Using Mobile Health Technology to Facilitate Rehabilitation Outcomes

Los Angeles/Orange County Association of Rehabilitation Nurses
A Sea of Innovation Conference

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8:30-9:30 am
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- Cedars-Sinai and California Rehabilitation Institute, Los Angeles, California
Disclosures

• None
Objectives

Participants will be able to:

• Recognize the value and importance of wearable sensors in collecting and transmitting various types of biodata—patient position, time in motion, and even responses to questionnaires delivered remotely

• Operational challenges in using wearable sensors in large scale research projects

• Evaluate, interpret, and discuss strategies for integration of sensors into clinical rehabilitation practice
Overview of Technology
Innovation is:

"Turning an idea into a solution that adds value from a customer's perspective."

Nick Skillicorn
@improvides

The ultimate definition of innovation:

Executing an idea which addresses a specific challenge and achieves value for both the company and customer.

David Burkus
@davidburkus
But what about Rehabilitation and Technology?
Change is Inevitable

- Incremental innovation
- Radical innovation
- Divergent thinking
Innovations can happen in all aspects of practice.
“Good-to-great companies think differently about the role of technology. They never use technology as the primary means of igniting a transformation. Yet they are pioneers in the application of carefully selected technologies. We learned that technology itself is never a primary root cause of either greatness or decline.”

Jim Collins
Good to Great
How good leaders can facilitate optimal technology implementation
The Why

• Need a compelling rationale for why we are implementing technology
  – What’s the story behind the work?
• Our people should want or need the technology
  – It makes life easier
  – It will greatly improve the care of the patient
The How

• Understanding the limitations of technology and the costs of implementation
• Acknowledging the impact on workflow
• Smarting small—the idea of the pilot
The What

- The technology solution we choose to address a priority problem
Change starts in your thoughts.
Sensing At-Risk Populations (SARP) Using Smart Watch Technology
System Components

SensePRO System Components

Position
- Key Positions
  - Lying
  - Sitting
  - Standing
  - Walking

Location

Activities
- Daily Living
  - Cooking
  - Laundry
  - Grooming
  - Driving

Speed & Distance
- Daily Average
  - Steps
  - Distance
  - Walking Speed
  - Climbing Speed

PROs
- PROMIS
  - Overall Health
  - Quality of Life
  - Physical Health
  - Mental Health
  - Social Satisfaction
  - Social Ability
  - Everyday activities
  - Emotional
  - Fatigue
  - Pain

Watch + Home Beacons

Independent Living

Risk Score

Daily Status Change over time
- (day to day)
- (week to week)
Smart Watch
Smart Watch

(a) Smart watch
(b) Skilled Nursing Facility
   Floor plan
(c) Bluetooth beacons

* is the Bluetooth beacons location in the bedroom
Facility Patient Room
Rehabilitation Area & Patient Room
Classification of Accelerometer Signal

Magnitude of Accelerometer Signal after filter

Non-active Stationary

Active Stationary

Walking
STEPS  ACTIVITY  PREDICTIVE ANALYSIS

ENERGY SPENT  SLEEP PATTERN

INDOOR LOCALIZATION  WEEKLY PATIENT CENTERED OUTCOMES

Good Usability  Tracks with Physical Therapy  Predicts Re-admission

>300 patients  >2500 patient days

UCLA Center for SMART Health
A partnership between the UCLA Institute for Precision Health, Clinical & Translational Science Institute, and the Garrick Institute for the Risk Sciences
Visualization - Patient Level

- Home: 14.61h
- Out: 6.33h
- Active: 5.06h
- Nonactive: 15.88h
- Up: 87.25%
- Off: 12.75%

Energy Expenditure

Time in Activities:
- active
- non-active
- Walking - not_assisted
- Walking - assisted
- stationary - active - sitting
- stationary - active - standing
- stationary - active - laying_down
- stationary - non-active - standing
- stationary - non-active - laying_down
- stationary - non-active - sitting
Visualization - Patient Level

Overall Activities
- Stationary: 92%
- Active: 13.2%
- Non-Active: 86.8%
- Walking: 8%
- Assisted: 43.2%
- Non-Assisted: 56.8%

Speed
- Time: 2019-04-23 to 2019-05-20
- Speed [km/h]: 0 to 40

Data points:
- 2019-04-23 00:00:00: 5 km/h
- 2019-04-23 01:00:00: 35 km/h
- 2019-04-23 02:00:00: 10 km/h
- 2019-04-23 03:00:00: 15 km/h
- 2019-04-23 04:00:00: 20 km/h
Review of SARP Studies
Skilled Nursing Home
Inpatient Rehabilitation
Introduction

Recent advances in technology allow for the possibility of more dynamic assessment and monitoring of older individuals across a variety of key environments including skilled nursing and inpatient rehabilitation.

Within the past several years, “intelligent” easy-to-use electronic devices have been brought to market that are able to collect and transmit various types of biodata—patient position, time in motion, and even responses to questionnaires delivered remotely.

These devices can also be paired with in-facility ambient activity and location sensors to monitor patient movement and activity continuously and provide real-time feedback about changes in patient status.

Accurate assessments of functional improvement play a significant role in rehabilitation success. This study uses a smart watch based remote sensor system to monitor physical activity in real-time.
Outcomes of Patients Discharged to Skilled Nursing Facilities
Difficulty with ADL and IADL by Age
Objective

• To use a novel Sensing At-Risk Population (SARP) system to monitor older frail patients’ physical activity and locations during post-acute rehabilitation
• To examine the correlation between the SARP measurements and standard physical (PT) and occupational therapists (OT) and nurse (RN) evaluations
• To examine the effectiveness of SARP to discriminate discharge dispositions
Design, Setting and Participants

Design: A prospective cohort study

Setting and Participants: Skilled nursing facility, 99 subjects, age 60 years or older
• Participants’ physical activity was evaluated by SARP/PT/OT/RN. Six SARP measurements and 22 in-person evaluations were used for data analysis. Spearman correlations were used to determine the associations between SARP measurements and in-person evaluations.

• Univariate logistic regression was used to identify predictors of discharge dispositions. Area under the curve (AUC) for the receiver operating characteristics was used to evaluate the ability of the predictors to discriminate discharge dispositions.
Results

- SARP measurements and PT/OT/RN evaluations were correlated significantly.
- Outside the PT/OT setting, SARP indicated that participants were active for only 5 minutes/hour during post-acute rehabilitation.
- SARP metric of Energy intensity significantly predicted hospital readmission (AUC>84%) with recall of 78%, versus PT/OT/RN evaluations (AUC>57%).
Results
Conclusions

- SARP, a smartwatch-based single triaxial accelerometer and Bluetooth beacons, provides older patients’ physical activity information during post-acute rehabilitation in real-time.
- Not only is SARP significantly correlated with PT/OT/RN evaluations, but it also helps to discern discharge disposition:
  - Patients readmitted to the hospital spent more minutes/hour in the room as compared to those discharged home (49.2 minutes versus hospital 57 minutes versus other nursing facilities 55.8 minutes, p=0.03)
  - Participants readmitted to the hospital were active for only 3.6 minutes/hour whereas those discharged home (6.6 minutes/hour and to other nursing facilities were active 6.0 minutes/hour, p=0.007)
  - SARP metrics ACTIVE and ENERGY significantly predicted hospital readmissions, with AUC 0.75 and 0.71 respectively (both p<0.05)
Sensing in At Risk Populations (SARP): Monitoring performance status, activities of daily living, and independence to promote safe outcomes for elderly patients in rehab, the home and long-term care.

SARP is a UCLA research project being conducted at California Rehabilitation Institute. The SARP system aims to gauge the wellbeing and independence level of elderly patients living at home, at-risk of functional decline. The SARP system harnesses the metrics achieved from the Smart Watch (activity) and sensors (indoor localization) to track its user’s activity. The system’s ultimate goal is to predict improvement and decline in patients to alert caregivers and doctors and prevent hospitalization.

As part of this project patients who choose to participate will be interacting with the following:

1) Sensors placed on walls. Think of them as lighthouses. They only broadcast their identity number and nothing else. They do not record anything, nor do they communicate with any other devices. Our watches can detect sensors only when they are close to the sensor. You may notice these sensors throughout the patient areas in the facility. Please do not remove them. If there are any concerns with their location please notify Dr. Pamela Roberts.

2) The Smart watch records the wearer’s activity (sitting, standing, walking, bathing and sleeping) and detects the sensors installed throughout the facility.

Dr. Pamela Roberts and UCLA study team members will recruit participants within the patient’s first 1-3 days of admission to Cal-Rehab. Individuals who agree to participate will sign an informed consent form, HIPAA form and will be assigned a Smart watch. The watch will be charged each morning and placed on the participants wrist to be worn the remainder of the day and all night.

Participation will last up to 21 days or the length of the patient’s Cal-Rehab stay.

SARP participants will wear the watch at all times, including when they are:
- Sleeping
- Bathing
- In Rehab sessions

If you have any problems or questions you can reach the study coordinator, Dr. Pamela Roberts at (310) 794-0989 or ECRI@mednet.ucla.edu
Reliable Monitoring of At Risk Individuals – Inpatient Rehabilitation

- Asking patients to wear the watch during waking and sleeping hours
  - Will remove for one hour per day
- Collection of data at admission, discharge and follow-up from California Rehabilitation Institute
Reliable Monitoring of At Risk Individuals Outside of Healthcare Institutions

- Using remote monitoring data to risk stratify older adults can lead to care strategies that increase quality at lower cost that can fund innovative bundled payments and shared savings models.
Lessons Learned/Next Steps
Facilitators

- Need for innovation to meet demands
- Role of sensors in healthcare can assist with health and patients in terms of prediction, anomaly detection and decision making
- Mobile technology can enable data collection in real-time
- Provides insight into patient’s functional status and its associated declines or improvements
• Standardization of clinical concepts
• Quantification of sensor-based data
• Translating sensor data to meaningful clinical insights
• Population-based versus personalized norms
• Extracting implicit interesting patterns/outcomes that are not very common, i.e., A LOT more data collection needed
• Older adults use of technology
• Battery Consumption of technology
• Need of passive technology: Building a system that requires bare minimum effort from patients
• System limitations and constraints
  – Sampling, Sensitivity, Battery Life, Uncertainty and ability to capture detailed scenarios
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