

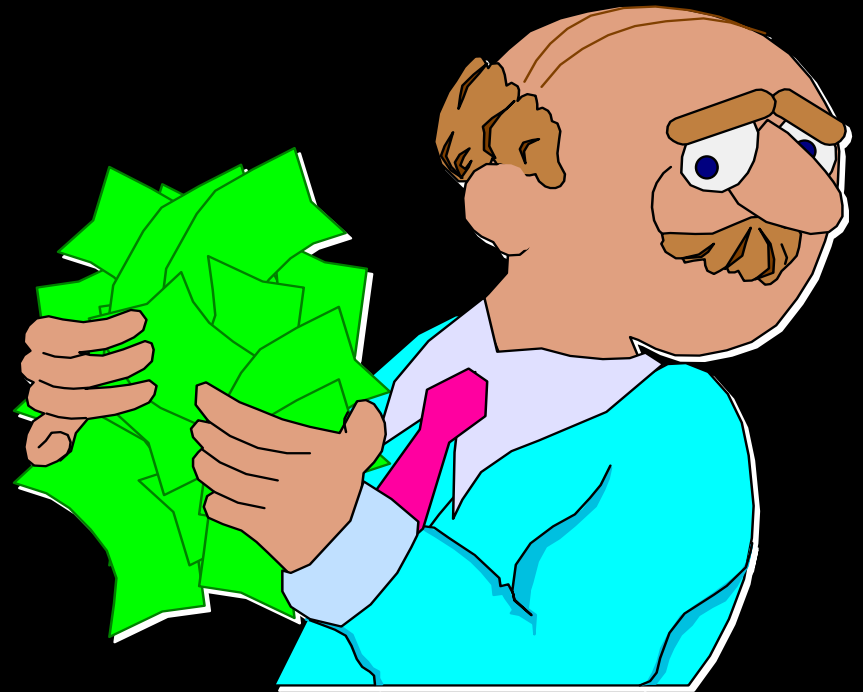
Smart Technology: Keeping our Elders Independent

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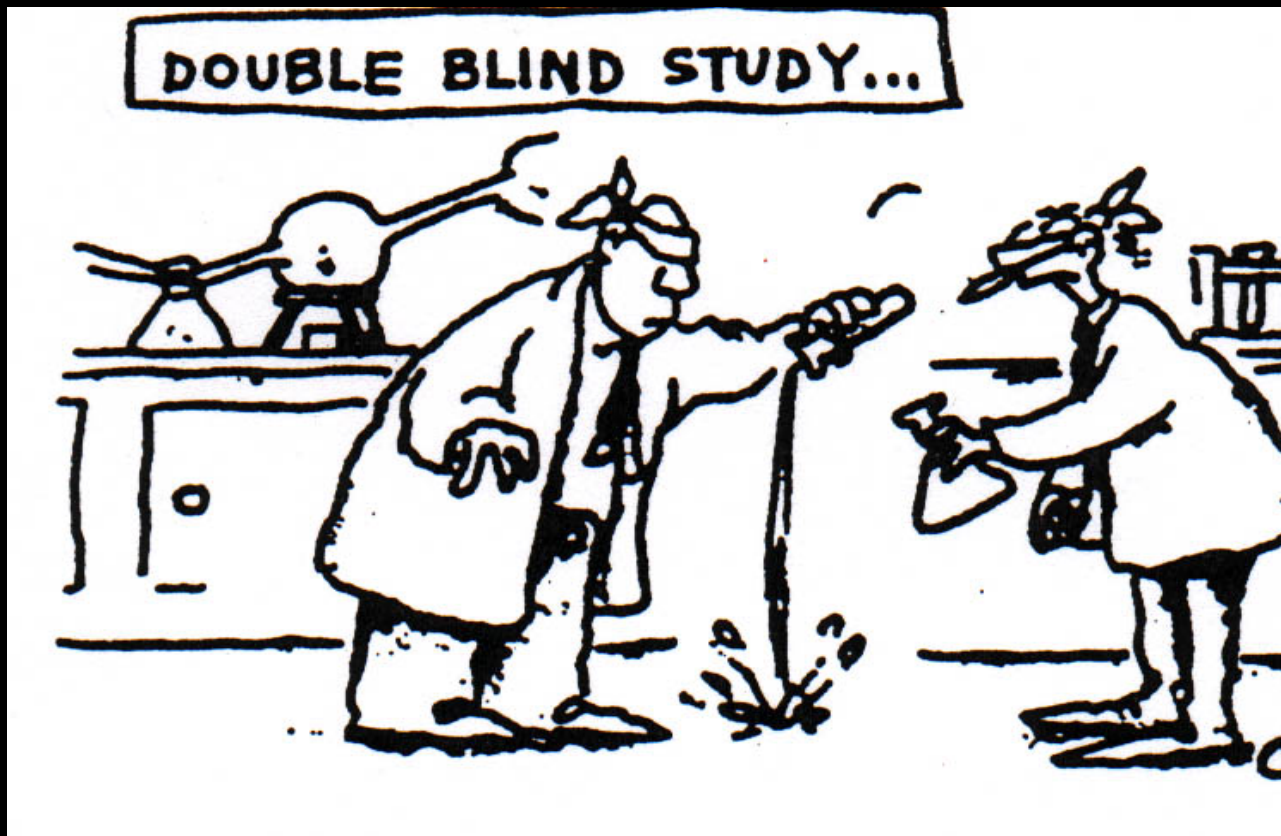
Introduction Cont'd

Why do Elders Deserve
Smart Technology??

- It's not just good healthcare, but good economics!!!!!!



Where are all the studies?



Models of Care

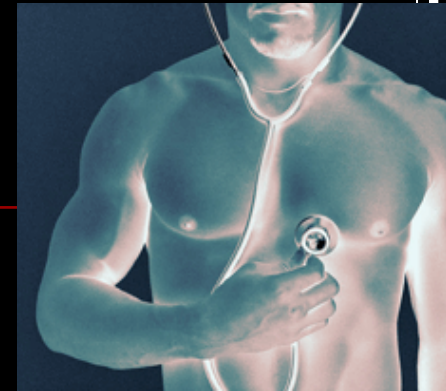
- Acute Care for the Elderly (ACE)
- Nurses Improving Care for Health Systems Elders (NICHE)
- Geriatric Resource Nurses (GRN)
- Transitional Care
- Family Centered Care



Smart Homes Technology



Use of Genomic Proteomic Screening in Personalized Health



Genomic
Screening
for Chronic
Disease



Targeted Daily Monitoring



Data Interpretation



Early Warning of Disease Onset



Proteomic Screening



Personal Health Maintenance

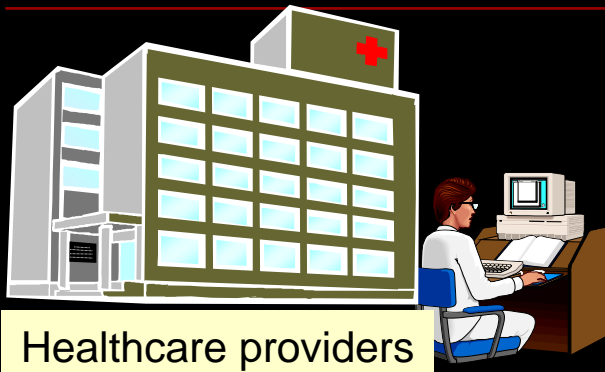


Health Intervention

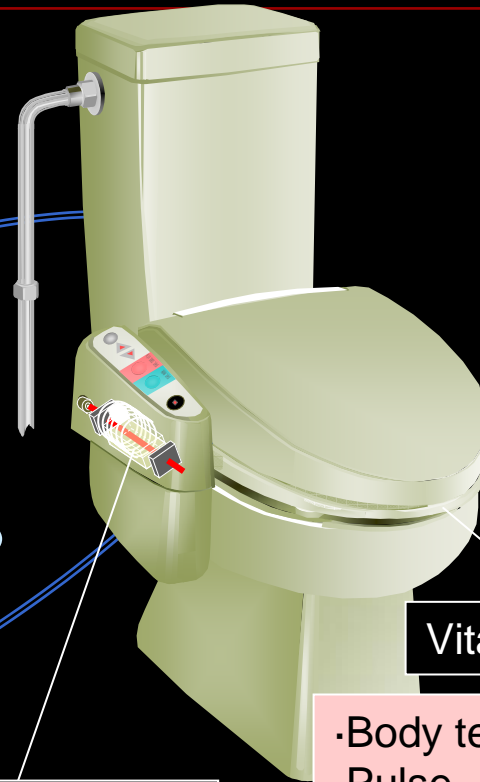


The MARC Blood Pressure
Measuring Bed

Home-Health Networked Medicine



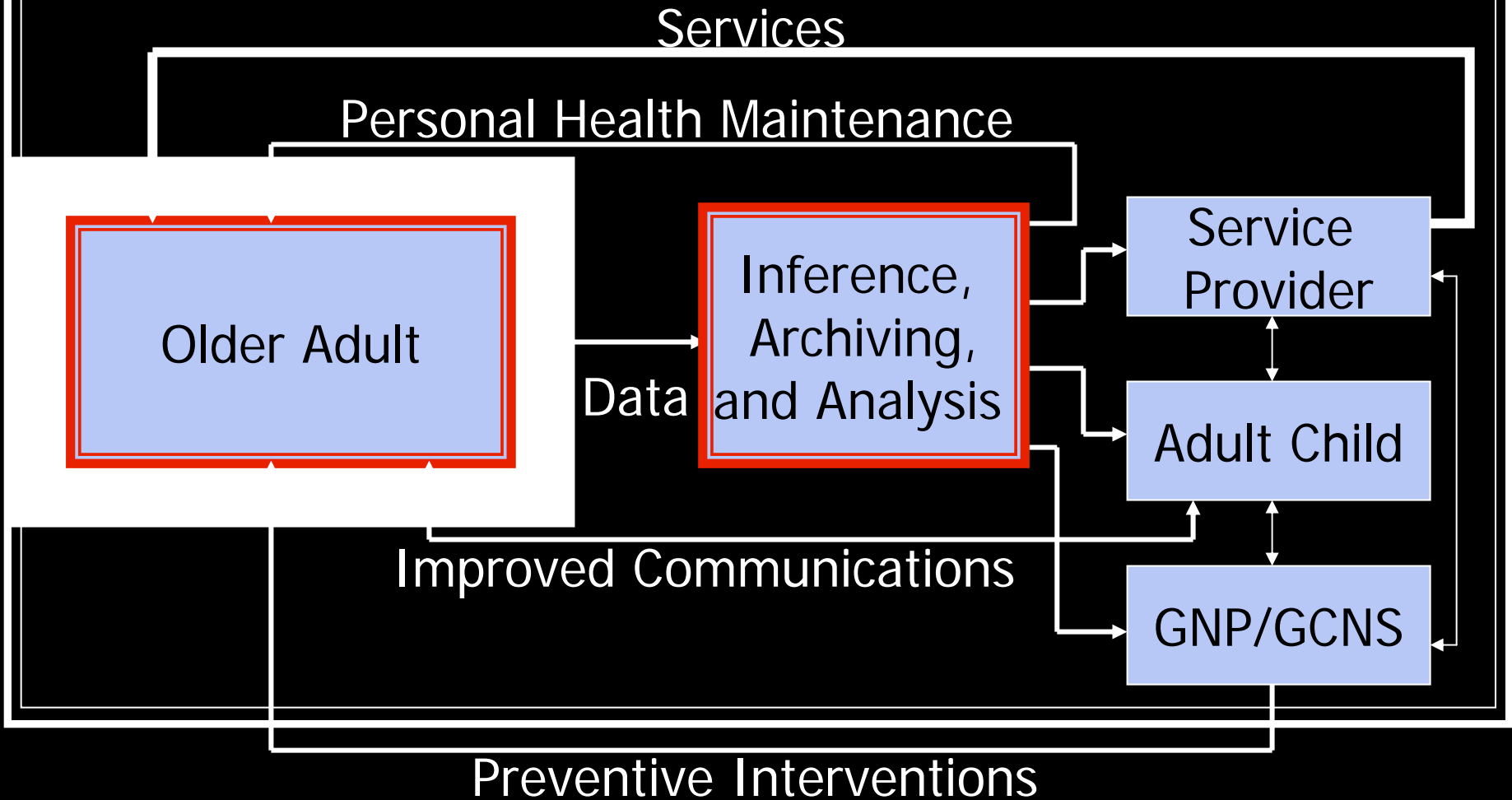
Home network



- Body temperature
- Pulse
- Blood Pressure
- Body fat percentage

- Urine protein
- Urine glucose

Model for Technology-Enabled Care



Objectives of In-Home Monitoring Project



- Enhance independence through monitoring Instrumental Activities of Daily Living (IADLs) and other health indicators
- Provide opportunity for medical and/or family intervention before a crisis occurs
- Provide reassurance and minimize caregiver burdens
- Potentially delay admittance to a nursing home and reduce the healthcare bill for payer

Focus on Independent ADLs

- Examined clinically accepted assessment tools: ADLs & IADLs
- Developed a method to detect most of these activities passively: sensors targeting activity, and inference rules that infer what activity took place, where, and when
- Deployed an extended suite of sensors particularly in the kitchen (temperature sensor, microwave and kitchen cabinets etc.)
- Needed to validate the results

Validation Results: Meal Preparation and Showering



The system was validated over 37 days, through comparisons to a customized PDA activity log

- Inference rules are reliable: high correlations between the user's activity log and the detected activities
- Detected activities that were not logged
- No lunch, dinner or showering events were missed by the detection

algorithm

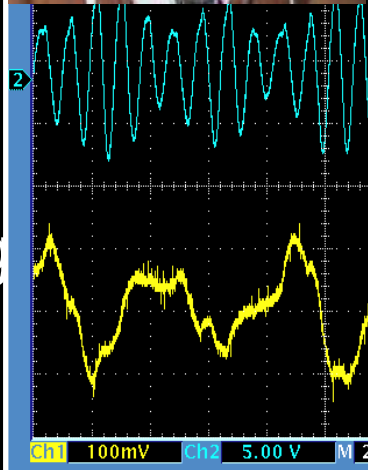


Once you have selected the appropriate room move to the "Activity" tab, located to the right of the "Room" tab. Select your appropriate activity by clicking on the arrow corresponding your activity selection.

Passive Vital Sign Bed Monitor

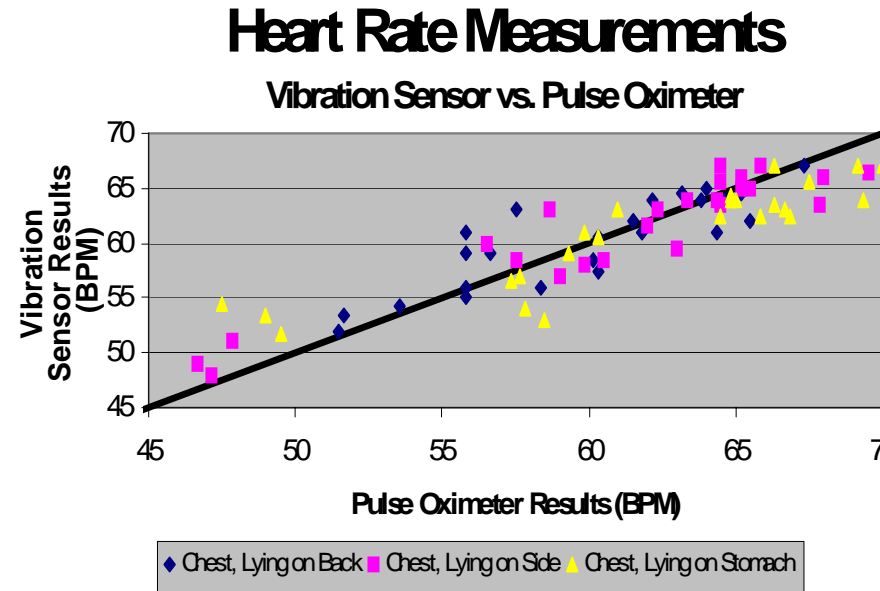
Mattress pad to measure:

- Sleep quality
- Pulse (and HRV)
- Breathing
- Movement/ restlessness
- Bed exit
- Subject position/ turning
- Body temperature
- *Exploring* measuring BP



Validation Results

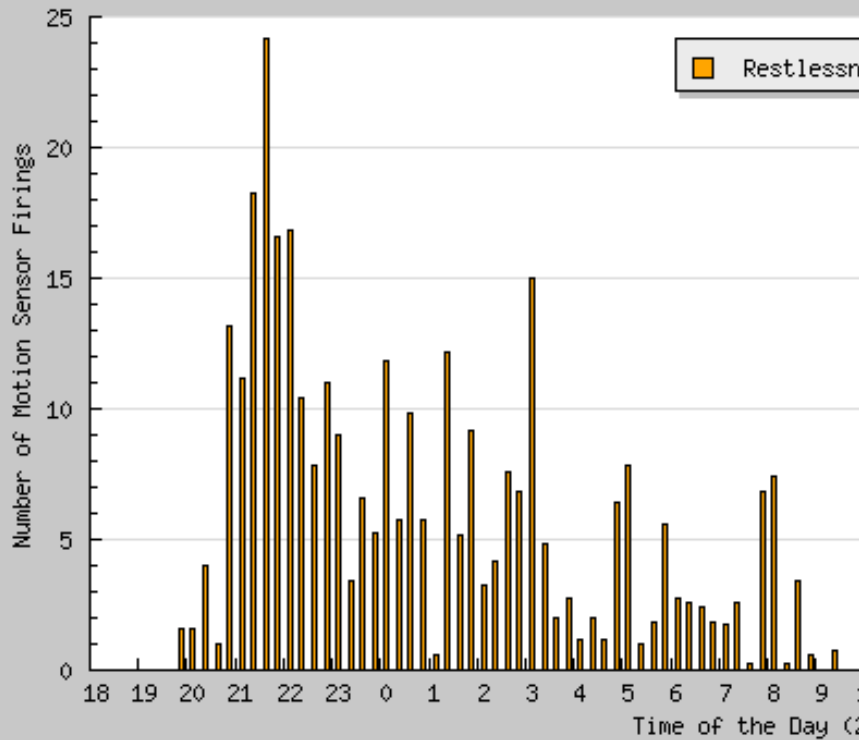
Results from passive interaction are demonstrably accurate



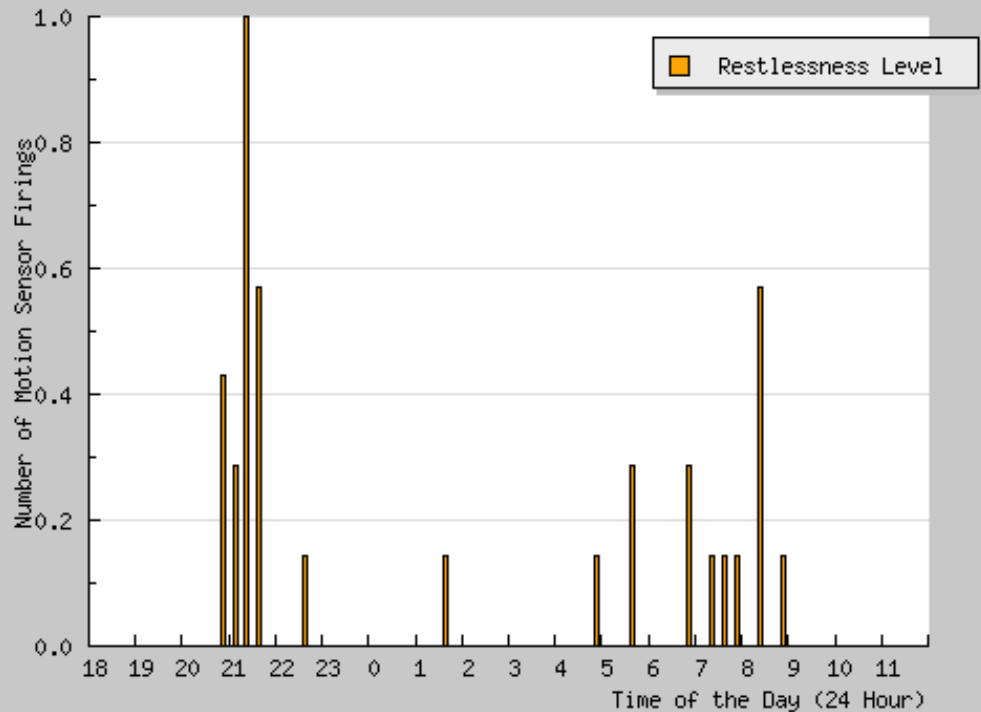
Heart Rate Measures	Correlation Coefficient		Standard Deviation in Beats per minute (BPM)	
	R ²	p	from best fit line (BPM)	From 45° line BPM)
Chest, all positions	0.811	<0.0001	2.09	2.55
Abdomen, all positions	0.854	<0.0001	2.16	2.23
Overall	0.829	<0.0001	2.16	2.39

Sleep Quality Graphs

Restful Resident



Restless Resident



Passive Gait Monitor and Fall Detector

- Falls are prevalent in older adults
- Passive floor vibration sensor measures steps
- Monitors gait characteristics
- Detects falls



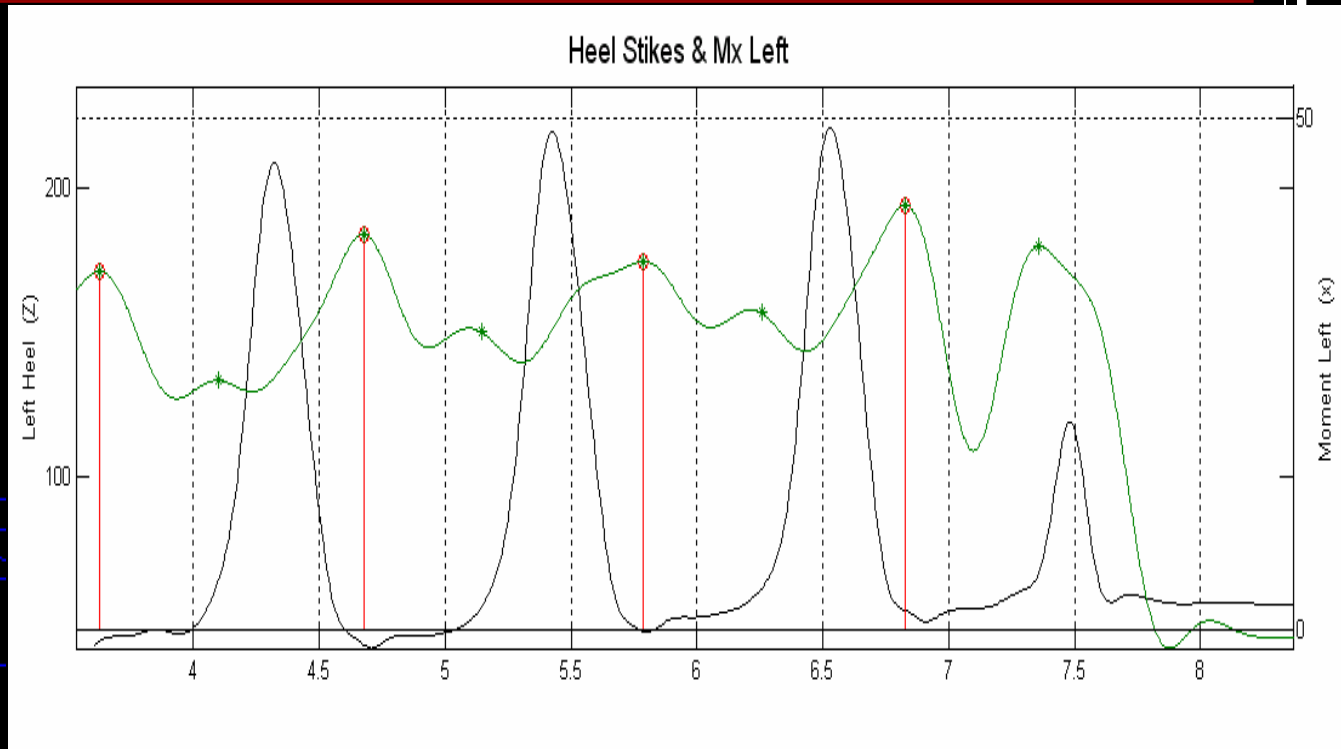
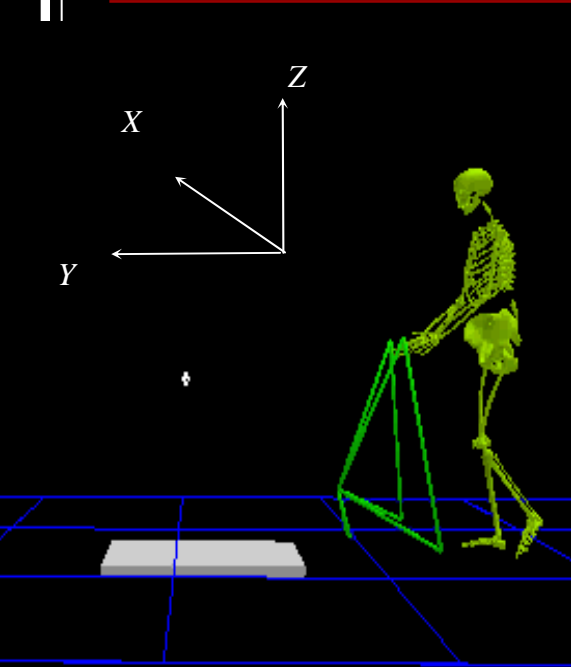
The sensor system shown mounted on the baseboard in walkway path

Other Eldercare Technology Projects: Robotic Walker

- Obstacle Avoidance
- User-Intent Inference:
 - Distinction between unseen obstacles and docking targets
 - Path prediction
 - Environment perception and building localized map
 - Identification of potential navigational goals
- Assistance in navigating cluttered environments



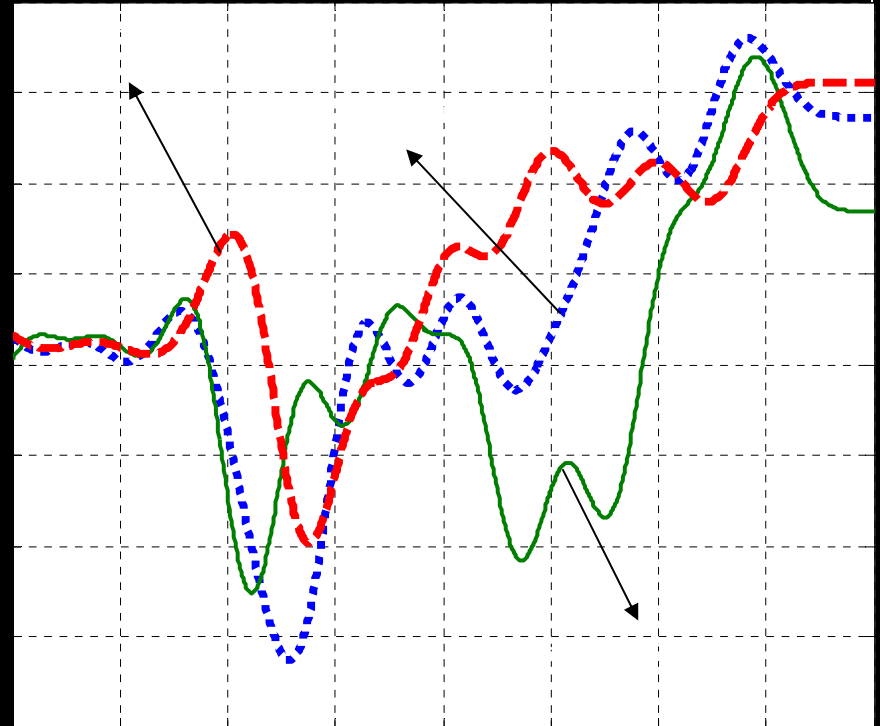
Inference of Walker-Assisted Gait



- Detected heel-strike events
- Estimated toe-off instances
- Computed gait phases

Walker-User System Balance

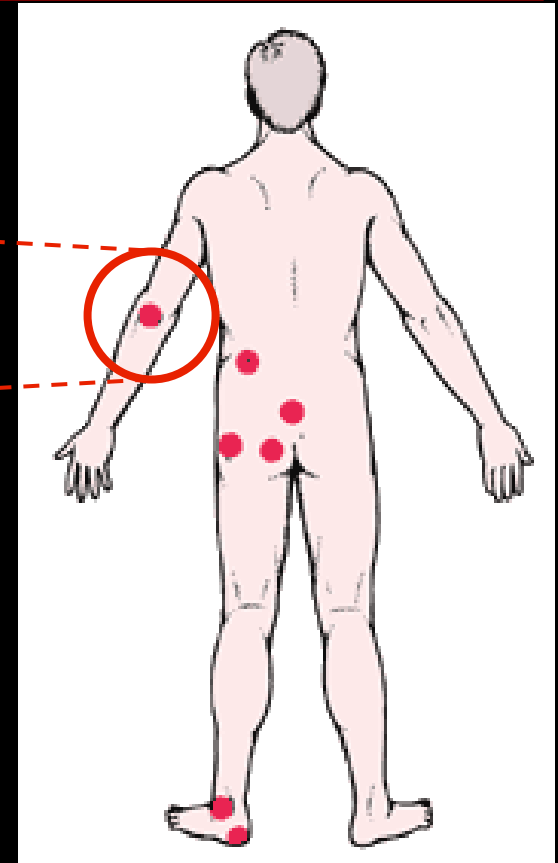
- Balance of the walker, under the user's force-moment input
- Inference of user's support/ balance needs
- Instrumented walker could potentially be used for gait and balance assessment



outside the labs (tele-rehabilitation).

Detection of Stage I Pressure Ulcers

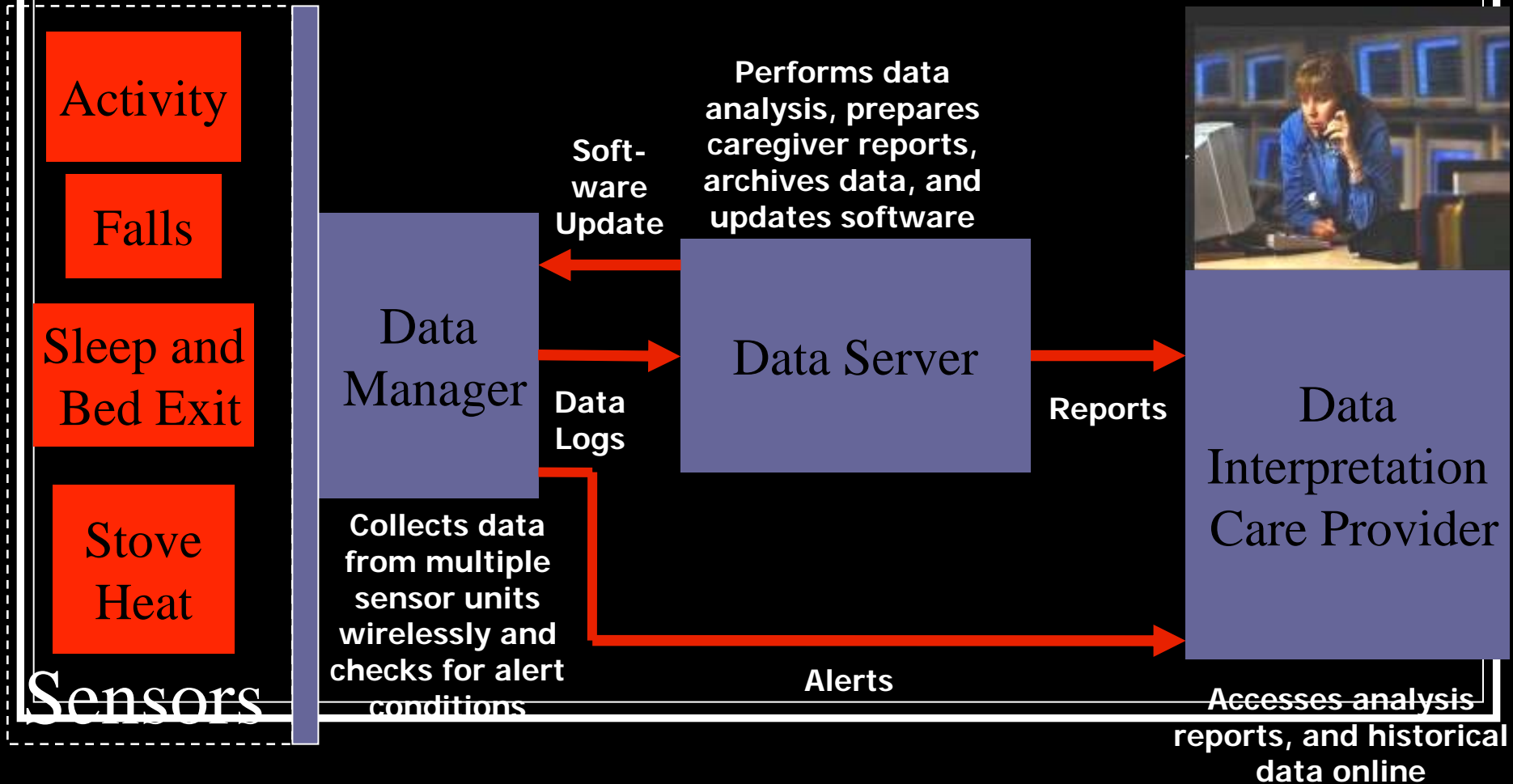
- Pressure ulcers are common in LTC settings
- Difficult to detect in patients with high melanin concentration
- Exploring different low cost imaging / image processing techniques



Assisted Living Pilot

in partnership with Volunteers of
America National Services

Monitoring System Overview



Sensor Components Installed in the Pilot site

- Movement detection – motion in every room, including bathroom and shower area, as well as entry way
- Temperature detection – monitors temperature over cook stove
- Bed sensor – monitors presence and movement in bed, bed-exit and whether heart rate is outside a predefined normal range

Activities Monitored and Alerts

- Optimized the System and the Activities Inference Engine for congregate care settings and augmented with immediate alerting capability
- Activities monitored: Bathroom use, Bathing/ Showering, Time in bed, Time out of bed, Movement in bed (restlessness)
- Implemented alerts: possible fall, forgotten stove, low pulse and high pulse in bed
- The Fall alert was based on bed-exit, inferred from the bed-pad and motion sensing only; no fall event sensor



Pilot I: Outcome Evaluation Method



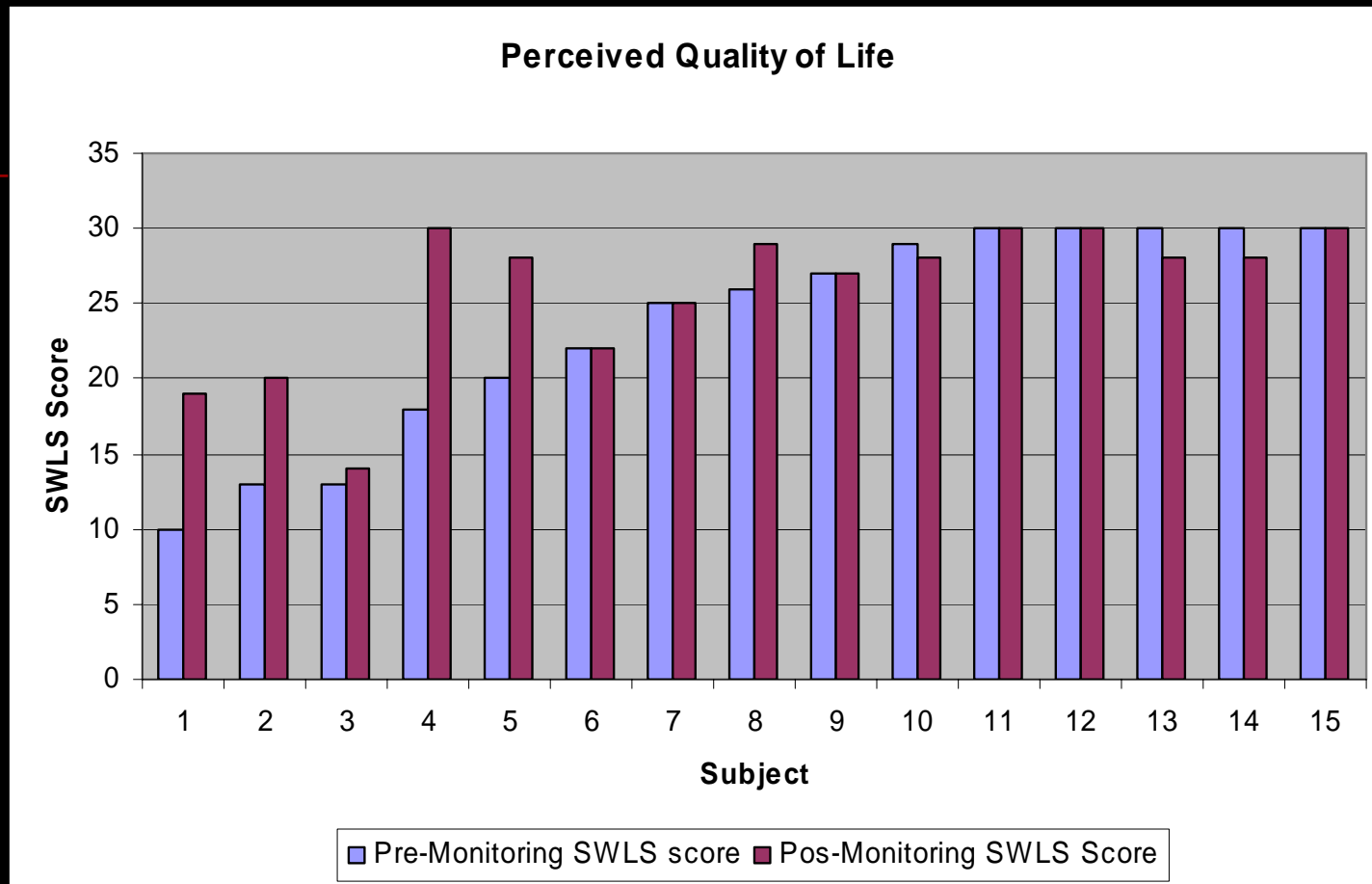
- Monitoring Surveys
- Caregiver Strain Index and Caregiver Burden Interview
- The quality of life of monitored residents was assessed using the Satisfaction With Life Scale

Survey Results



- Enrollment success rate of 92% (24 out of 25 approached)
- 21 out of 22 (95%) older adults asked said they accepted non-invasive monitoring (one person checked *Maybe*)
- The majority said they would allow professional caregivers (91%) and their informal caregivers (68%) access to their data
- Most common concern was falling and not receiving help quickly

Resident's Quality of Life



- Pre-monitoring mean (23.53 ± 7.12 , Standard Error= 4.90)
- Post-monitoring mean (25.87 ± 1.84 , Standard Error= 1.26)
- A paired t-test for means yielded $p = 0.031$

Care Delivery and Planning



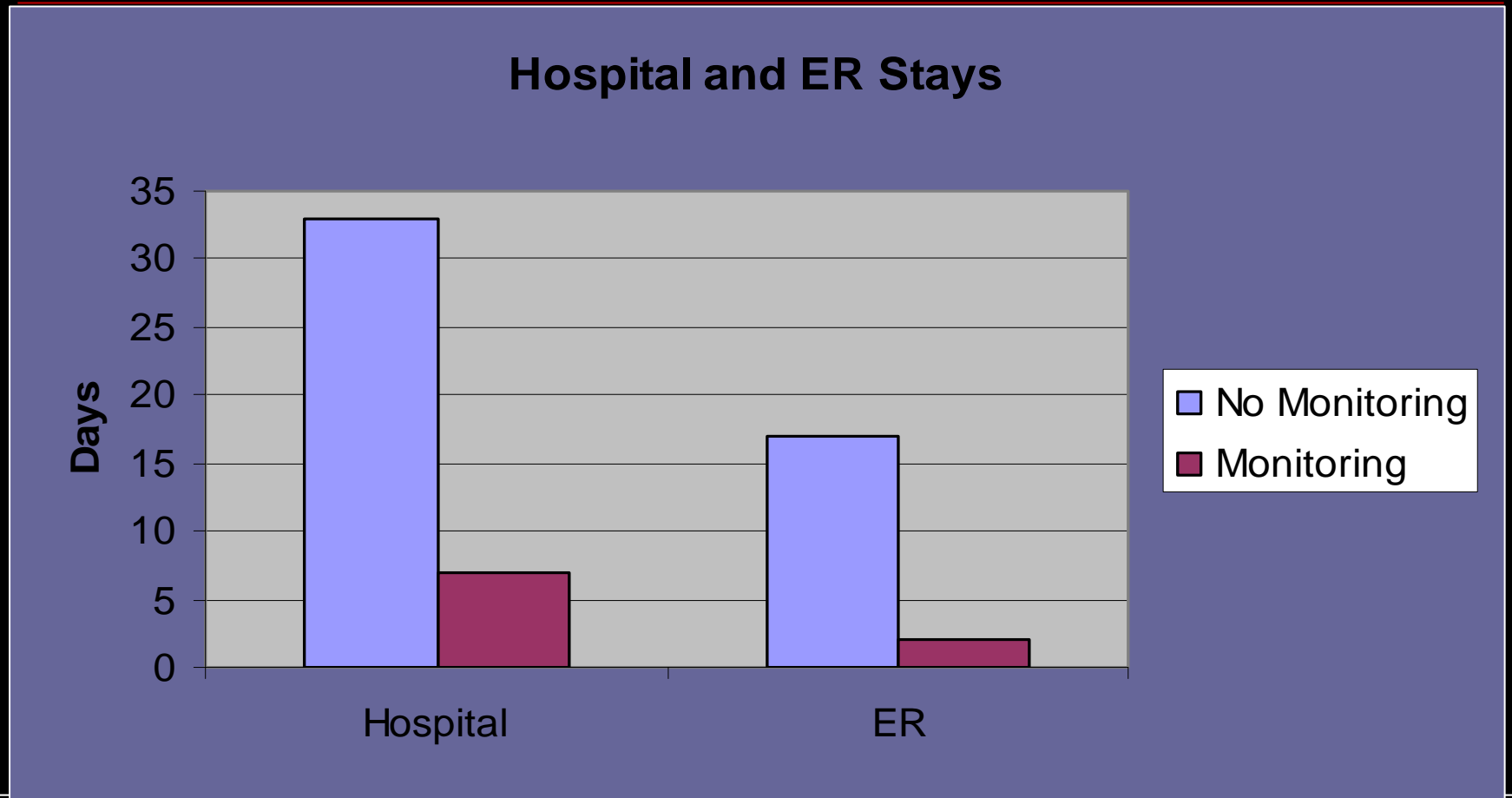
- The data analysis and reports (increased nightly bathroom visits, increased restlessness) allowed the detection of two cases:
 - Urinary Tract Infection (UTI)
 - Rectal bleeding

Pilot II: Outcome Evaluation Method



- Controlled study design (21 subjects in each group)
- Measured frequencies of billable interventions to assess impact on cost of care to payer
- Measured staff workloads and Care Recipients to Caregivers ratios
- Data collected over 3 months

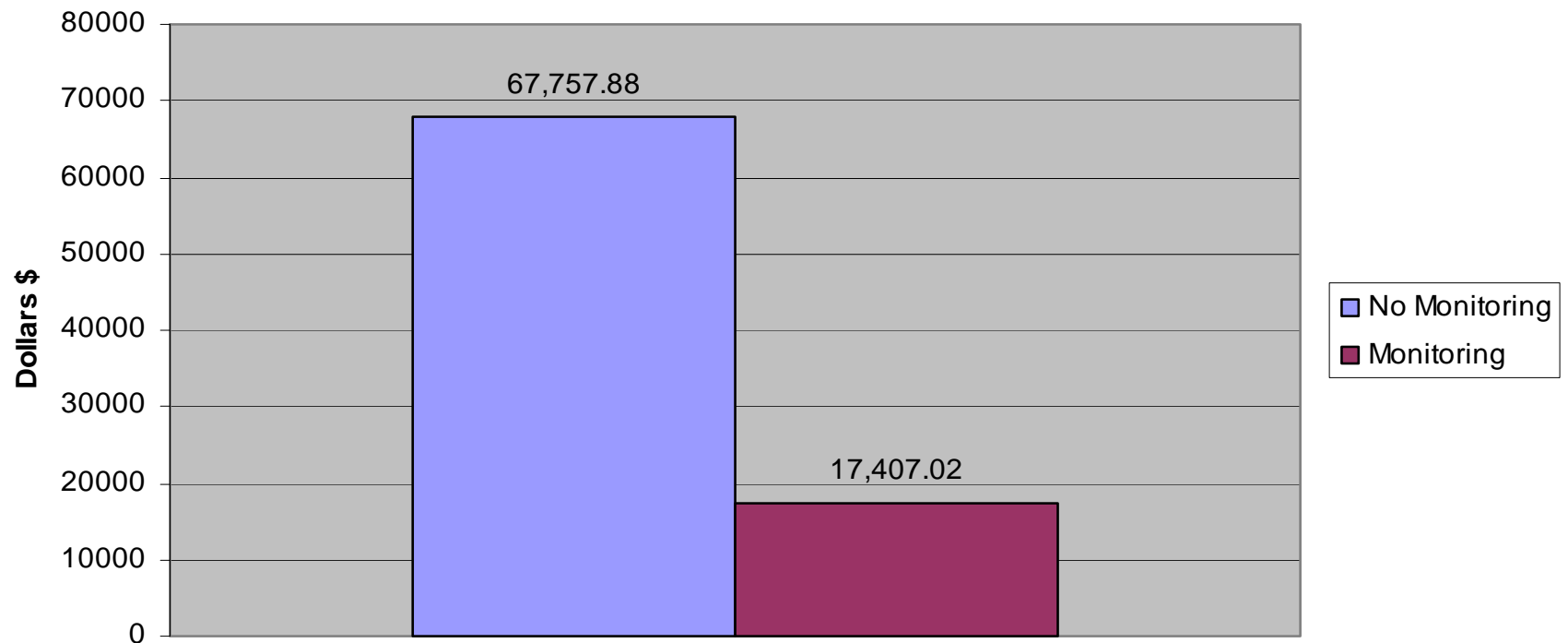
Hospital Days



N=21 in each group, P<0.05 statistically significant

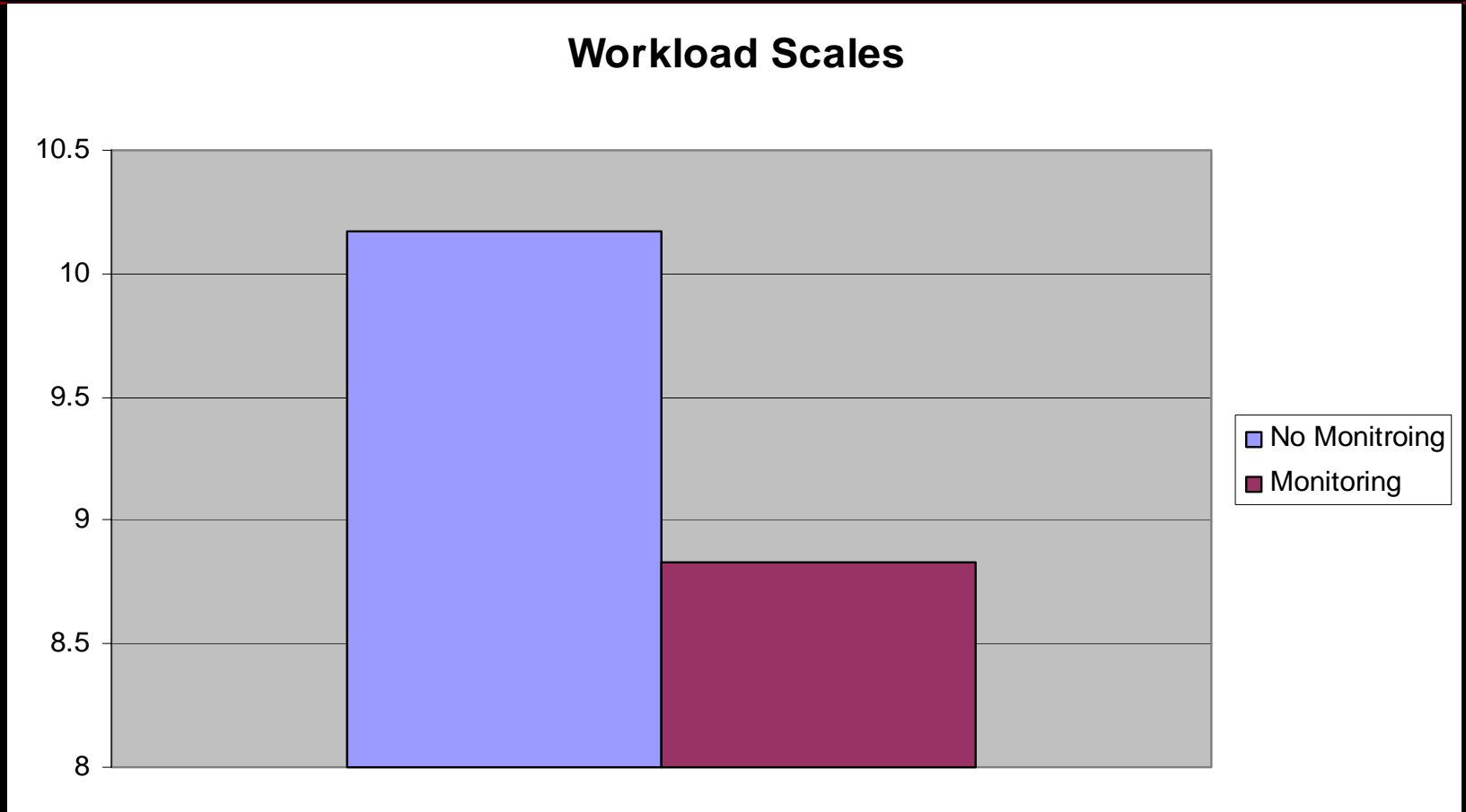
Cost of Care to Payer

Overall Cost of Care Comparison



N=21 in each group, P<0.05 statistically significant

Professional Caregivers Workloads



N=6 in each group, $P > 0.05$ non-significant

Conclusions from Pilot II



- The monitoring technology enabled preventive interventions
- This study shows that the appropriate utilization of the technology could result in cost savings to payers
- The technology did not increase non-billable interactions via fax/ phone with the physician/ health care provider
- Monitoring may have improved professional caregivers' efficiency.

**“In God We Trust . . .
All Others Bring Data”**





Conclusion

- Age wave
 - Population
 - Nursing workforce
- Innovative models of geriatric care needed
 - Cost-effective technologies that keep elders safe, independent and functioning may be key to the future!

Creative Geriatric Technology



"Never, ever, think outside the box."

*Leo
Lieber*

Where Heading to the World Cup!



Thank you for your attention.....

