Nausea Now	Vomiting this morning	Feelings of Being Upset Now	Disturbed Sleep Last Night	Drowsiness Now	Diet Yesterday	Cups of Liquid Yesterday (incl tube)
2/6/2012	Yes	No	3	3	8	3	0	2	0	6	8	3	Regular	>6
2/7/2012	No	No	3	4	8	3	0	2	0	6	8	3	Regular	>6
2/8/2012	No	No	3	4	8	3	0	2	0	6	8	3	Regular	>6
2/9/2012	Yes	No	3	4	8	3	0	2	0	6	8	3	Regular	3-6
2/10/2012	No	No	3	4	8	3	0	3	0	5	8	3	Soft/ chewable	3-6
2/27/2012	No	No	3	4	8	7	8	2	0	7	8	3	Cold liquid	<3
2/28/2012	No	No	3	3	8	7	8	2	0	7	8	3	Cold liquid	<3
2/29/2012	No	No	2	3	8	7	8	2	0	7	9	6	Could not eat	<3
3/1/2012	No	No	3	2	8	7	8	2	0	7	8	6	Could not eat	No liquid
3/2/2012	No	No	3	2	8	8	8	2	0	6	8	6	Tube	>6

Results

- 7 out of 8 Radiation Oncologists approached agreed to participate
- 50 participants were enrolled
- 48 completed the sensor study during radiation

Clinician & Patient Qualitative Analysis

To nurse: "(Participant's) BP was low and she was tachy. Can you contact her to see how she is, and maybe get her in for a quick vitals check?"

Adam Garden, MD; Professor, Radiation Oncology Department

"(CYCORE) has been great. I can tell when a patient's numbers aren't looking so good."

Beth Beadle, MD, PhD; Assistant Professor, Radiation Oncology Department

Can I continue to use the scale and blood pressure device (in between 5-day trials) to continue to monitor myself?

I like the size of (the accelerometer) —it's inconspicuous.

CYCORE Participants

I liked being able to monitor my wife's weight every day, to make sure she was eating enough and not losing too much weight.
- (Spouse caregiver)

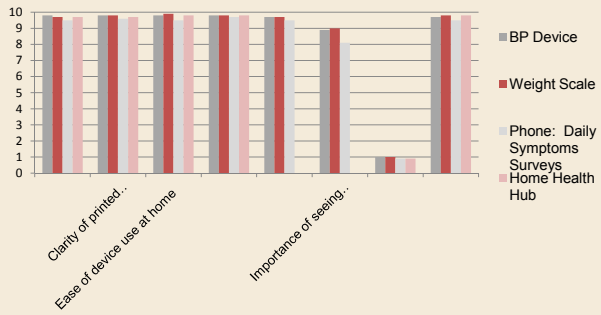
I loved the instructions. I'm normally not a good device-user, but you made it very easy for me.

Using the devices (at home) is no problem at all.

Patient Satisfaction Results

Post Training Survey, Mean Scores (N=48)

Mean Age 56.5 (Min=41, Max=71)



Overarching goal of CYCORE: Cyberinfrastructure to facilitate CER

User-friendly, open-source cyber-infrastructure (CI) for collecting behavioral, clinical, & environmental data relevant to cancer outcomes from multiple sources

> "[CI] **is the coordinated aggregate of software, hardware, and other technologies, as well as human expertise, required to support current and future discoveries in science and engineering. The challenge of [CI] is to integrate relevant and often disparate resources to provide a useful, usable, and enabling framework for research and discovery characterized by broad access and "end-to-end" coordination."**
>
> SBE/CISE Workshop on CI for the Social Sciences
> Fran Berman, San Diego Supercomputer Center, UCSD

Dehydration Related Events

- **60% (n=29) of patients who completed the study had at least one event, and 35% (n=17) had two or more events.**
- **Three symptoms were associated with having had a dehydration-related event:**
  - **nausea (p=0.004),**
  - **vomiting (p=0.0004), and**
  - **swallowing difficulty (p=0.004)**

CYCORE 2.0 and beyond

- **Broaden scope and quality of data on factors contributing to prevention, treatment and control, in both cancer survivors and those at risk**
  - **Increase capacity for larger, more complex data sets**
- **Demonstrate improved integration and analysis of sensor-captured patient data for patient care and research**
- **Provide decision support for patients and providers**
  - **Patient Centered Outcomes Research Institute (PCORI)**
- **Increase patient engagement in cancer prevention and treatment**
- **Increase evidence base for utility of health IT in improving health behaviors and health outcomes**
- **Translation and dissemination**

CYCORE Consortium Investigators

MD Anderson
- Susan Peterson, PhD, PI
- Alex Prokhorov, MD, PI
- Karen Basen-Engquist, PhD, PI
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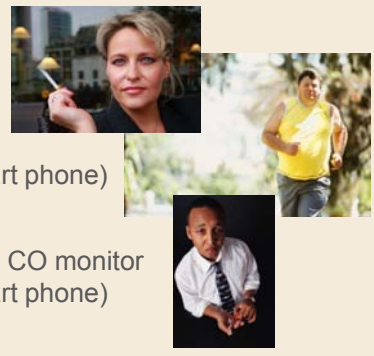
- Celal Ziftci, MS
- Kai Lin, PhD
- Yan Yan, MS

http://cycore.ucsd.edu/index.php/

Specify use cases for CI development

- **Improving Quality of Life in Colorectal Cancer Survivors with Metastatic Disease**
  - **Maintenance of physical functioning, symptom and toxicity management**
- **Monitoring Long-term Outcomes of Smoking Cessation Treatment**
  - **Remote monitoring of expired CO**
- **Managing Treatment-related Side Effects in Head and Neck Cancers**
  - **Adherence to swallowing exercises, managing dehydration risk**

CYCORE use cases define behavioral, clinical, environmental data collection requirements



- Physical activity
  - Movement: accelerometer
  - Location: GPS
  - Health indicators: BP, HR, pulse, weight
  - Self-reported outcomes: EMA (smart phone)
- Smoking
  - Expired carbon monoxide: portable CO monitor
  - Self-reported outcomes: EMA (smart phone)
- Adherence
  - Swallowing exercises, CO monitoring: video capture
  - Self-reported outcomes mapped to behavioral data (CO values, exercise indicators)
  - Self-reported medication adherence mapped to symptoms