INNOVATION

Clinicians' perceptions of usability of an electronic medical record over time

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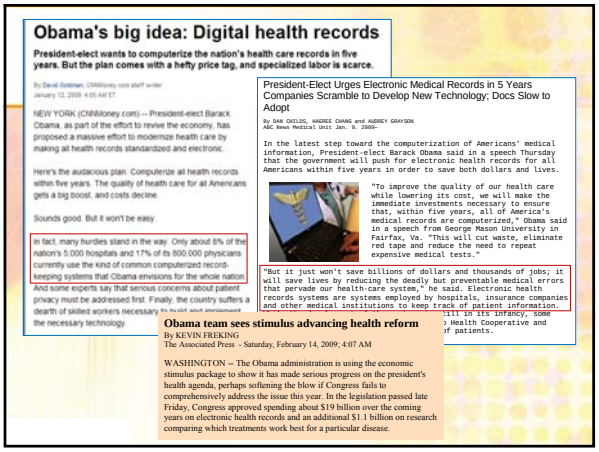
Objectives

- Briefly review background and purpose of the study.
- Identify research questions and study model.
- Describe the study methodology to include instrumentation, procedures for data collection, analysis, and limitations.
- Explore findings for each research question.
- Discuss recommendations and implications for education, practice, and research.



Obama's big idea: Digital health records

President-elect wants to computerize the nation's health care records in five years. But the plan comes with a hefty price tag, and specialized labor is scarce.

By David Goldman, CNNMoney.com staff writer
January 12, 2009: 4:05 AM ET

NEW YORK (CNNMoney.com) -- President-elect Barack Obama, as part of the effort to revive the economy, has proposed a massive effort to modernize health care by making all health records standardized and electronic.

Here's the audacious plan: Computerize all health records within five years. The quality of health care for all Americans gets a big boost, and costs decline.

Sounds good. But it won't be easy.

In fact, many hurdles stand in the way. Only about 8% of the nation's 5,000 hospitals and 17% of its 800,000 physicians currently use the kind of common computerized record-keeping systems that Obama envisions for the whole nation.

And some experts say that serious concerns about patient privacy must be addressed first. Finally, the country suffers a dearth of skilled workers necessary to build and implement the necessary technology.

President-Elect Urges Electronic Medical Records in 5 Years
Companies Scramble to Develop New Technology; Docs Slow to Adopt

By DAN CHILDS, WAGREE CHANG and AUDREY GRAYSON
ABC News Medical Unit Jan. 9, 2009—

In the latest step toward the computerization of Americans' medical information, President-elect Barack Obama said in a speech Thursday that the government will push for electronic health records for all Americans within five years in order to save both dollars and lives.

"To improve the quality of our health care while lowering its cost, we will make the immediate investments necessary to ensure that, within five years, all of America's medical records are computerized," Obama said in a speech from George Mason University in Fairfax, Va. "This will cut waste, eliminate red tape and reduce the need to repeat expensive medical tests."

"But it just won't save billions of dollars and thousands of jobs; it will save lives by reducing the deadly but preventable medical errors that pervade our health-care system," he said. Electronic health records systems are systems employed by hospitals, insurance companies and other medical institutions to keep track of patient information.

...ill in its infancy, some ... Health Cooperative and ...f patients.

Obama team sees stimulus advancing health reform

By KEVIN FREKING
The Associated Press - Saturday, February 14, 2009; 4:07 AM

WASHINGTON -- The Obama administration is using the economic stimulus package to show it has made serious progress on the president's health agenda, perhaps softening the blow if Congress fails to comprehensively address the issue this year. In the legislation passed late Friday, Congress approved spending about $19 billion over the coming years on electronic health records and an additional $1.1 billion on research comparing which treatments work best for a particular disease.

Importance of the Study

- EMR becoming the standard in the healthcare
- Productively tied into how well clinicians interact with the computer
- Continued resistance among clinical staff to accept technology
- Little empirical evidence concerning the overall usability of an EMR
- Limited long term impact of EMR implementation and consequences of frequent system updates
- User acceptance focused on one time evaluations
- Understanding the conditions under which EMR systems will be embraced by clinicians

Purpose

This purpose of this study was to evaluate clinicians' perceptions of usability of an electronic medical record over time.

Research Questions

1. What is the pattern of change in usability from before to 4 months and 16 months after the implementation of a new electronic medical record and subsequent upgrade?
2. Does the implementation of an EMR produce a short term change in perceived usability?
3. Does the implementation of an EMR produce a long term change in perceived usability?
4. Does the pattern of usability change in relation to the frequency of EMR use?
5. Is the pattern of usability influenced by gender, age, length of service, or role of the user?

Theoretical Framework

Four Models:

- Human Factors (Staggers, 2003)
- Staggers and Parks Nurse-Computer Interaction Framework (1993)
- Technology Acceptance Model (Davis, 1989)
- Two-Wave Panel Model of Information Systems Use (Kim & Halhotra, 2005)

Methodology

Descriptive retrospective longitudinal design using secondary data

STUDY DESIGN

Baseline Observation (Pre-Implementation)	Intervention (Implementation)	4 month Observation (Post-Implementation)	16 month Observation (Post-Implementation)
O_{T0}	X	O_{T1}	O_{T2}
O_{T2}	X	O_{T3}	O_{T4}

The first 16 month evaluation served as the pre-implementation baseline for the upgrade to the EMR.

Methodology (cont.)

- **Setting**
  - 256 bed research facility
  - Med-surg, ped's, mental health, oncology, ICU, and ambulatory care services
  - Support for clinical care and research activities
  - Mainframe EMR was used for over 25 years
- **Sample**
  - Cross sectional convenience sample of nurses, physicians, and other clinical staff (lab, respiratory therapy, rehab, etc)

Table 1: Summary of Observation Intervals and Sample Size

Baseline Date	N	4 months Date Post-Implementation	N	16 months Date Post-Implementation	N
T_0-Dec 03	444	T_1-Dec 04	373	T_2-Jan 06	331
T_2-Jan 06	331	T_3-Jun 06	315	T_4-Jun 07	305

Table 1: Case processing list by role, gender, and age category

Case	Age Range	Gender	Role	Wave 1			Wave 2		
				T0	T1	T2	T2	T3	T4
6	20-30	F	RN	19	10	17	17	16	8
12	31-40	F	RN	40	30	37	37	39	23
18	41-50	F	RN	73	47	61	61	62	35
24	51-60	F	RN	31	35	39	39	48	51
30	61 or more	F	RN	9	5	5	5	7	7
3	20-30	M	RN	1	1	2	2	1	1
9	31-40	M	RN	4	2	4	4	4	2
15	41-50	M	RN	14	5	4	4	3	4
21	51-60	M	RN	4	5	5	5	4	6
27	61 or more	M	RN	1	0	0	0	0	0

T=Time

Instrumentation

- Perceived Ease of Use and Usefulness Tool (Venkatesh & Davis, 2000)
  - Perceived usefulness (4 items) related to job performance, productivity, effectiveness, and overall usefulness for the job
  - Perceived ease of use (4 items) related to clear and understandable, free of mental effort, easy to get system to do what is needed, overall ease of use
- Questions added related to:
  - Support for clinical care and support for research
  - Customer Service and Training
- 1-5 Likert scale (1 =strongly disagree; 5=equals strongly agree)
- Frequency of use – never, rarely, occasionally, often, very often
- User characteristics of age group, gender, and length of service

Data Analysis

- Descriptive statistics and frequencies used to describe the sample
- Univariate and multivariate analysis used to screen the data for normality and outliers
- Linear mixed model analysis used to determine patterns of change over time for the outcome variables:
  - Perceived usefulness
  - Perceived ease of use
  - Supports clinical care
  - Supports research
  - Customer service
  - Training

Results & Discussion

- Sample Description
- Research Question One: Patterns of Change
- Research Question Two: Short Term Change
- Research Question Three: Long Term Change
- Research Question Four: Frequency of Use
- Research Question Five: User Characteristics

Sample Description

- The number of individuals in each case was proportionally consistent for most data collection periods
- Dominant cases
  - Female RN's 31- 50 years (n=23 to 73)
  - Male MD's 31- 50 years (n=5 to 35)
  - Female Other 31- 50 years (n=11 to 29)
- Least represented cases
  - 20-30 years old (except female RN's)
  - All roles over 61 years
  - Male RN's all ages

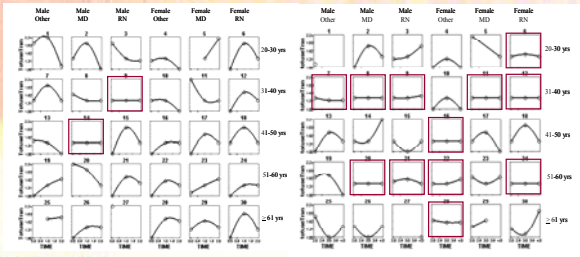
RQ1: Patterns of Change

- What is the pattern of change in usability from before to 4 months and 16 months after the implementation of a new electronic medical record and subsequent upgrade?
- Two waves related to initial implementation then after system upgrade
- Nonparametric empirical growth trajectories for each variable to determine patterns of change

RQ1: Perceived Usefulness

Growth plots for Perceived Usefulness in Wave 1 (Initial)

Growth plots for Perceived Usefulness in Wave 2 (Upgrade)



Short and Long Term Change

- RQ2: Does the implementation of an EMR produce a short term change in perceived usability?
- RQ3: Does the implementation of an EMR produce a long term change in perceived usability?
- Linear mixed model analysis conducted to determine significant linear or quadratic changes in trajectory patterns related to each outcome over time

RQ2: Short Term Change

Summary of the polynomial change trajectory findings in wave 1

Wave 1 Variable	Model Pattern	Intercept	Linear	Quadratic	Within Cases	Between Cases
Usefulness[‡] (Actual Value)	Quadratic	1.5921[+] (3.4652)	0.2974[+]	-0.1524[+]	0.1030[+]	0.0139
Ease of Use	Linear	2.6885[+]	0.1622**	n/a	1.1426[+]	0.0883*
Supports Care[§] (Actual Value)	Quadratic	0.2852[+] (4.6700)	0.2037[+]	-0.0942[+]	0.0407[+]	0.0014
Supports Research[‡] (Actual Value)	Quadratic	1.5684[+] (3.5401)	0.1471[+]	-0.0755**	0.1226[+]	0.0027

[‡]= Reflect/SQRT [§]= Reflect/Log10 *p < .05 **p < .01 [+]p < .001 n/a= not applicable

RQ3: Long Term Change

Summary of the polynomial change trajectory findings in wave 2

Wave 2 Variable	Model Pattern	Intercept	Linear	Quadratic	Within Cases	Between Cases
Usefulness[□] (Actual Value)	No change	1.5707[+] (3.5329)	n/a	n/a	0.0955[++]	0.0036*
Ease of Use	Quadratic	4.0788[+]	-0.8228	0.1493*	0.8927[+]	0.0000
Supports Care[§] (Actual Value)	No change	0.3139[+] (4.6312)	n/a	n/a	0.0374[+]	0.0009*
Supports Research[□] (Actual Value)	No change	1.5789[+] (3.5071)	n/a	n/a	0.1158[+]	0.0031
Customer Service[□] (Actual Value)	No change	1.5493[+] (3.5997)	n/a	n/a	0.1042[+]	0.0012
Training	No change	3.3204[+]	n/a	n/a	1.1890[+]	0.0316

[□]= Reflect/SQRT [§]= Reflect/Log10 *p < .05 **p < .01 [+]p < .001 n/a= not applicable

RQ4: Frequency of Use

Summary of contribution of frequency of use to outcome variables

Frequency of Use	Perceived Usefulness	Perceived Ease of Use 1	Supports Clinical Care	Supports Research	Perceived Ease of Use 2
Time	↓[+]	ns	↓[+]	↓[+]	ns
Time2	↑[+]	--	↑[+]	↑[+]	ns
FreqV1 (Very often vs. Often)	↓*	ns	ns	ns	ns
FreqV2 (Rare/Occ vs. Very Often)	↓[+]	ns	↓[+]	↓*	ns
Time x FreqV1	↑[+]	ns	↑*	ns	ns
Time x FreqV2	↑[+]	ns	↑*	↑*	ns
Time^2 x FreqV1	↓[+]	--	↓*	ns	ns
Time^2 x FreqV2	↓**	--	ns	↓*	ns

*p < .05 ** p < .01 [+]p < .001 ns=not significant -- not applicable

Summary of contribution of gender to outcome variables

Gender	Perceived Usefulness	Perceived Ease of Use[1]	Supports Clinical Care	Supports Research	Perceived Ease of Use[2]
Time	↓*	↑*	↓[+]	ns	ns
Time2	↑**	--	↑[+]	ns	ns
Gender	ns	ns	ns	ns	ns
Time x Gender	ns	ns	ns	ns	ns
Time^2 x Gender	ns	--	ns	ns	ns

1 = wave 1 2 = wave 2 *p < .05 ** p < .01 [+]p < .001 ns=not significant -- not applicable

Summary of contribution of age to outcome variables

Age	Perceived Usefulness	Perceived Ease of Use[1]	Supports Clinical Care	Supports Research	Perceived Ease of Use[2]
Time	ns	↑[+]	ns	ns	ns
Time2	↑*	--	ns	ns	ns
Age	↑[+]	ns	↑*	ns	ns
Time x Age	↓*	↓[+]	↓*	ns	ns
Time^2 x Age	ns	--	ns	ns	ns

1 = wave 1 2 = wave 2 *p < .05 ** p < .01 [+]p < .001 ns=not significant -- not applicable

Summary of contribution of length of service to outcome variables

Length of Service	Perceived Usefulness	Perceived Ease of Use[1]	Supports Clinical Care	Supports Research	Perceived Ease of Use[2]
Time	↓[+]	↑**	↓[+]	↓**	ns
Time2	↑[+]	--	↑[+]	↑**	ns
LOS	↑[+]	↑[+]	↑[+]	↑*	ns
Time x LOS	↓[+]	↓[+]	↓[+]	↓**	ns
Time^2 x LOS	↑**	--	↑**	ns	ns

1 = wave 1 2 = wave 2 *p < .05 ** p < .01 [+]p < .001 ns=not significant -- not applicable

Summary of contribution of role to outcome variables

Role	Perceived Usefulness	Perceived Ease of Use[1]	Supports Clinical Care	Supports Research	Perceived Ease of Use[2]
Time	↓[+]	ns	↓[+]	↓[+]	ns
Time2	↑[+]	--	↑[+]	↑*	ns
Role V1 (RN/MD)	ns	↓[+]	ns	ns	ns
Role V2 (RN/Other)	ns	ns	ns	ns	ns
Time x RoleV1	↑**	ns	ns	ns	ns
Time x RoleV2	ns	ns	↑*	ns	ns
Time^2 x RoleV1	↓**	--	ns	ns	ns
Time^2 x RoleV2	ns	--	ns	ns	ns

1 = wave 1 2 = wave 2 *p < .05 ** p < .01 [+]p < .001 ns=not significant -- not applicable

Final Analysis

- Best model fit with multiple significant predictors
  - Age, role, & length of service (LOS) with usefulness, supports clinical care, ease of use (wave 1)
- Role and LOS were significant predictors (age was not)
  - Overall MD's found the new system more useful over time than RN's or other clinicians
  - Supports clinical care was high for all Roles and LOS
  - RN's with longer LOS found EMR harder to use over time.
  - MD's & other clinicians found EMR easier to use over time

Conclusions

- Perceived usefulness, perceived ease of use, supports clinical care and supports research significant for the short term usability outcomes but not after the major upgrade
- Age, role, length of service, and frequency of computer use were significant predictors for usefulness, ease of use, and supports clinical care
- Added to the body of knowledge related to HCI research and provided a foundation for further research
- Practical implications for education, practice, & research

Implications - Practice

- Short term findings were most significant
- Revise what is important to evaluate
- Implications for system development
- Early assessment and planning
- Consider needs of different clinical roles
- Iterative consultations from clinicians
- Experts in informatics

Implications - Education

- Consider age, length of service, and computer experience when designing training programs
- Provide training that reflects practice through role specific practice scenarios and department based experiences
- Provide multiple training delivery methods, adequate training time, extra practice, and ongoing support

Implications - Research

- Location of phenomena on the developmental trajectory will help determine what is important to evaluate (Staggers & Parks, 1993)
- Clinician's and informatics specialist work together to design and implement systems that promote patient safety and improve quality of care

Limitations

- Research facility in the Mid-Atlantic
- EMR product used in the facility
- Sample population unique
- Use of secondary data
- Survey used to increase validity/reliability
- Assistive technology used to minimize effects of researcher bias and survey administration

Recommendations

- Repeating this study tracking individuals instead of cases over time
- Expanding to other healthcare settings
- Explore other dimensions of the theories, concepts, and variables
- Evaluate the proposed model
- Explore differences between self-report appraisals and actual behavior
- Iterative evaluations of computer system design

Comments/Questions