



**Agency for Healthcare Research and Quality**  
*Advancing Excellence in Health Care*

# **AHRQ**

# **Health IT Grantee and Contractor Meeting**

**Friday June 4, 2010**



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Advancing Excellence in Health Care

## Boston University School of Medicine / Northeastern University

# Emerging Technologies Demonstrations of the Virtual Patient Advocate

*Annual Health IT Conference  
Agency for Health Research and Quality  
Washington, DC  
June 26, 2010*



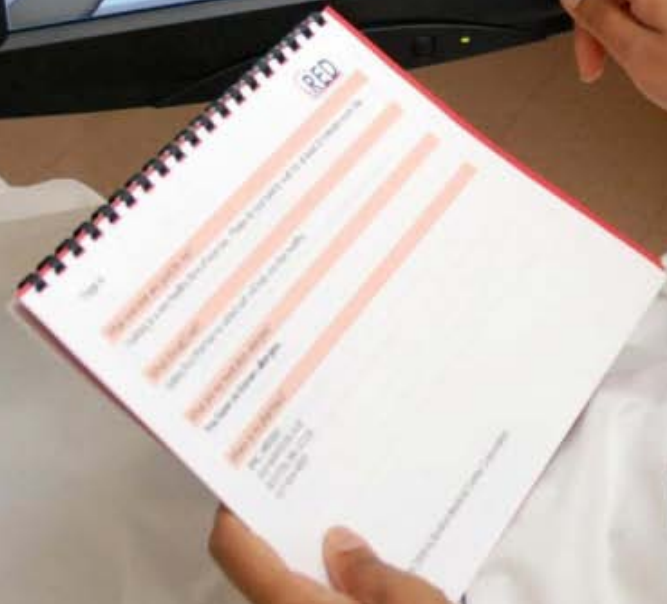
Northeastern  
University

Brian Jack MD  
Associate Professor and Vice Chair  
Department of Family Medicine /  
Boston University School of Medicine

Tim Bickmore PhD  
College of Computer and Information Science  
Northeastern University

BOSTON  
UNIVERSITY  
SCHOOL of  
Medicine







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# Motivation: Rapid Acceptance

Natural, intuitive modality provides rapid acceptance

Emulate human face-to-face conversation

Focus on nonverbal communicative behavior

gaze, posture,  
gesture, etc.



# Motivation: Patients with Low Health Literacy

Face-to-face communication, in conjunction with written instructions, is best

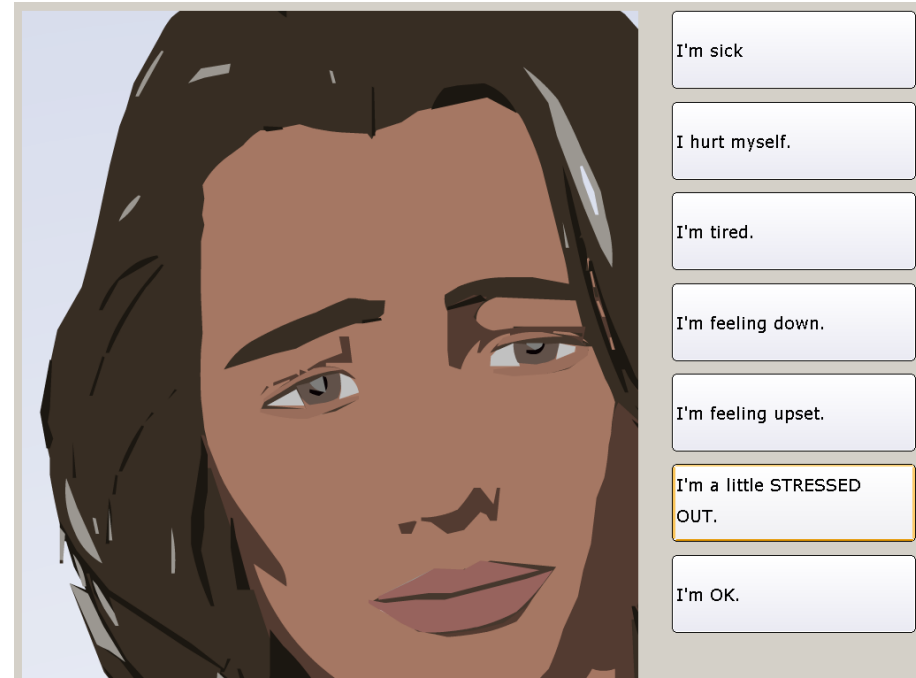
However, most health professionals have extremely limited time to spend with a patient



# Motivation: Therapeutic Alliance

Maintaining engagement is a pre-requisite for longitudinal interventions.

Agents can emulate human relationship-building behavior to build and maintain trusting, therapeutic alliance.





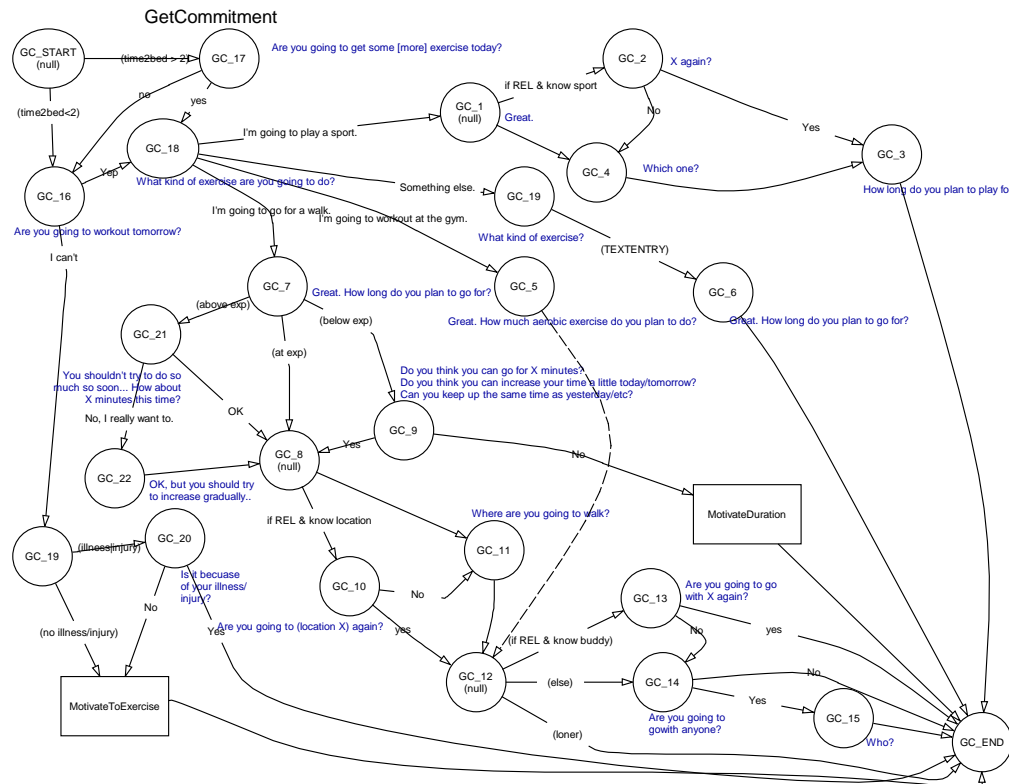
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# Technology Overview



# Agent Architecture: Dialogue Representation

## Hierarchical Transition Networks





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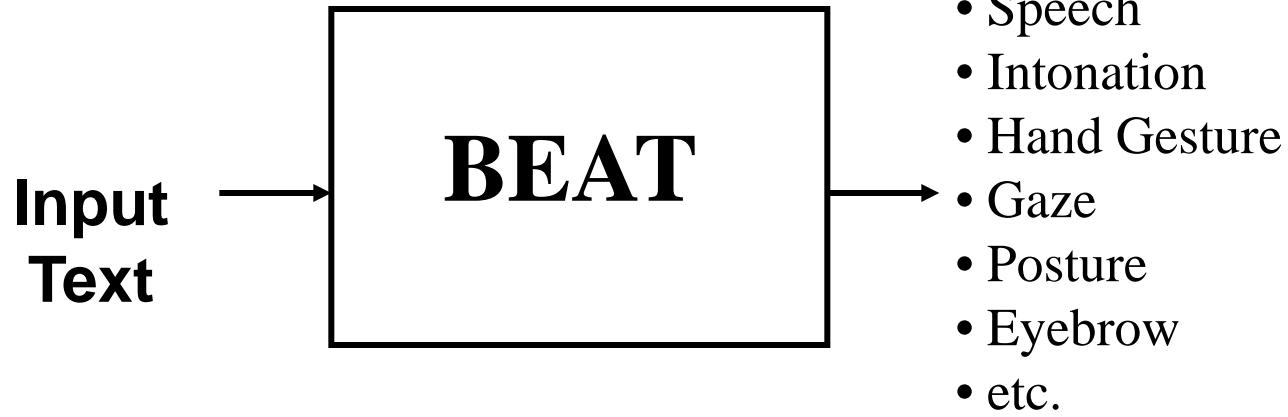
# Agent Architecture

## Dialogue Representation

Agent utterances represented by words plus XML annotations for synchronized nonverbal behavior

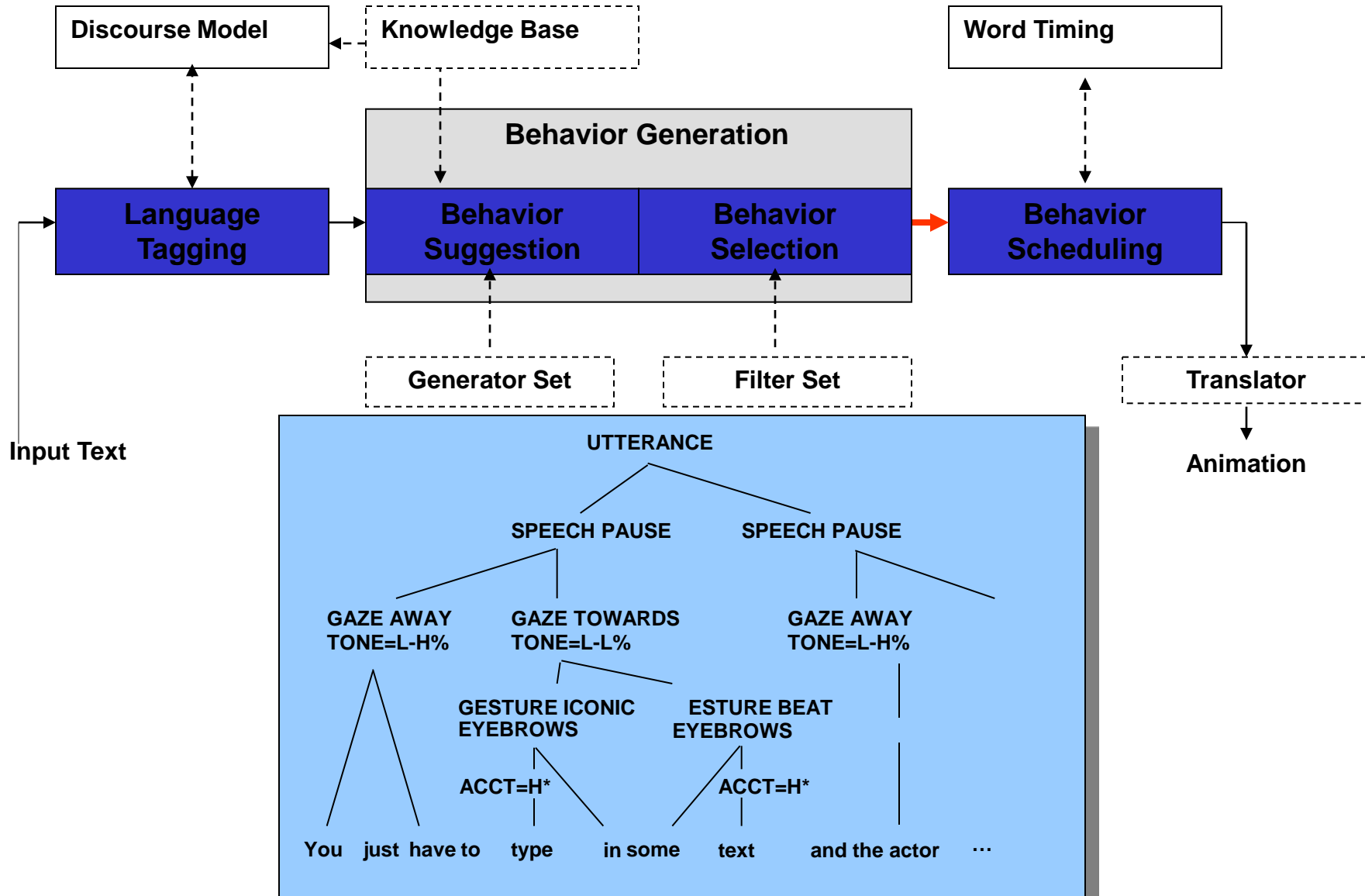
```
<UTTERANCE>It is for your  
<HEADNOD/><BEAT>blood  
pressure.</BEAT></UTTERANCE>
```

# BEAT



**Animation**

# XML Trees Passed Among Modules



# Agent Architecture Development Tools

The screenshot displays the Eclipse IDE with the following components:

- Navigator:** Shows a project structure with folders like 'bin', 'src', and 'java'.
- Main Editor:** Contains a state transition diagram with five states:
  - I1:** Agent asks for name, user responds 'Louise', agent confirms.
  - I2:** Agent greets user, user says 'OK-A'.
  - I3:** Agent offers help, user says 'OK-A'.
  - I4:** Agent shows a camera zoom, user says 'OK-A'.
  - I5:** Agent shows a business look.
- Console:** Shows the BEAT code for each state:
 

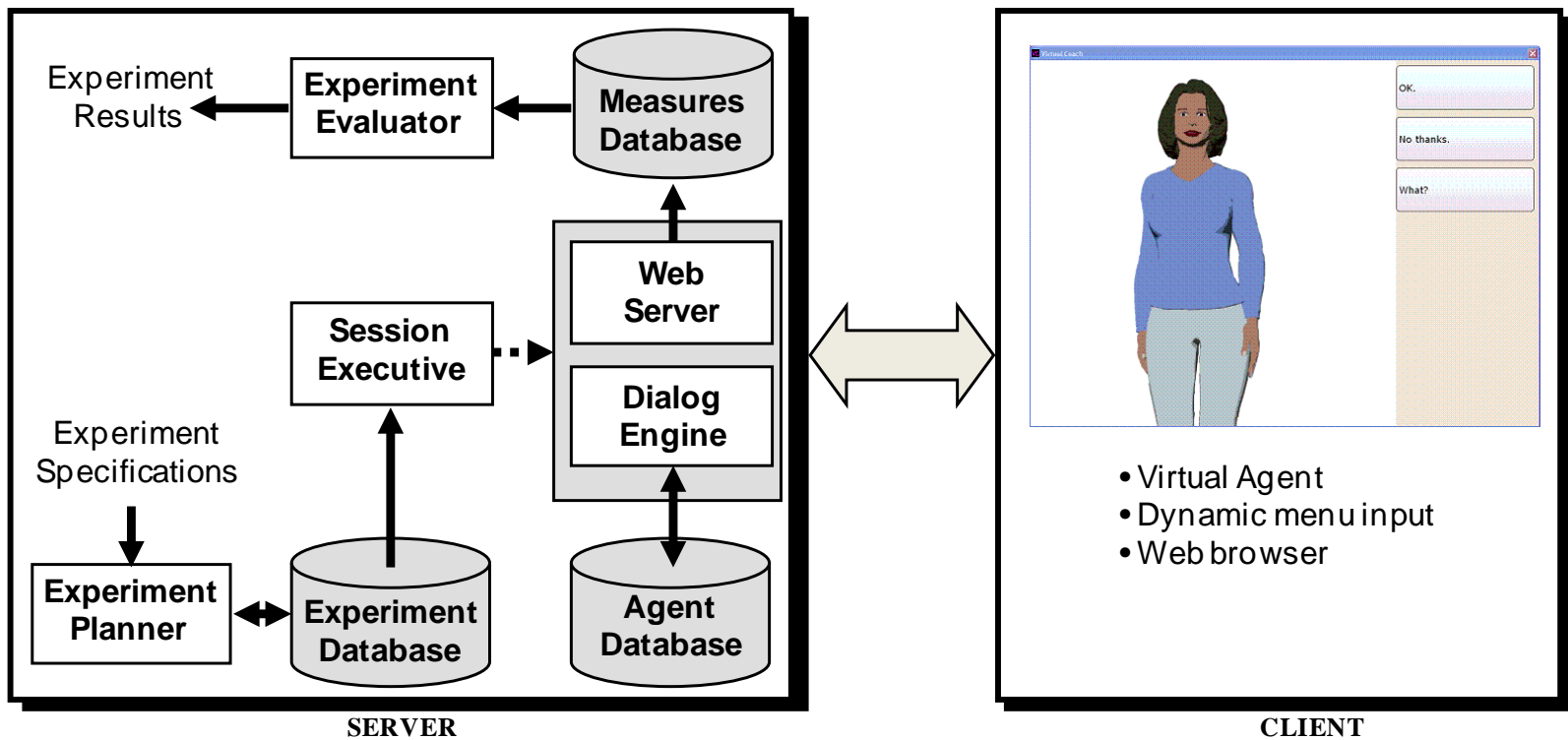
```
STATE: I1
AGENT: $ <BEAT><HAPPY/>My name is Louise. You are =| GET("NAME") |=, is that right? </BEAT> $
USERMENU: Yes, that's right. => $ GO("I2"); $

STATE: I2
AGENT: $ <BEAT><HAPPY/>Great to meet you =|GET("NAME")|=, I will be your
discharge advocate for today. Is it alright, if we talk a bit?</BEAT> $
USERMENU:
    OK => I3

STATE: I3
AGENT: $ <BEAT><HAPPY/>Well, I am going to do my best to help make sure you are
one-hundred percent ready to leave the hospital, and that you have all the
information you are going to need after you go home.</BEAT> $
```

- Custom, Eclipse-based IDE
- Integrated debug and test
- BEAT

# Run Time Architecture



# Platforms





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# Development Methodology



# Studies of Nurse-Patient Interaction



Page 2

**EACH DAY** follow this schedule:

**MEDICINES**

What time of day do I take this medicine?	Why am I taking this medicine?	Medication name Amount	How much do I take?	How do I take this medicine?
	Blood pressure	PROCARDIA XL NIFEDIPINE 90 mg	1 pill	By mouth
	Blood pressure	HYDROCHLOROTHIAZIDE 25 mg	1 pill	By mouth
	Blood pressure	CLONIDINE HCl 0.1 mg	3 pills	By mouth
	cholesterol	LIPITOR ATORVASTATIN CALCIUM 20 mg	1 pill	By mouth
	stomach	PROTONIX PANTOPRAZOLE SODIUM 40 mg	1 pill	By mouth



# Resulting model of Gesture Stroke

New Topic Level	Gesture		
	NONE	POINT	REGION
No Change	80.8%	13.1%	6.1%
PAGE	63.6%	13.6%	22.7%
SECTION	48.3%	32.8%	19.0%
ITEM	31.2%	65.9%	2.9%



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# Interdisciplinary Collaboration

Doctors, Nurses,  
Pharmacologists,  
Computer Scientists,  
Animators

3 Year Development

2,254 medications

48 diagnoses

32,000 lines of  
dialogue script





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# Designing for Patients with Low Health Literacy

Simple language

Pictographs

Face-to-face explanation by  
provider

Scaffold

Teach back & Comprehension  
checks



# Agent Architecture Development Tools

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  - I2:** O <BEAT><HAPPY/>Great to meet you =|GET("NAME")|=
  - I3:** O <BEAT><HAPPY/>Well, I am going to do my best to help make sure you are ...
  - I4:** O <FACE EXPR="CONCERN"/><CAMERA ZOOM="1"/><
  - I5:** O <BEAT><NEUTRAL/>This is my business look. </BEAT>
- Console:** Shows the BEAT code for each state:
 

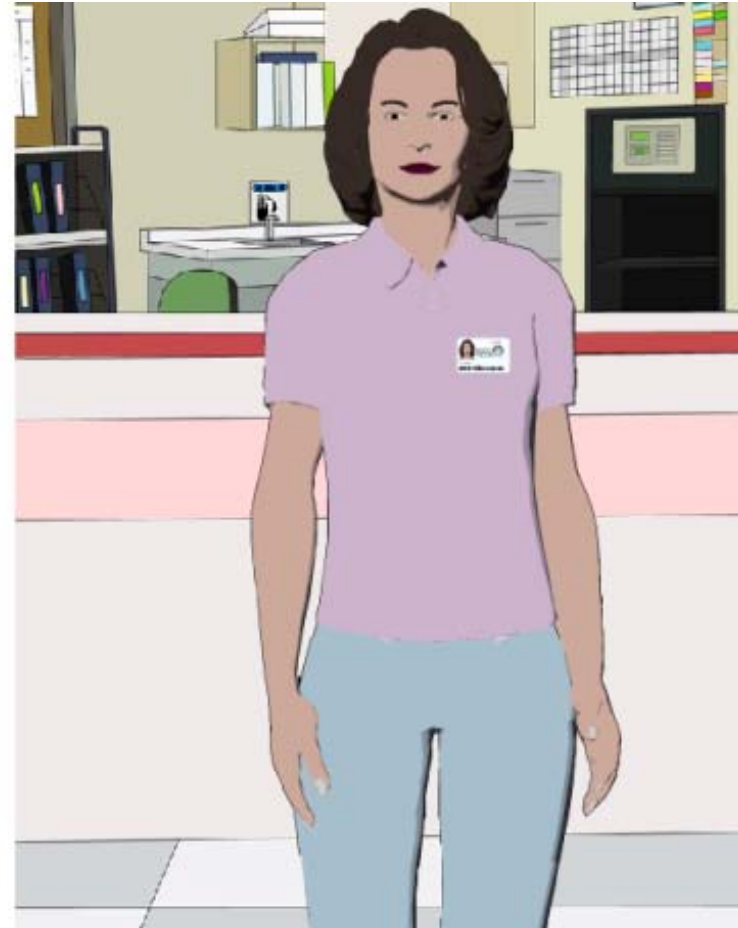
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USERMENU:
OK => I3

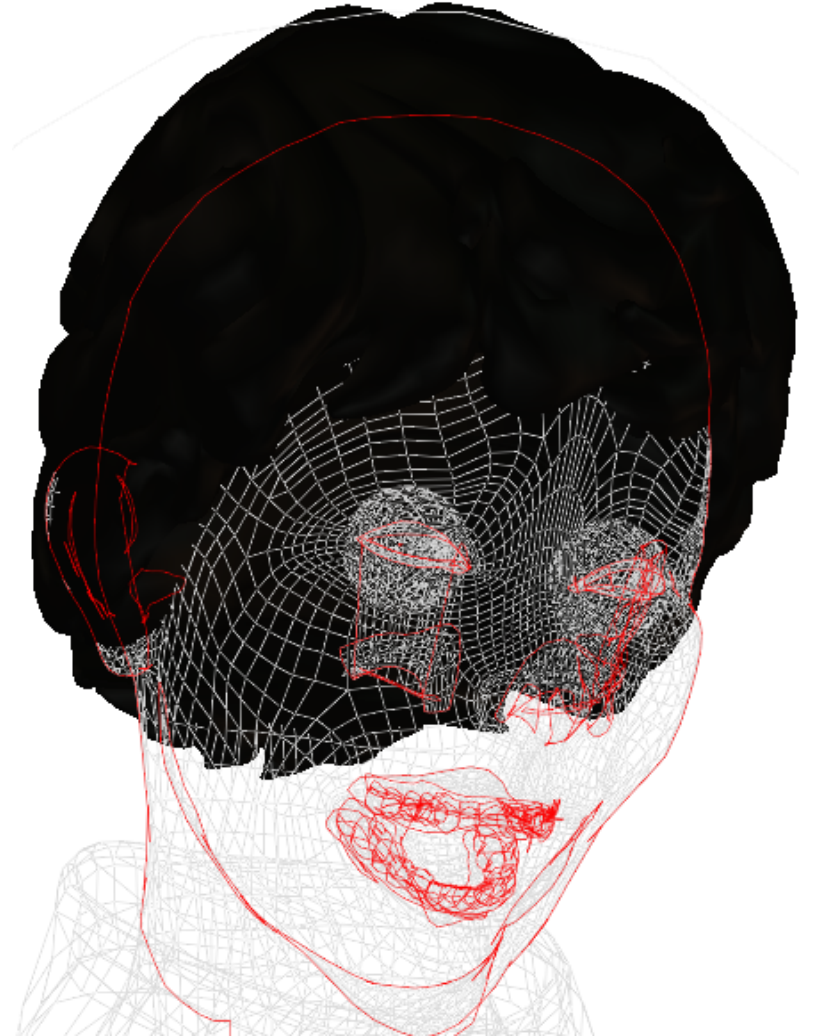
STATE: I3
AGENT: $ <BEAT><HAPPY/>Well, I am going to do my best to help make sure you are
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information you are going to need after you go home.</BEAT> $
```

- Custom, Eclipse-based IDE
- Integrated debug and test
- BEAT

# Character and Art Development



# Animation





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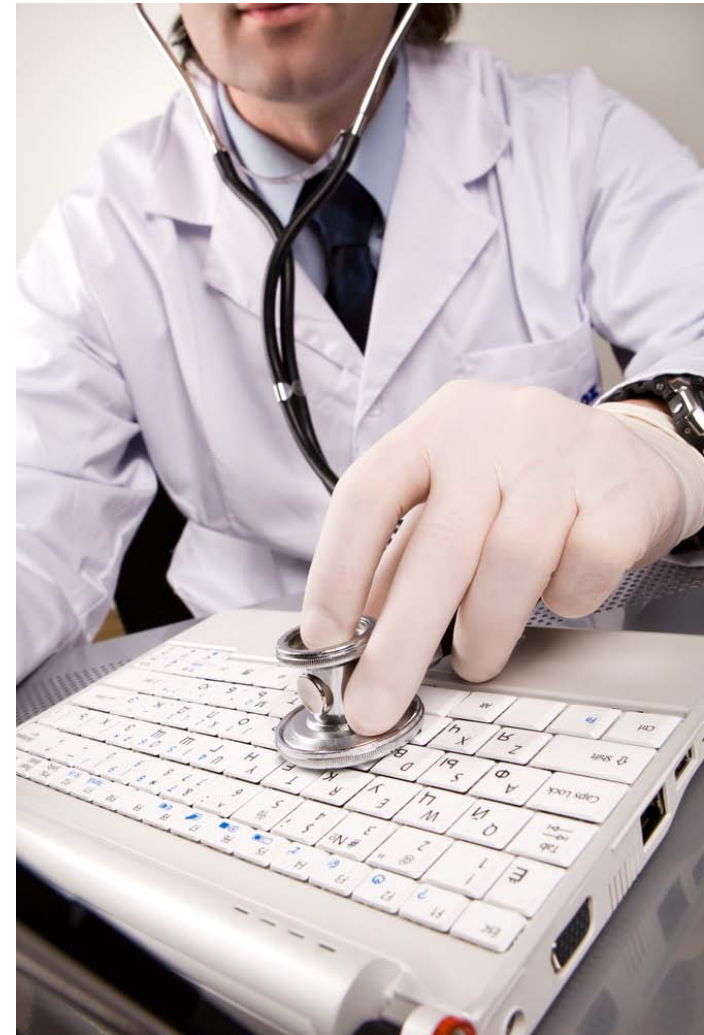
# Evaluation

HCI Lab Studies

Pilot studies with non-patients

Pilot studies with patients

Clinical trials







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# Clinical Applications of Conversational Agents

- Project 1: ReEngineered Discharge – design “Louise” to complete an evidence-based comprehensive hospital discharge (PIPs)
- Project 2: Post Discharge Online Ambulatory “Louise” (Ambulatory Safety and Quality)
- Project 3: Improve Health of Young African American Women (RFTO-3 Communication Focused Technologies)



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# RED Checklist

Eleven mutually reinforcing components:

- ① Medication reconciliation
- ② Reconcile dc plan with National Guidelines
- ③ Follow-up appointments
- ④ Outstanding tests
- ⑤ Post-discharge services
- ⑥ Written discharge plan
- ⑦ What to do if problem arises
- ⑧ Patient education
- ⑨ Assess patient understanding
- ⑩ Dc summary to PCP
- > Telephone Reinforcement



**Adopted by  
National Quality Forum  
as one of 30  
"Safe Practices" (SP-11)**

## Project 1

# Using Agents for Comprehensive Discharge

### Conversational Agents

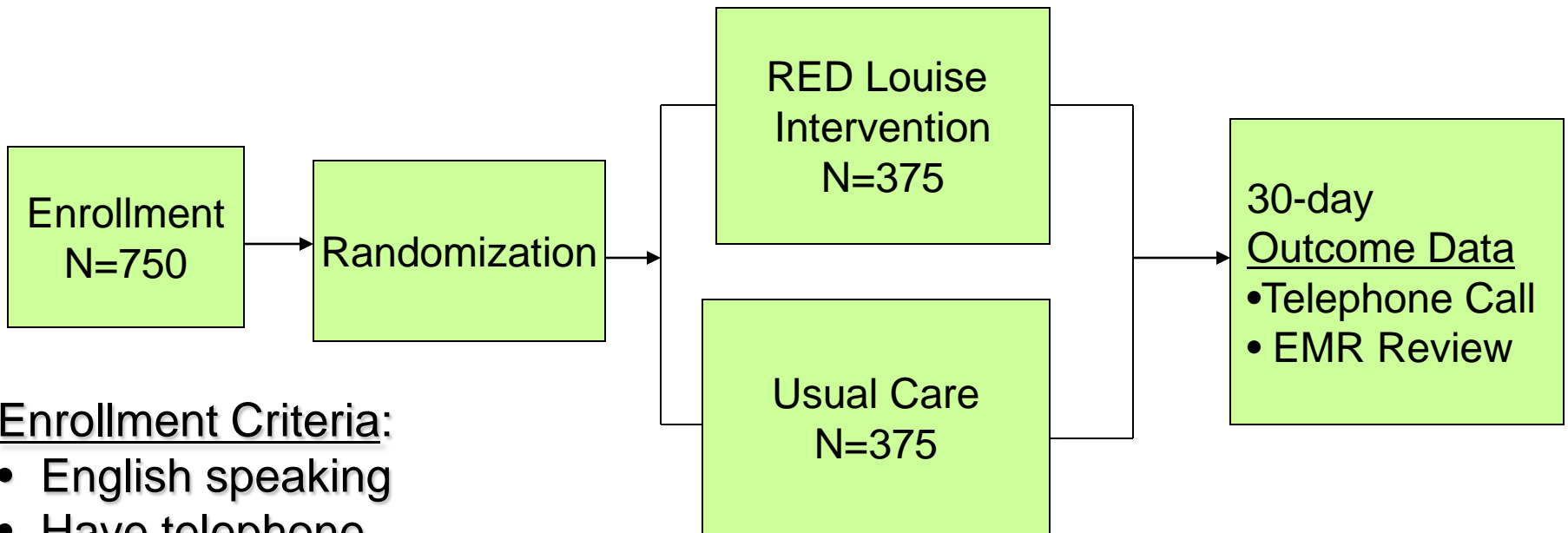
- Programmed to teach an evidence-based comprehensive hospital discharge (RED)
- Determine competency
- Can drill down
  - High Risk Meds
    - Lovenox
    - Insulin
    - Prednisone taper
- Print a report



Characters: Louise (L) and Elizabeth (R)

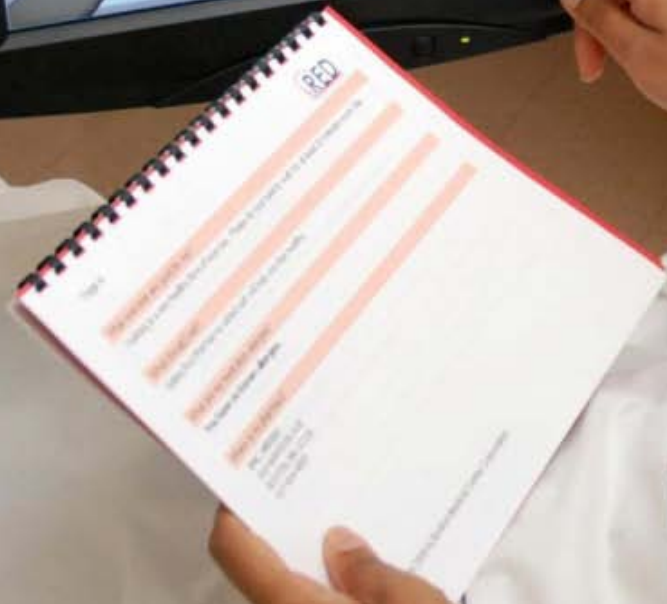


# RCT of ECA Teaching Hospital Discharge

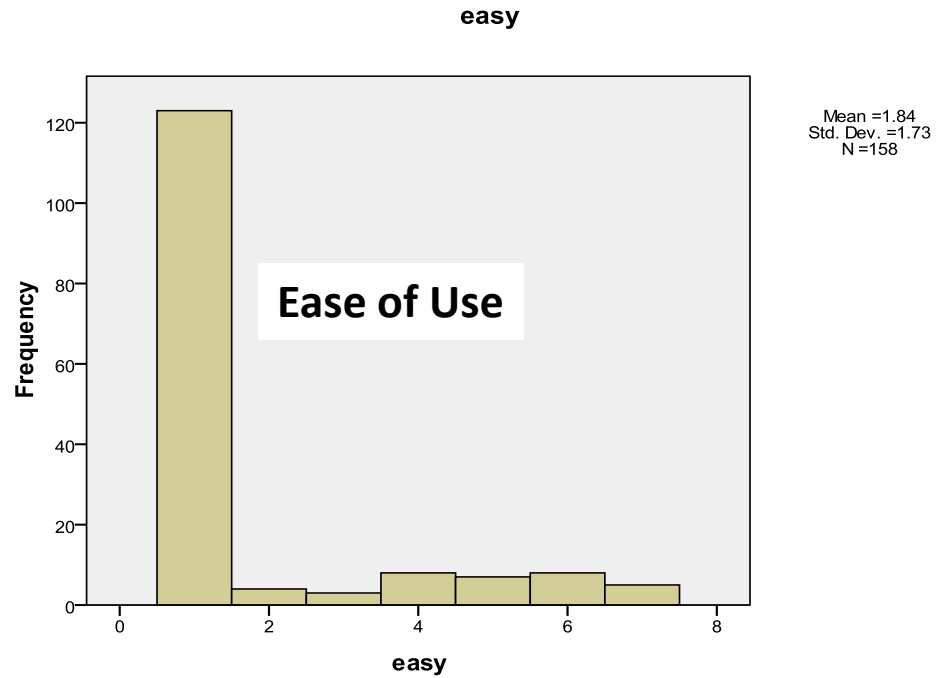
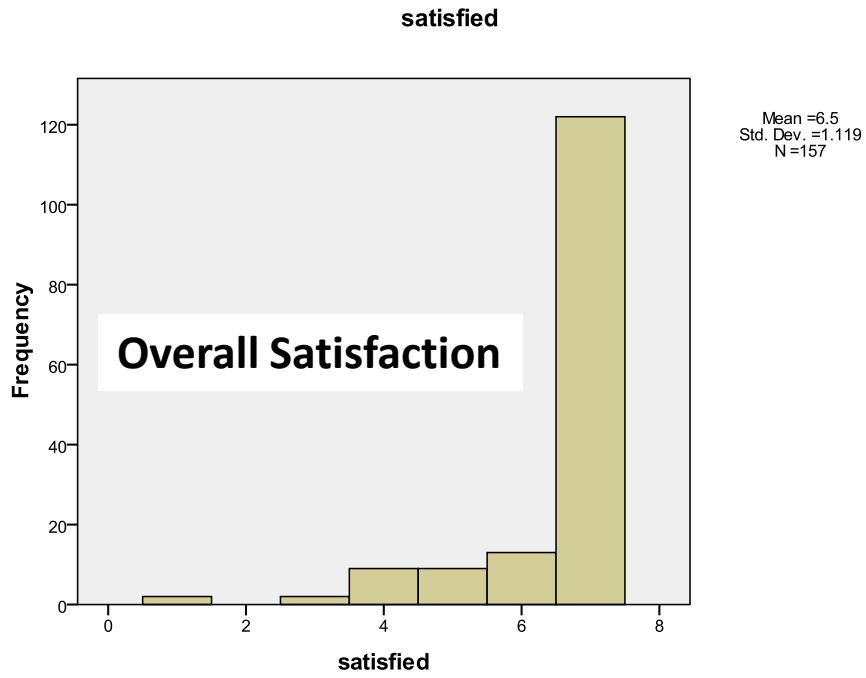


## Enrollment Criteria:

- English speaking
- Have telephone
- Able to independently consent
- Not admitted from institutionalized setting
- Adult medical patients admitted to Boston Medical Center (urban academic safety-net hospital)

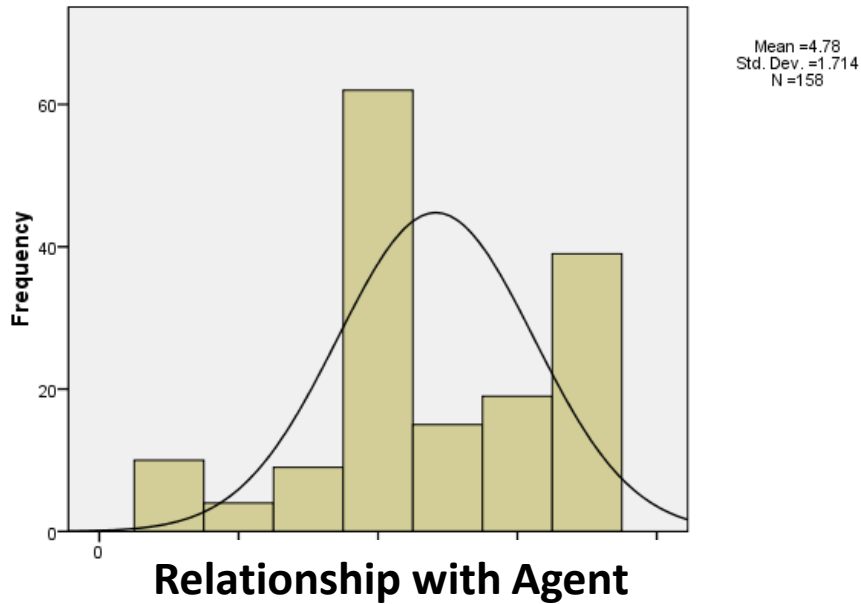


# Overall Usability



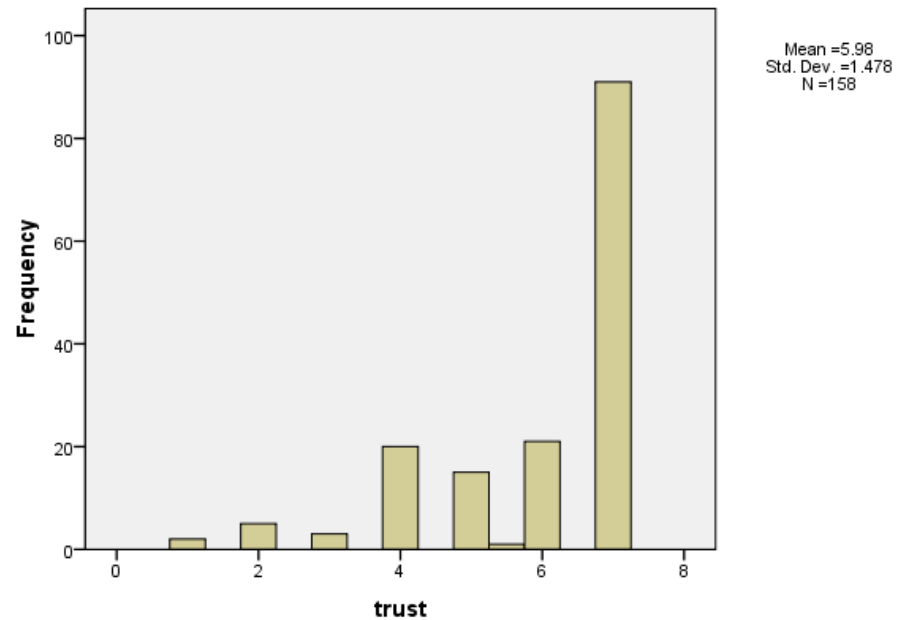
# Overall Attitudes

relationship



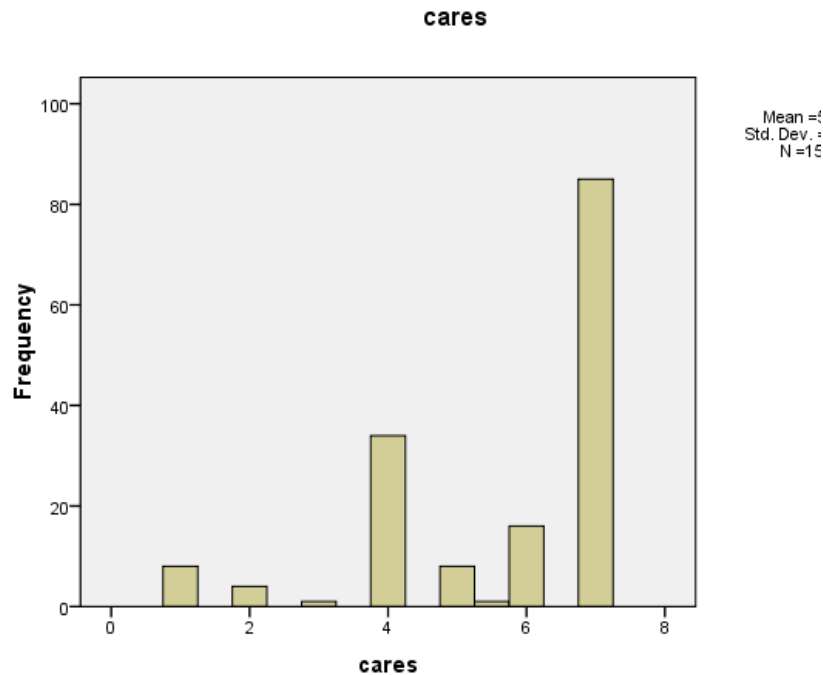
1=stranger, 4=neutral, 7=close friend

trust



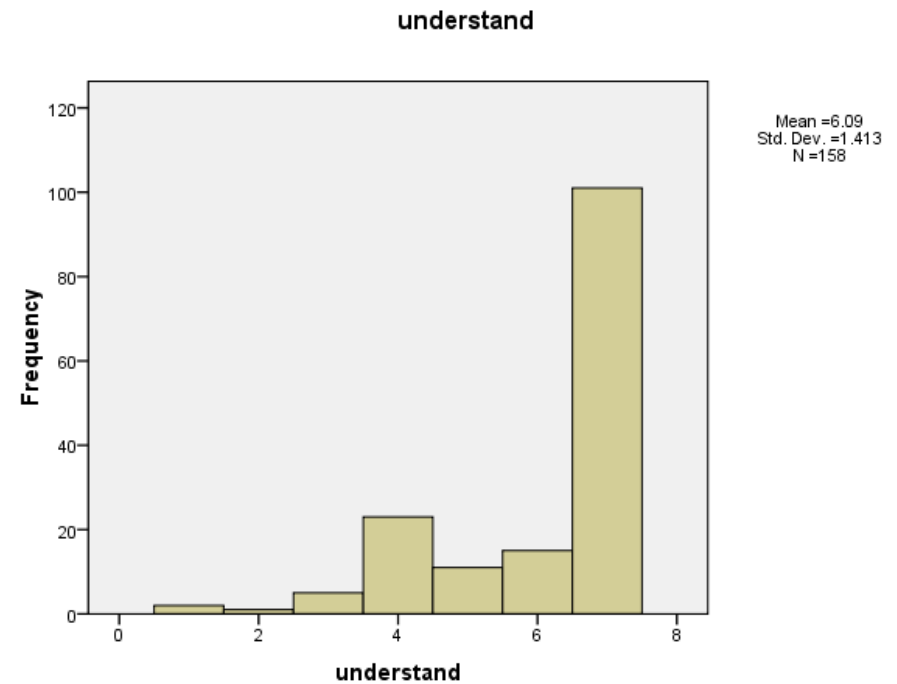
Trust in Agent

# Overall Attitudes



**How much do you feel that Elizabeth cares about you?**

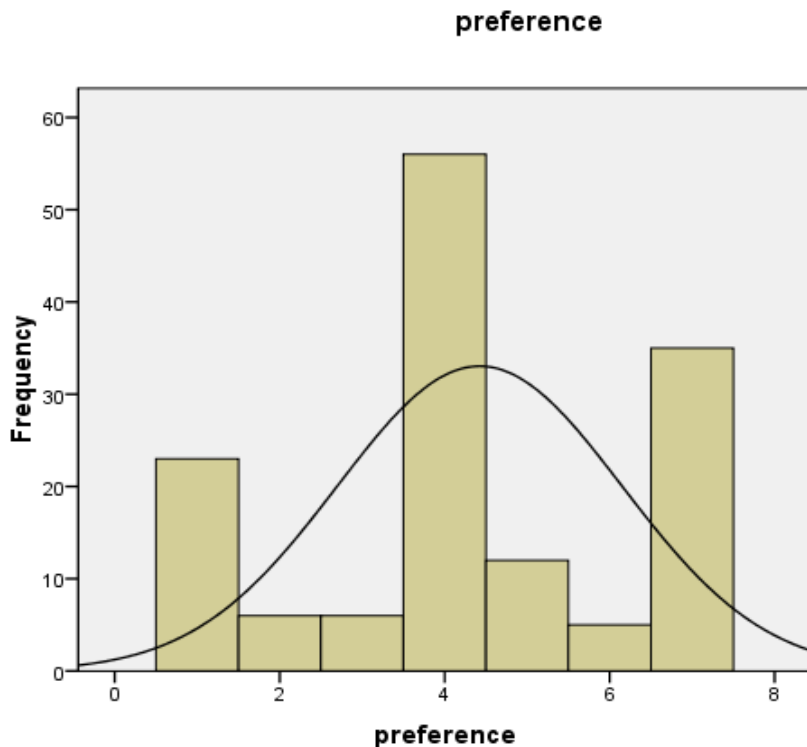
1=not at all, 7= very much



**How much do you feel that you and Elizabeth understand each other?**



# Who Would You Rather Receive Discharge Instructions From?



**36% prefer agent**

**48% neutral**

**16% prefer doc or nurse**

*"I prefer Louise, she's better than a doctor, she explains more, and doctors are always in a hurry."*

*"It was just like a nurse, actually better, because sometimes a nurse just gives you the paper and says 'Here you go.' Elizabeth explains everything."*

1=definitely prefer doc, 4=neutral, 7=definitely prefer agent



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## Project 2

# Post Hospital Discharge Web-based “Louise”

- Post-discharge web-based system designed to emulate the post-hospital phone call
  - Promote Medication Adherence
  - Promote Appointment Adherence
  - Adverse Event Screening
- Posts “alerts” to nurse who follow-up each morning
- Tracks patient status over time



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# Online “Louise” Status

- Development and pilot testing complete next month.
- Test of Concept trial with 80 patients to begin July 1, 2010
- Outcomes:
  - 30-day Readmissions
  - ED visits
  - # AEs detected
  - Time to detect AEs\*
  - Medication & Appointment Adherence
  - Satisfaction

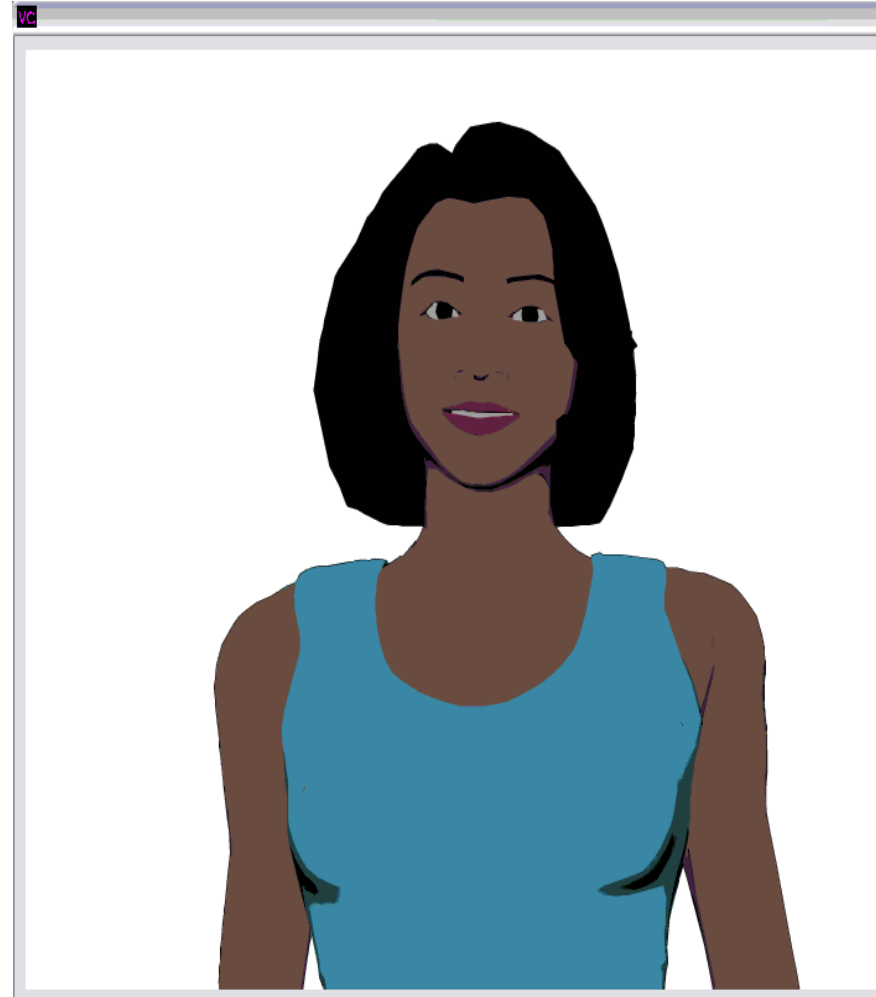
Name:

Password:

## Project 3: Social Networking to Improve Health of Young African American Women

Goal – to address disparities in IM and LBW

- Assess 54 Reproductive Risks in 12 Health Domains
- Assess Readiness for change in each risk area
- Provides information
- Provides “story” appropriate for readiness level (personal change narratives)
- Opportunity to leave your story behind
- Encourages “referral” to your friends
- Pilot study with 50 women in Fall, 2010





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# Conclusions

## Conversational Agents:

- Deliver a variety of health messages
- Improve fidelity of health messages
- Well accepted by patients
- Usable with wide range of computer and health literacy
- Provide time and cost savings
- Can be 'scaled' for far reaching impact
- Relevant in the context of the PCMH
  - chronic disease
  - health promotion / disease prevention
  - health education
  - could serve as a primary care "coach"



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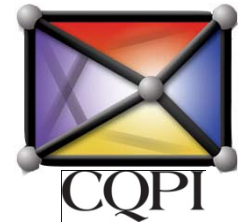
# Thank you!

Brian Jack [brian.jack@bmc.org](mailto:brian.jack@bmc.org)

Tim Bickmore [bickmore@ccs.neu.edu](mailto:bickmore@ccs.neu.edu)

Project RED Website

<http://www.bu.edu/fammed/projectred/>



# Workflow Toolkit and Lessons in User Centered Design

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Pascale Carayon, PhD

Ben-Tzion (Bentzi) Karsh, PhD

Industrial & Systems Engineering

Center for Quality and Productivity Improvement

University of Wisconsin



# Goals of the toolkit

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- Help small and medium sized practices to
  - Analyze their workflows in preparation health IT implementation
  - Improves workflows during and post implementation
  - Use health IT to further improve workflows

# Support activities

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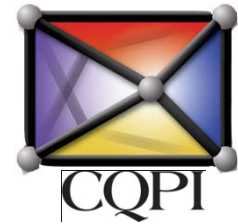
- Technical expert panel
- Request for Information
- Literature Review
- Environmental Scan
- User centered design?*

# Lessons in user centered design

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- A lot of talk about usability
- All of us are designing *tools*, for some *users*, to accomplish *goals*
- So all of us *should be* using user centered design processes



Designs are hypotheses  
about how artifacts affect  
cognition

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David Woods



# Who are the users?

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- Small and medium sized practices
  - Physician champions
  - Practice managers
- Regional Extension Centers
- Two levels of expertise
  - Beginners
  - Advanced



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http://fpm1552.fpm.wisc.edu:8995/integtest1-Project1-context-root/faces/test.jsp

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Health IT Toolkit

## Workflow Integration Toolkit for Health IT

Advanced Search

Workflow 101 Tools 101 Selected User Stories

- Home
- Advanced Workflow
- Advanced Tools
- Advanced User stories
- FAQs
- Links

The key to successful implementation of **health information technology (health IT)** is to recognize its impact on both clinical and administrative **workflow**. Once implemented, health IT can provide information to help you reorganize and improve your workflow.

This toolkit is designed for people and organizations interested or involved in the planning, design, implementation and use of health IT in ambulatory care. The toolkit can help these individuals and organizations by providing resources to better understand:

- what workflow is and why it must be incorporated in planning, design, implementation and use of health IT; [more](#)
- what tools are available to use when assessing workflow; [more](#)
- the impact of health IT on workflow as experienced by clinical practices; [more](#)
- the research on how health IT implementation affects workflow; [more](#)
- how health IT can be used to assess and improve workflow; [more](#)

start | Inbox - Microsoft Out... | Re: web based form -... | Health IT Toolkit - Wi... | Trusted sites | 100% | 9:54 AM

# Users?

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- REC staff did not exist at the time -so who are they and what do they know?
- What is “advanced” and what is “beginner”?
  - In implementation experience?
  - In stage of implementation?
  - Years of using health IT?
  - In workflow analysis?
  - Can they self-select?
- What about other users?
  - Vendors?
  - Curriculum developers?

# User goals

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- Learn about workflow and its importance
- Learn how to analyze workflows
- Learn state of evidence regarding workflow and health IT success



# Learn about workflow and importance

A screenshot of a Windows Internet Explorer browser window displaying the Health IT Toolkit website. The browser's address bar shows the URL: http://128.104.193.65:8995/integtest1-Project1-context-root/faces/test.jsp?view=showWorkflow101.jsp#C. The website header includes the title "Health IT Toolkit for Health IT" and a search bar. The main content area is titled "Workflow 101" and contains a list of bullet points under the heading "Home > Workflow 101". The browser's taskbar at the bottom shows several open applications, including Microsoft Excel, AA toolkit link, RE: screen shots..., Microsoft Power..., Health IT Toolkit, and Document1 - Mic... The system tray on the right shows the time as 11:42 AM and the date as 11/14/2009.

Health IT Toolkit - Windows Internet Explorer provided by UW Madison - AIMS

http://128.104.193.65:8995/integtest1-Project1-context-root/faces/test.jsp?view=showWorkflow101.jsp#C

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Health IT Toolkit

Workflow Integration Toolkit for Health IT

Advanced Search

Workflow 101 Tools 101 Selected User Stories

Home

Advanced Workflow

Advanced Tools

Advanced User stories

FAQs

Links

Home > Workflow 101

- What is workflow?

Workflow is the sequence of physical and/or mental tasks performed by various people over time and through space. It can occur at different and /or multiple levels (e.g., one person, between people, across organizations) & can occur sequentially and / or simultaneously.

- What must I consider when I think about workflow?
- Why is it important to assess workflow?

Anytime you make a change to your practice, ESPECIALLY when implementing Health IT, the workflow associated with clinical & practice management processes will change.

- What are consequences of NOT analyzing workflow?
- How do I analyze workflow?
- Who should collect & analyze workflow?
- When should I assess workflow?

[More on Workflow]

start Microsoft Excel - ... AA toolkit link - ... RE: screen shots... Microsoft Power... Health IT Toolkit ... Document1 - Mic... Internet 100% 11:42 AM

# Learn about ways to analyze workflow



Workflow Integration Toolkit for Health IT

Workflow 101 Tools 101 Selected User Stories

Home  
Advanced Workflow  
Advanced Tools  
Advanced User stories  
FAQs  
Links

Home >> Tools 101

Although there are many different tools you can use to collect & analyze workflow information, the following tools, appropriately used, will be extremely useful in helping you better understand current workflows & modify current or design new workflows that will make it easier to use your health IT.

Tool Name	Description
Check Sheet	A check sheet is a table or form used for registering data as they are collected. It is a simple, generic tool that can .....more
Flowchart	A diagram that uses graphical symbols to depict the flow of the steps in a process.....more
Usability	A usability evaluation is a tool for determining the extent to which a system is easy to use or "user friendly".....more

[More Tools]

# User goals?

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- What users thought *workflow* meant, and therefore expected to learn about was all over the map.
- Our simple *tools* embedded our own assumptions – users still would not know what to use the tools for or how

# Users' needs to achieve goals

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- ❑ Need to know what tools are available
- ❑ How they have been used by others
- ❑ Where to learn how to use them
- ❑ Strengths and weaknesses of the tools



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Health IT Toolkit

## Workflow Integration Toolkit for Health IT

ehr search  
Advanced Search

Workflow 101 Tools 101 Selected User Stories

- Home
- Advanced Workflow
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- Links

### Home » Advanced Tools

The more than 100 tools included in this compendium are grouped to at least one of twelve categories based on what they are used for. For example, tools such as flowcharts are a means of "process mapping", check lists are a type of "data collection" tool, histograms provide "data display/organization", and focus groups are of source of "idea generation". By first selecting a category on this page, you then are provided a list of tools - and their short descriptions. Details on each tool - including steps on how to use the tool, examples of the tool's use as found in published papers and/or user stories, and more - can then be obtained by selecting the specific tool you wish to learn more about.

[Data Collection](#) | [Data Display / Organization](#) | [Idea Creation](#) | [Proactive Risk Assessment](#) | [Problem Solving](#) | [Process Improvement](#) | [Process Mapping](#) | [Project Planning / Management](#) | [Statistical](#) | [Task Analysis](#) | [Usability](#) | [Health IT](#)

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**FAQs**  
**Links**

**Home » Advanced Tools » Data Collection**

Although there are many different tools you can use to collect & analyze workflow information, the following tools, appropriately used, will be extremely useful in helping you better understand current workflows & modify current or design new workflows that will make it easier to use your health IT.

Tool Name	Description
Backlog Reduction Worksheet	.....more
Balanced Scorecard	The balanced scorecard suggests that we view the organization from four perspectives, and to develop metrics, collect da.....more
Check Sheet	A check sheet is a table or form used for registering data as they are collected. It is a simple, generic tool that can .....more
Cognitive Task Analysis	The purpose of cognitive task analysis is to capture the way the mind works, to capture cognition. The researcher or pra.....more
Cognitive Walkthrough	The cognitive walkthrough method is used to evaluate user interface usability. The main driver behind the development of.....more
Focus Group	A focus group brings together up to a dozen people to discuss their attitudes and concerns about a subject.....more
Interview	Interviews collect data (generally qualitative) from a targeted group of people about their opinions, behavior, or knowl.....more

Done Trusted sites 100%

start | Inbox - Microsoft Out... | Re: web based form -... | Health IT Toolkit - Wi... | screen shots 5-24-10... | 10:02 AM



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Home » Advanced Tools » Data Collection » Details

### REFERENCES

Brownbridge, G., A. Evans, M. Fitter and M. Platts (1986). "An interactive computerized protocol for the management of hypertension: effects on the general practitioner's clinical behaviour." *Journal of the Royal College of General Practitioners* 36(286): 198-202.

### ABSTRACT

This paper reports an experimental study of general practitioners' use of an interactive computerized protocol for the management of hypertension, focussing particularly on the protocol's effects on doctors' clinical behaviour. Prior to its computerization a paper-based version of the protocol was used enabling a comparison of the alternative forms. Doctors' delivery of care was assessed from video recordings of 89 consultations and from the records made during these consultations. Comparisons were made of consultations conducted under control and experimental conditions. Use of paper and computer protocols resulted in significant improvements in the doctors' delivery of care, in terms of the range of verbal and physical examinations conducted and recorded. The protocol's effects were most marked when the computerized version was used. However, use of the computer protocol resulted in the recording of information on the non-occurrence of certain events which had not been explicitly elicited during the verbal examination; features of the design which were intended to encourage adherence to the protocol resulted in the recording of unsubstantiated information. It is concluded that the detail of the verbal examination suggested by the protocol may have been inappropriate to the realities of a general practice consultation. The findings provide some useful insights for the design of future computerized protocols for the management of chronic conditions.

### OBJECTIVE

To report an experimental study of general practitioners' use of an interactive computerized protocol for the management of

Trusted sites 100%

start | Inbox - Microsoft Out... | Re: web based form -... | Health IT Toolkit - Wi... | screen shots 5-24-10... | 10:03 AM



# User needs?

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- ❑ Our initial design allowed a user to *learn about*. New design will let them *learn how*.
- ❑ It did not take into account potential time constraints of user in actual practice
- ❑ Small and medium sized practices may not have the resources to invest in this kind of learning



# User centered design – devil is in the details

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- ❑ User centered design is *NOT* asking users what they want and giving it to them
- ❑ User centered design is *NOT* designing something, showing it to users and asking “so does this make sense?” / “do you like it?”
- ❑ User centered design is *NOT* usability
- ❑ Knowledge about performance and skill to execute UCD is critical

# UCD from Mockup to Real Use

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- Rapid cycle of user feedback, evaluation, and redesign
- Differences between simulated use and actual use
- Updates
  - Development vs. maintenance
  - User involvement
  - Changing users and user needs



# Next hypothesis

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- Redesign website to be action oriented, right from the homepage
  - [Click here to start analyzing your workflow](#)
  - [Click here to learn how to improve you existing workflows](#)
  
- Make materials readily available
  - [Click here to get workflow training materials](#)
  - [Click here for workflow curriculum presentations](#)

# Larger Challenge


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- Users *need to know a whole*. Each of our toolkits gives a *part*. [sound like clinical needs and health IT?]
- Bigger question for all of the toolkits is *how do we help users to integrate* over all of the toolkits to get something useful?

Thank you  
[cqpi.engr.wisc.edu/withit\\_home](http://cqpi.engr.wisc.edu/withit_home)

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# **AHRQ**

# **Health IT Grantee and Contractor Meeting**

**Friday June 4, 2010**