CIL-VIZ: CLINICIAN-IN-THE-LOOP VISUALIZATION TOOL

Development of a Remote Health Monitoring System Through Iterative Design

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INTRODUCTION

- Sensor data can be used to monitor patient activities and to identify behavior changes that are related to important health events.
- The process is currently time intensive.
- To maximize the benefits of smart home data, an efficient way to recognize behavioral changes related to health status is needed.
- Project aim: translate information from sensors to visual analytics that illustrate health information.
  - Design visual analytics that enable clinicians to quickly identify changes in health status.
  - Help people stay healthy and live independently longer.

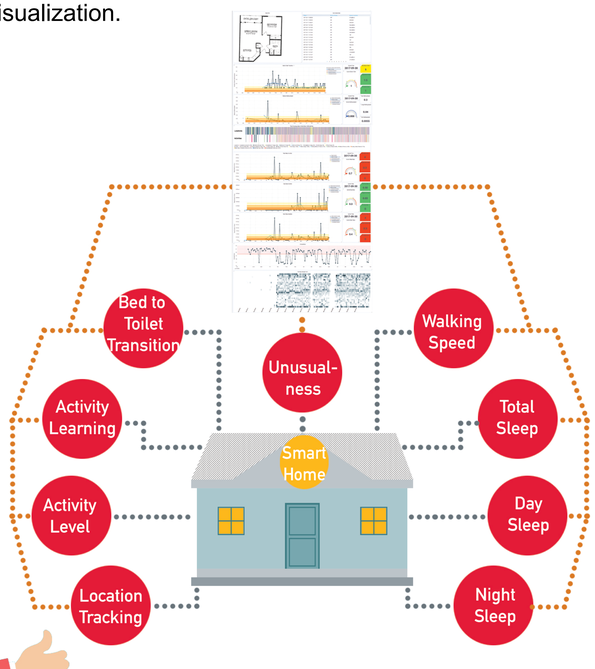
METHODS

Data Collection

- Sensor data from 3 Smart Homes
- Residents' clinical information

Iterative Design Process

- Participants: 3 trained clinicians (longitudinal), 4 nursing students (cross-sectional)
- Participants viewed visualizations and provided:
  - Responses to open-ended and quantitative survey questions assessing the ease of interpretation and clinical utility of each visualization.



"It is clinically meaningful to not only know something like how much a person is sleeping at night, but how much are they sleeping relative to their baseline. This system assesses individual habits and patterns so clinicians can easily pick up on changes in habits." *(Participant feedback)*

RESULTS

Longitudinal	Strongly Agree							Strongly Disagree
	Iteration	1	2	3	4	5	6	7
Overall, I am satisfied with how easy it is to use this system.	1			33% (1)	66% (2)			
	2		33% (1)		33% (1)	33% (1)		
	3		33% (1)	33% (1)			33% (1)	
I could effectively complete the tasks and scenarios using this system.	1			100% (3)				
	2		33% (1)	33% (1)		33% (1)		
	3		33% (1)		33% (1)		33% (1)	
This system has all the functions and capabilities I expect it to have.	1					33% (1)	33% (1)	33% (1)
	2				66% (2)		33% (1)	
	3		33% (1)		33% (1)			33% (1)
Overall, I am satisfied with this system.	1			33% (1)	33% (1)		33% (1)	
	2			66% (2)		33% (1)		
	3			66% (2)			33% (1)	

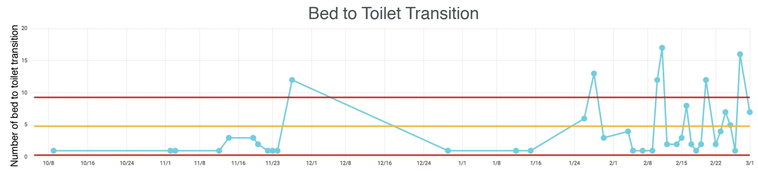
Cross-Sectional	Strongly Agree						Strongly Disagree		
	Iteration	1	2	3	4	5	6	7	N/A
Overall, I am satisfied with how easy it is to use this system.	1					50% (1)	50% (1)		
	2			100% (2)					
I could effectively complete the tasks and scenarios using this system.	1					50% (1)	50% (1)		
	2			100% (1)					
This system has all the functions and capabilities I expect it to have.	1								100% (2)
	2		50% (1)	50% (1)					
Overall, I am satisfied with this system.	1					50% (1)	50% (1)		
	2			50% (1)	50% (1)				

Tables 1 and 2. Frequency of longitudinal (top) and cross-sectional (bottom) responses by percentage and number to survey questions assessing the usability of visualizations for iterations 1-3.

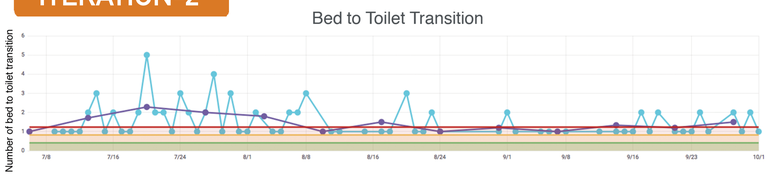
- Changes implemented following participant feedback:
  - Activity level presented as a heat map
  - Anomaly graph added to depict "unusualness" of the day
  - "Dial" graphics added
  - Rolling baseline and additional standard deviation lines added
- Cross-sectional and longitudinal participants provided similar requests related to the first two iterations including more precise, descriptive labels and clearer use of color.

VISUALIZATION DESIGN ITERATIONS

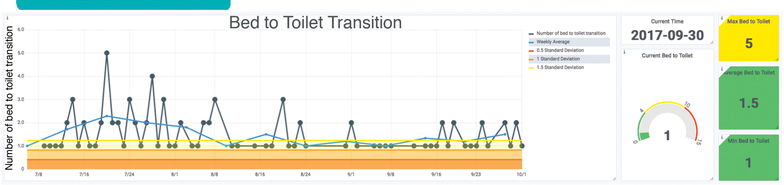
ITERATION-1



ITERATION-2



ITERATION-3



CONCLUSIONS

- Overall, we were able to make substantial improvements to an online dashboard that displays a variety of health information and receive feedback from clinicians in terms of ease of visualization interpretation and clinical utility
- Across longitudinal and cross-sectional analyses, we discovered significant individual participant variability in preferences and suggestions
- Based on participant feedback, we intend to address some of the remaining limitations to clinical utility by:
  - Improving anomaly graph to better capture irregularities in the data
  - Incorporating more specific information from the data (e.g., depict when someone else enters the home, distinguish between sleep interruptions due to bed-to-toilet and other reasons, distinguish between "relaxing" and sleeping in areas other than the bedroom)

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