A Framework for Predicting EHR Adoption Attitudes: A Physician Survey

by Mary E. Morton, PhD, RHIA, and Susan Wiedenbeck, PhD

Abstract

With a focus on improving the quality of patient care, the President George W. Bush called for electronic health records (EHRs) for all Americans by the year 2014; however, recent estimates for EHR adoption in the ambulatory care environment are just over 10 percent. The objective of this study was to determine the individual characteristics and the social and technical factors that may contribute to physician acceptance of EHRs. This first paper of a two-part study presents a framework grounded in Diffusion of Innovations theory and the Technology Acceptance Model, which was developed using case study and survey methods, and tested using structural equation modeling (SEM). Model variables explained over 73 percent of the variance in attitude toward EHRs, and acceptable model fit was achieved. Lack of user acceptance continues to impede diffusion of EHRs, and this analysis supports the impact that leadership and other organizational changes have on user adoption.

Key words: electronic health records, barriers, user adoption, physicians, attitudes, technology acceptance, health information systems, ambulatory care, diffusion of innovations, perceptions

Introduction

With a heightened awareness of medical errors and an increased focus on improving the quality of patient care, President George W. Bush called for electronic health records (EHRs) for all Americans by the year 2014.[1, 2] While the EHR has been in development for nearly three decades, few providers have yet realized a fully integrated electronic health record environment.[3–8] Recent figures estimate EHR adoption in the ambulatory care environment to be 13 percent for a basic system and a mere 4 percent for a fully functional EHR system.[9] The American Recovery and Reinvestment Act of 2009 (ARRA) includes $17.2 billion for financial incentives to physicians and hospitals through Medicare and Medicaid to accelerate adoption of health information technology. It also includes penalties for providers failing to adopt by 2015.[10] Some speculate that even with incentives, critical mass adoption by the prescribed deadline is unlikely, and the informatics literature warns that hasty deployment of health information technology may result in implementation failure or unintended consequences.[11–13] The literature also provides evidence of clinical system implementation failures due to lack of adoption by users.[14–16] Because physicians are the key coordinators and providers of patient care, their acceptance of an EHR application will determine the overall success of a product's implementation.[17–19]

The purpose of this study is to confirm a hypothesized correlational model for predicting physician attitudes toward EHR adoption. Using case study and survey methods, this first part of a two-part study

presents a framework for examining physician perceptions prior to implementation. The second part of the study will provide an analysis of the participants and their perspectives to gain deeper insight into the antecedents of EHR adoption attitudes. This research is important because an understanding of the reasons why a system may succeed or fail is crucial for a successful implementation.[20, 21]

Background

In order to achieve nationwide interoperability and realize the benefits that EHRs can provide, physician adoption rates must be increased substantially. However, implementing the right system the right way is essential for ensuring project success and protecting patient safety. Nearly 75 percent of all large health information technology (HIT) projects fail, as well as 30 percent of EHR implementations.[22, 23] An understanding of the factors associated with physicians' acceptance will allow organizations to better assess system readiness and facilitate successful implementation.[24, 25] Much of the published research on physician attitudes focuses on satisfaction with clinical applications already in use. This research examines physician attitudes prior to EHR implementation in an academic healthcare system. A variety of disciplines contributes to information system evaluation; the current study draws upon Diffusion of Innovations theory and the Technology Acceptance Model (TAM).[26, 27]

Theoretical Framework

Lorenzi et al. classified key factors associated with successful implementations and user acceptance.[28] These include factors at the organizational level, the group level, and the individual level. The model in this study was developed to address usage determinants at all three levels.

While not specific to information technology, Diffusion of Innovations research examines the social processes surrounding changes that occur when an innovation—a new idea, practice, or object—is introduced into an organization.[29] Healthcare organizations are complex social systems comprising individuals with varying backgrounds, experiences, and values. It is important to understand how these social factors influence adoption attitudes. The Technology Acceptance Model (TAM) (Figure 1) focuses exclusively on factors that determine users' behavioral intentions toward using a new computer technology, specifically perceived usefulness and perceived ease of use.[30] It hypothesizes that a user's intended behavior predicts actual system use. This theory suggests that external variables, such as human and social factors, indirectly determine an individual's attitude toward technology acceptance by influencing perceived usefulness and perceived ease of use.[31, 32] Both models have been used extensively in prior research, and the TAM is one of the most influential frameworks for predicting users' perceptions about information system use.[33–35]

Few empirical studies have evaluated physician attitudes toward EHR adoption prior to implementation. Dansky et al. found perceived usefulness, computer experience, patient care values, and organizational support to positively impact attitudes.[36] Gadd and Penrod assessed physician attitudes prior to and after EHR implementation.[37, 38] Findings indicated perceived usefulness to be the significant predictor before and after implementation, along with concerns regarding patient privacy, interference with physician-patient rapport, workflow, efficiency, and autonomy. A study by van der Meijden et al. found computer experience to be the major predictor of acceptance, with age being nonsignificant.[39] Poor training and absence of computer skills were perceived to be adoption barriers in a recent survey of general practitioners.[40] In a study of medical group practices, Gans et al. observed "people barriers" to be significant obstacles to EHR adoption.[41]

Research Questions and Model Variables

The purpose of the study was to test the hypothesized extended TAM shown in Figure 2 to determine which factors contribute to physician acceptance of an EHR system. Research questions are as follows:

1. Which physician characteristics influence attitude about EHR use?
2. Which social factors influence attitude about EHR use?
3. Which technical factors influence attitude about EHR use?

Methods

This case study was conducted at the University of Mississippi Medical Center (UMMC), an academic-based healthcare system in Jackson, Mississippi. This site was selected because it was in the process of choosing an EHR application that would eventually be implemented in all physicians' offices in the system.

Data were collected between August and December 2007. A self-reporting online questionnaire was distributed to 802 UMMC faculty, fellow, and resident physicians. Three follow-up e-mail reminders were sent to nonresponders.

The research instrument was based upon a survey developed by Aldosari and incorporates some additional questions developed by Cork, Detmer, and Friedman.[42, 43] Both have been validated and tested for reliability in prior studies. Section 1 elicited general information about the respondents. Sections 2 through 9 collected data regarding eight constructs (unobserved variables composed of multiple survey items):

1. management support
2. physician involvement
3. adequate training
4. physician autonomy
5. doctor-patient relationship
6. perceived ease of use
7. perceived usefulness
8. attitude about EHR usage

Section 10 gave respondents an opportunity to provide comments. All questions, except those in the general information and comment sections, captured responses via a five-point Likert scale with responses ranging from "strongly disagree" to "strongly agree." A more in-depth description of the variable constructs will be provided in the second part of the study. Copies of the survey are available from the authors.

Data Analysis

A total of 239 usable responses was received, resulting in a net response rate of 29.8 percent. Data were imported into SPSS 16.0 from the online survey application. Using the SPSS Syntax Editor, scales were created for the eight constructs by averaging the participant's responses (i.e., one to five) for all question items for each construct. Construct variables in this study include the social and technical factors shown in Figure 2.

A preliminary correlation matrix revealed no significant correlations between the individual physician characteristics and the construct variables, as hypothesized in research question 1. Consequently, individual physician characteristics were excluded from the final predictive model. Descriptive analysis of the participants and the social and technical factors will be reported in the second part of the study.

Structural equation modeling (SEM) was used to analyze the predicted paths between model variables. SEM is the preferred approach for analyzing interactions between multiple independent and dependent variables, such as those used in our model.[44, 45] The proposed conceptual path model (Figure 3) was created using AMOS 16.0 structural equation modeling software and includes the following sociotechnical construct variables: management support ("Support"), physician involvement ("Involve"), adequate training ("Train"), physician autonomy ("Autonomy"), doctor-patient relationship ("Dprelation"), perceived ease of use ("Ease"), perceived usefulness ("Useful"), and attitude about EHR use ("Att").[46]

The existing data set was imported directly into AMOS from SPSS. Path (regression) coefficients were estimated for each of the proposed paths to determine the strength of the relationships. During model testing, some unpredicted paths emerged and were added to the result model presented in Figure 4.

New paths include direct effects from physician involvement ("Involve") and physician autonomy ("Autonomy") to attitude about EHR use ("Att").

Results

In this model, independent variables may directly or indirectly affect dependent variables. Standardized estimates allow the researcher to evaluate the relative contribution of each predictor variable to each outcome variable, as well as to compare across groups.[47, 48] Standardized direct effects are illustrated in Figure 4. Larger path coefficients indicate stronger correlations. To gain an understanding of a variable's overall impact on a dependent variable, it is necessary to examine its combined direct and indirect, or total, effects. Standardized total effects are reported in Table 1.

The variable with the strongest combined total effects on perceived ease of use ("Ease") is management support ("Support") (see Table 1). Doctor-patient relationship (Dprelation) had a significant negative influence on perceived ease of use (-.23) due to the negative content of the questions in the doctor-patient relationship construct. Items in this construct asked whether respondents felt that the EHR would diminish the patient's confidence in the physician, threaten the physician's credibility with patients, or decrease patients' satisfaction with the quality of their healthcare. As a physician's perception of the EHR's ability to inhibit the doctor-patient relationship increases, his or her perceived ease of use decreases. Physician involvement ("Involve") also had significant total effects on perceived ease of use ("Ease"), while adequate training ("Train") was not found to be statistically significant.

Perceived ease of use ("Ease") had the strongest total impact on perceived usefulness ("Useful") with a standardized coefficient of .55. Doctor-patient relationship ("Dprelation") had a significant negative influence on perceived usefulness (–.33), again due to the negative content of questions in the doctor-patient relationship construct. Management support (Support), physician involvement (Involve), and adequate training ("Train") had minimal overall impact on perceived usefulness ("Useful").

Perceived usefulness had the strongest impact (.63) on attitude about EHR use, with physician involvement (.47), perceived ease of use (.34) and doctor-patient relationship (–.21) making noteworthy contributions. Perceived ease of use did not directly impact attitude about EHR use as hypothesized.

Figure 4 also shows the R^2 values (explained variance) for each of the dependent variables. Together, management support ("Support"), physician involvement ("Involve") and doctor-patient relationship ("Dprelation") accounted for 30 percent of the variance in perceived ease of use ("Ease"). Perceived ease of use ("Ease") and doctor-patient relationship ("Dprelation") explained 46 percent of the variance of perceived usefulness ("Useful"). The model reflects that 73 percent of the variance of attitude about EHR usage ("Att") is captured by the independent variables in the model. R^2 values are summarized in Table 2.

Using AMOS, the research model was tested for goodness-of-fit using three popular model fit indices. Obtained values were within recommended limits (Table 3), indicating good fit.

Discussion

In a comparison of well-known information technology acceptance models, Venkatesh et al. identify common limitations of most prior research studies.[49] These studies have been conducted with simple rather than complex information technologies, and the subjects have been students. The research usually was conducted after users had been exposed to the system and had already chosen to adopt or reject the technology. Most prior studies have also tested the models in contexts where use is discretionary rather than mandated. This last issue could be problematic in the healthcare environment, as clinicians will ultimately be required by the U.S. government to use health information technology. This research proposes a framework for predicting physician acceptance of EHRs and was tested using a case study. While the TAM has been successfully used to predict attitudes toward technology adoption, the model's explanatory power has varied in prior research. Some studies have reported R^2 (explained variance) values as low as 37 percent, while others have been closer to 100 percent.[50] The variables in this study

explained 73 percent of the variance in attitude, which suggests it is an appropriate mechanism for assessing preadoption perceptions.

In this study, none of the physician characteristics correlated with the social and technical variables in the model. These findings could be reflective of a homogenous sample and are consistent with several prior studies.[51–58] The majority of respondents (67 percent) in the study were under the age of 40, which could signify a broad exposure to computers prior to their medical practice experiences. In addition, virtually all of these subjects had prior experience with the Veterans Affairs (VA) hospital's Computerized Patient Record System (CPRS).

The second and third research questions focus upon the impact of the social and technical variables on attitude about EHR use. Path analysis revealed a strong positive relationship between management support and perceived ease of use, which is consistent with previous findings.[59] Perceptions of organizational leadership relate to management's ability to provide adequate time and resources for EHR implementation.[60–62] Respondents' written comments suggest an expectation of management to ensure availability of adequate workstations, provide training and support, and resolve technical problems in a timely manner. They also expect management to incorporate their feedback regarding system use.

As hypothesized by the TAM, perceived usefulness was highly correlated with attitude about EHR use and was its strongest predictor. An EHR system must provide clear benefits to the medical staff.[63, 64] Systems often fail because they support the values of management, not the values of staff and users.[65] In a survey conducted by the American Medical Association in 2001, only 13 percent of physicians responded that EHRs would make it easier to practice medicine or to manage a medical practice.[66] A more recent study found physicians to be dissatisfied with the currently available EHR software applications, and many felt the products disrupted workflow and caused additional problems.[67] Successful EHR implementations have been associated with a focus on improving clinical processes and solving clinical problems with information technology.[68] Addressing physicians' immediate needs rather than emphasizing future predicted benefits of system use is critical in achieving EHR acceptance.[69] Ongoing evaluation and modification based on medical staff feedback is key for continued use of the EHR.[70]

User involvement in the system selection and implementation process can foster development of user ownership.[71, 72] SEM analysis revealed a positive correlation between physician involvement and perceived ease of use. Comments indicated that physicians should be responsible for product selection because of their innate understanding of clinical workflow. It is important to them that the system be compatible with clinicians' practice patterns. A number of concerns were noted regarding computerized documentation, and there was an overall apprehensiveness related to use of inflexible data entry templates and online forms. The literature warns that use of structured data entry tools may result in a loss of contextual meaning of patient information and may also compel physicians to cut and paste text from previous documents.[73] An unexpected finding was the discovery of a strong positive relationship between physician involvement and attitude about EHR use. This unmediated direct effect indicates that physicians' attitudes are affected by their perceptions of involvement, regardless of the usability or utility of the system selected.

There was a strong negative direct relationship between autonomy and attitude about EHR use. This relationship was not hypothesized but is consistent with previous studies.[74, 75] Gadd and Penrod found that perceptions of the system's impact on physician autonomy was one of the top concerns physicians had about using EHRs.[76, 77] This point was evident prior to EHR implementation and increased in a postimplementation satisfaction study. The literature reports technology-related adverse events where information systems have actually increased error rates and resulted in unintended consequences.[78–83] The current study was conducted prior to the Joint Commission's increased scrutiny on safe implementation of HIT.[84] It is likely this factor will be a stronger consideration in subsequent studies.

Limitations

This case study is limited to one large healthcare system, and results may not be reflective of attitudes found in other physician populations. The study is also constrained by the use of an anonymous survey for data collection. The small sample size is a shortcoming of the subjects' willingness to participate.

Limitations of structural equation modeling include the use of a model development process to improve goodness of fit, which is sometimes referred to as a "post hoc" procedure for hypothesis formulation. Another limitation of SEM is the use of goodness-of-fit measures to accept or reject a proposed model. These measures can inform the researcher whether a model is acceptable but cannot tell whether it is a superior model. Because SEM analysis requires a complete data set, the process of imputing missing data could potentially influence analysis as well.

Future Research

Follow-up studies with focus groups, user interviews, or observations would provide a more detailed understanding of physicians' needs. Future research could also address additional user groups within the healthcare system, such as nurses, administrators, or clerical staff. The EHR acceptance model might be tested in other venues to determine if attitudes vary by care setting. A postimplementation study on actual system use could be performed to determine if preimplementation attitudes accurately predicted true behaviors.

Some of the most interesting findings that emerged from this study are related to perceptions of the EHR's impact on clinician workflow and efficiency. Related factors include time required to document, loss of data granularity collected in patient records, and the need for sufficient training, hardware, and technical support. Postimplementation usability studies could be conducted to gain a better understanding of the EHR's overall impact on the physicians' workflow and productivity.

Different specialties may use the system in various ways. Observations, interviews, or focus groups could further investigate if and how documentation templates are being customized and if physicians are using workarounds for completing documentation. Further study might also compare the use of templates to other data entry formats, such narrative documentation, digital dictation, or data capture via handheld devices. The results would be useful to EHR vendors as well as other healthcare systems that are working through data entry challenges.

Conclusion

The national push for EHR adoption is accelerating; however, the focus should now be on successful implementation.[85] The complexity of EHR systems, as well as the healthcare environment, cannot be underestimated. Results from this study highlight the need for strong physician leadership and management support in the EHR selection and implementation process. By assessing the information needs of physicians and other EHR users, HIM practitioners can help develop criteria for evaluating and selecting EHR systems specific to their users' needs. This study revealed an overwhelming need for flexible, customizable EHR products. In general, commercial EHR system development is still quite immature, and often healthcare vendors welcome input from the user community.[86] HIM and information technology (IT) practitioners, in conjunction with medical staff leaders, should recommend hardware and software functionality to developers based upon workflow requirements and user needs. HIM practitioners can assist physicians in the selection or design of user interfaces to improve ease of use, and can advise developers on the need for diverse modes of data entry and flexible documentation tools. HIM and IT professionals must consistently work in harmony with clinicians and other users in order to promote initial and long-term EHR adoption.

Mary E. Morton, PhD, RHIA, is an assistant professor of health informatics and information management at the University of Mississippi Medical Center's School of Health Related Professions in Jackson, MS.

Susan Wiedenbeck, PhD, is a professor and PhD program director at the College of Information Science and Technology in Philadelphia, PA.

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Notes

1. Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press, 2001.
2. Bush, G. W. "Executive Order: Incentives for the Use of Health Information Technology and Establishing the Position of the National Health Information Technology Coordinator." Washington, DC: The White House, 2004.
3. DesRoches, C. M., E. G. Campbell, S. R. Rao, K. Donelan, T. G. Ferris, A. Jha, R. Kaushal, D. E. Levy, S. Rosenbaum, A. E. Shields, and D. Blumenthal. "Electronic Health Records in Ambulatory Care: A National Survey of Physicians." *New England Journal of Medicine* 359 (2008): 50–60.
4. Menachemi, N. "Barriers to Ambulatory EHR: Who Are 'Imminent Adopters' and How Do They Differ from Other Physicians?" *Informatics in Primary Care* 14, no. 2 (2006): 101–8.
5. Ford, E. W., N. Menachemi, L. T. Peterson, and T. R. Huerta. "Resistance Is Futile: But It Is Slowing the Pace of EHR Adoption Nonetheless." *Journal of the American Medical Informatics Association* 16, no. 3 (2009): 274–81.
6. Kaplan, B., and K. Harris-Salamone. "Health IT Success and Failure: Recommendations from Literature and an AMIA Workshop." *Journal of the American Medical Informatics Association* 16, no. 3 (2009): 291–99.
7. Lorenzi, N. M., and R. T. Riley. *Organizational Aspects of Health Informatics: Managing Technological Change*. New York: Springer-Verlag, 1995.
8. Lorenzi, N. M., R. T. Riley, M. J. Ball, and J. V. Douglas. *Transforming Health Care through Information: Case Studies*. New York: Springer-Verlag, 1995.
9. DesRoches, C. M., E. G. Campbell, S. R. Rao, K. Donelan, T. G. Ferris, A. Jha, R. Kaushal, D. E. Levy, S. Rosenbaum, A. E. Shields, and D. Blumenthal. "Electronic Health Records in Ambulatory Care: A National Survey of Physicians."
10. Steinbrook, R. "Health Care and the American Recovery and Reinvestment Act." *New England Journal of Medicine* 360, no. 11 (2009): 1057–60.
11. Menachemi, N. "Barriers to Ambulatory EHR: Who Are 'Imminent Adopters' and How Do They Differ from Other Physicians?"
12. Ford, E. W., N. Menachemi, L. T. Peterson, and T. R. Huerta. "Resistance Is Futile: But It Is Slowing the Pace of EHR Adoption Nonetheless."
13. Kaplan, B., and K. Harris-Salamone. "Health IT Success and Failure: Recommendations from Literature and an AMIA Workshop."
14. Lorenzi, N. M., and R. T. Riley. *Organizational Aspects of Health Informatics: Managing Technological Change*.
15. Lorenzi, N. M., R. T. Riley, M. J. Ball, and J. V. Douglas. *Transforming Health Care through Information: Case Studies*.
16. Gans, D., J. Kralewski, T. Hammons, and B. Dowd. "Medical Groups' Adoption of Electronic Health Records and Information Systems." *Health Affairs* 24, no. 5 (2005): 1323–33.

17. Lorenzi, N. M., and R. T. Riley. *Organizational Aspects of Health Informatics: Managing Technological Change*.

18. Lorenzi, N. M., R. T. Riley, A. J. C. Blyth, G. Southon, and B. J. Dixon. "Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature." *Journal of the American Medical Informatics Association* 4 (1997): 79–93.

19. Anderson, J. G. "Clearing the Way for Physicians' Use of Clinical Information Systems." *Communications of the ACM* 40, no. 8 (1997): 83–90.

20. Lorenzi, N. M., R. T. Riley, M. J. Ball, and J. V. Douglas. *Transforming Health Care through Information: Case Studies*.

21. Lorenzi, N. M., and R. T. Riley. "Managing Change: An Overview." *Journal of the American Medical Informatics Association* 7 (2000): 116–24.

22. Wears, R. L., and M. Berg. "Computer Technology and Clinical Work: Still Waiting for Godot." *Journal of the American Medical Association* 293, no. 10 (2005): 1261–63.

23. Gater, L. "CPOE Uncertainty." *For the Record*, May 9, 2005, 25–28.

24. Lorenzi, N. M., R. T. Riley, M. J. Ball, and J. V. Douglas. *Transforming Health Care through Information: Case Studies*.

25. Davis, F. D., R. P. Bagozzi, and P. R. Warshaw. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models." *Management Science* 35, no. 8 (1989): 982–1003.

26. Rogers, E. M. *Diffusion of Innovations*. 5th ed. New York: Free Press, 2003.

27. Davis, F. D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly* 13, no. 3 (1989): 319–40.

28. Lorenzi, N. M., R. T. Riley, A. J. C. Blyth, G. Southon, and B. J. Dixon. "Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature."

29. Rogers, E. M. *Diffusion of Innovations*.

30. Davis, F. D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology."

31. Ibid.

32. Davis, F. D., R. P. Bagozzi, and P. R. Warshaw. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models."

33. Ibid.

34. Davis, F. D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology."

35. Hu, P. J., P. Y. K. Chau, O. R. L. Sheng, and K. Y. Tam. "Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology." *Journal of Management Information Systems* 16, no. 2 (1999): 91–112.

36. Dansky, K. H., L. D. Gamm, J. J. Vasey, and C. K. Barsukiewicz. "Electronic Medical Records: Are Physicians Ready?" *Journal of Healthcare Management* 44, no. 6 (1999): 440–55.

37. Gadd, C. S., and L. E. Penrod. "Dichotomy between Physicians' and Patients' Attitudes Regarding EMR Use During Outpatient Encounters." *Proceedings of the AMIA Symposium* (2000): 275–79.

38. Gadd, C. S., and L. E. Penrod. "Assessing Physician Attitudes Regarding Use of an Outpatient EMR: A Longitudinal, Multi-Practice Study." *Proceedings of the AMIA Symposium* (2001): 194–98.

39. Van der Meijden, M. J., H. Tange, J. Troost, and A. Hasman. "Development and Implementation of an EPR: How to Encourage the User." *International Journal of Medical Informatics* 64 (2001): 173–85.

40. Meade, B., D. Buckley, and M. Boland. "What Factors Affect the Use of Electronic Patient Records by Irish GPs?" *International Journal of Medical Informatics* 78, no. 8 (2009): 551–58.

41. Gans, D., J. Kralewski, T. Hammons, and B. Dowd. "Medical Groups' Adoption of Electronic Health Records and Information Systems."

42. Aldosari, B. "Factors Affecting Physicians' Attitudes About the Medical Information System Usage and Acceptance through the Mandated Implementation of Integrated Medical Information System at the Saudi Arabia National Guard Health System: A Modified Technology Acceptance Model." *Dissertation Abstracts International* 64, no. 07 (2003): 3169B (UMI No. 3097602).

43. Cork, R. D., W. M. Detmer, and C. P. Friedman. "Development and Initial Validation of an Instrument to Measure Physicians' Use of, Knowledge About, and Attitudes toward Computers." *Journal of the American Medical Informatics Association* 5, no. 2 (1998): 164–76.

44. Garson, G. D. "Structural Equation Modeling." Available at http://www2.chass.ncsu.edu/garson/pa765/structur.htm (accessed April 7, 2008).

45. Hoyle, R. H. (Editor). *Structural Equation Modeling: Concepts, Issues, and Applications*. Thousand Oaks, CA: Sage, 1995.

46. Amos (Version 16.0) [computer program]. SPSS, Chicago.

47. Garson, G. D. "Structural Equation Modeling."

48. Division of Statistics and Scientific Consulting at the University of Texas at Austin. "Structural Equation Modeling Using AMOS: An Introduction." Available at http://ssc.utexas.edu/consulting/tutorials/stat/amos/ (accessed February 13, 2008).

49. Venkatesh, V., M. G. Morris, G. B. Davis, and F. D. Davis. "User Acceptance of Information Technology: Toward a Unified View." *MIS Quarterly* 27, no. 3 (2003): 425–78.

50. Hu, P. J., P. Y. K. Chau, O. R. L. Sheng, and K. Y. Tam. "Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology."

51. Aaronson, J. W., C. Murphy-Cullen, W. M. Chop, and R. D. Frey. "Electronic Medical Records: The Family Practice Resident Perspective." *Family Medicine* 33, no. 2 (2001): 128–32.

52. Brown, S. H., and R. D. Coney. "Changes in Physicians' Computer Anxiety and Attitudes Related to Clinical Information System Use." *Journal of the American Medical Informatics Association* 1, no. 5 (1994): 381–94.

53. Dansky, K. H., L. D. Gamm, J. J. Vasey, and C. K. Barsukiewicz. "Electronic Medical Records: Are Physicians Ready?"

54. Gadd, C. S., and L. E. Penrod. "Dichotomy between Physicians' and Patients' Attitudes Regarding EMR Use During Outpatient Encounters."

55. Gadd, C. S., and L. E. Penrod. "Assessing Physician Attitudes Regarding Use of an Outpatient EMR: A Longitudinal, Multi-Practice Study."

56. Gardner, R. M., and H. P. Lundsgaarde. "Evaluation of User Acceptance of a Clinical Expert System." *Journal of the American Medical Informatics Association* 1, no. 6 (1994): 428–38.

57. Gaster, B., C. L. Knight, D. E. DeWitt, J. V. L. Sheffield, N. P. Assefi, and D. Buchwald. "Physicians' Use of and Attitudes toward Electronic Mail for Patient Communication." *Journal of General Internal Medicine* 18, no. 5 (2003): 385–89.

58. Laerum, H., G. Ellingsen, and A. Faxvaag. "Doctors' Use of Electronic Medical Records Systems in Hospitals: Cross Sectional Survey." *British Medical Journal* 323 (2001): 1344–48.

59. Aldosari, B. "Factors Affecting Physicians' Attitudes About the Medical Information System Usage and Acceptance through the Mandated Implementation of Integrated Medical Information System at the Saudi Arabia National Guard Health System: A Modified Technology Acceptance Model."

60. Anderson, J. G. "Clearing the Way for Physicians' Use of Clinical Information Systems." *Communications of the ACM* 40, no. 8 (1997): 83–90.

61. Lorenzi, N. M., and R. T. Riley. "Managing Change: An Overview."

62. Lorenzi, N. M., R. T. Riley, A. J. C. Blyth, G. Southon, and B. J. Dixon. "Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature."

63. Anderson, J. G. "Clearing the Way for Physicians' Use of Clinical Information Systems." *Communications of the ACM* 40, no. 8 (1997): 83–90.

64. Ash, J. S., J. G. Anderson, P. N. Gorman, R. D. Zielstorff, N. Norcross, J. Pettit, and P. Yao. "Managing Change: Analysis of a Hypothetical Case." *Journal of the American Medical Informatics Association* 7, no. 2 (2000): 125–34.

65. Lorenzi, N. M., R. T. Riley, A. J. C. Blyth, G. Southon, and B. J. Dixon. "Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature."

66. Pearsaul, S. "Connections to Care: How Technology Makes Information Accessible." *Journal of the American Health Information Management Association* 73, no. 6 (2002): 28–31.

67. Weimar, C. "Electronic Health Care Advances, Physician Frustration Grows." *Physician Executive Journal* 35, no. 2 (2009): 8–15.

68. Doolan, D. F., D. W. Bates, and B. C. James. "The Use of Computers for Clinical Care: A Case Series of Advanced U.S. Sites." *Journal of the American Medical Informatics Association* 10, no. 1 (2003): 94–107.

69. Guthrie, M. B. "Get Real: What Will Draw Physicians to the Web?" *Physician Executive* 27, no. 2 (2001): 36–40.

70. Doolan, D. F., D. W. Bates, and B. C. James. "The Use of Computers for Clinical Care: A Case Series of Advanced U.S. Sites."

71. Lorenzi, N. M., and R. T. Riley. "Managing Change: An Overview."

72. Lorenzi, N. M., R. T. Riley, A. J. C. Blyth, G. Southon, and B. J. Dixon. "Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature."

73. Simborg, D. "Promoting Electronic Health Record Adoption. Is It the Correct Focus?" *Journal of the American Medical Informatics Association* 15, no. 2 (2008): 127–29.

74. Detmer, W. M., and C. P. Friedman. "Academic Physicians' Assessment of the Effects of Computers on Health Care." *Proceedings of the Annual Symposium on Computer Application in Medical Care* (1994): 558–62.

75. Gardner, R. M., and H. P. Lundsgaarde. "Evaluation of User Acceptance of a Clinical Expert System."

76. Gadd, C. S., and L. E. Penrod. "Dichotomy between Physicians' and Patients' Attitudes Regarding EMR Use During Outpatient Encounters."

77. Gadd, C. S., and L. E. Penrod. "Assessing Physician Attitudes Regarding Use of an Outpatient EMR: A Longitudinal, Multi-Practice Study."

78. Ash, J. S., M. Berg, and E. Coiera. "Some Unintended Consequences of Information Technology in Health Care: The Nature of Patient Care Information System-Related Errors." *Journal of the American Medical Informatics Association* 11, no. 2 (2004): 104–12.

79. Kaplan, B., and K. Harris-Salamone. "Health IT Success and Failure: Recommendations from Literature and an AMIA Workshop."

80. Koppel, R., and D. Kreda. "Health Care Information Technology Vendors' 'Hold Harmless' Clause." *Journal of the American Medical Association* 301, no. 12 (2009): 1276–78.

81. Koppel, R., J. P. Metlay, A. Cohen, B. Abaluck, A. R. Localio, S. E. Kimmel, and B. Strom. "Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors." *Journal of the American Medical Association* 293, no. 10 (2005): 1197–203.

82. Kuehn, B. M. "IT Vulnerabilities Highlighted by Errors, Malfunctions at Veterans' Medical Centers." *Journal of the American Medical Association* 301, no. 9 (2009): 919–20.

83. McDonald, C. J. "Computerization Can Create Safety Hazards: A Bar-Coding Near Miss." *Annals of Internal Medicine* 144, no. 7 (2006): 510–16.

84. The Joint Commission. "Safely Implementing Health Information and Converging Technologies." *Sentinel Event Alert* 42 (2008). Available at http://www.jointcommission.org/SentinelEvents/SentinelEventAlert/sea_42.htm (accessed December 13, 2008).

85. Berner, E. S., D. E. Detmer, and D. Simborg. "Will the Wave Finally Break? A Brief View of the Adoption of Electronic Medical Records in the United States." *Journal of the American Medical Informatics Association* 12, no. 1 (2005): 3–7.

86. Kukafka, R., S. B. Johnson, A. Linfante, and J. P. Allegrante. "Grounding a New Information Technology Implementation Framework in Behavioral Science: A Systematic Analysis of the Literature on IT Use." *Journal of Biomedical Informatics* 36 (2003): 218–27.

Figure 1
Davis's Technology Acceptance Model

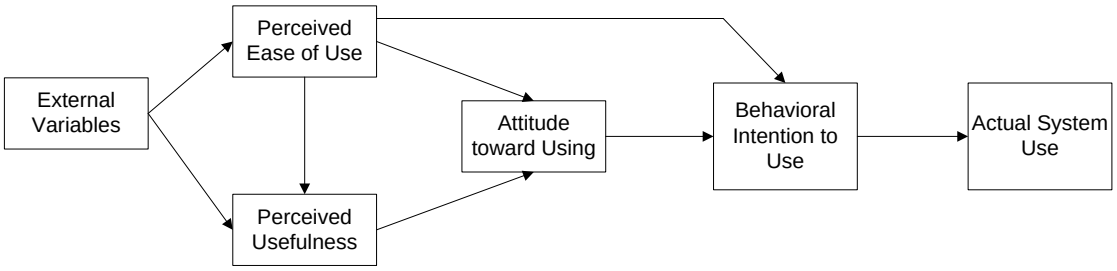
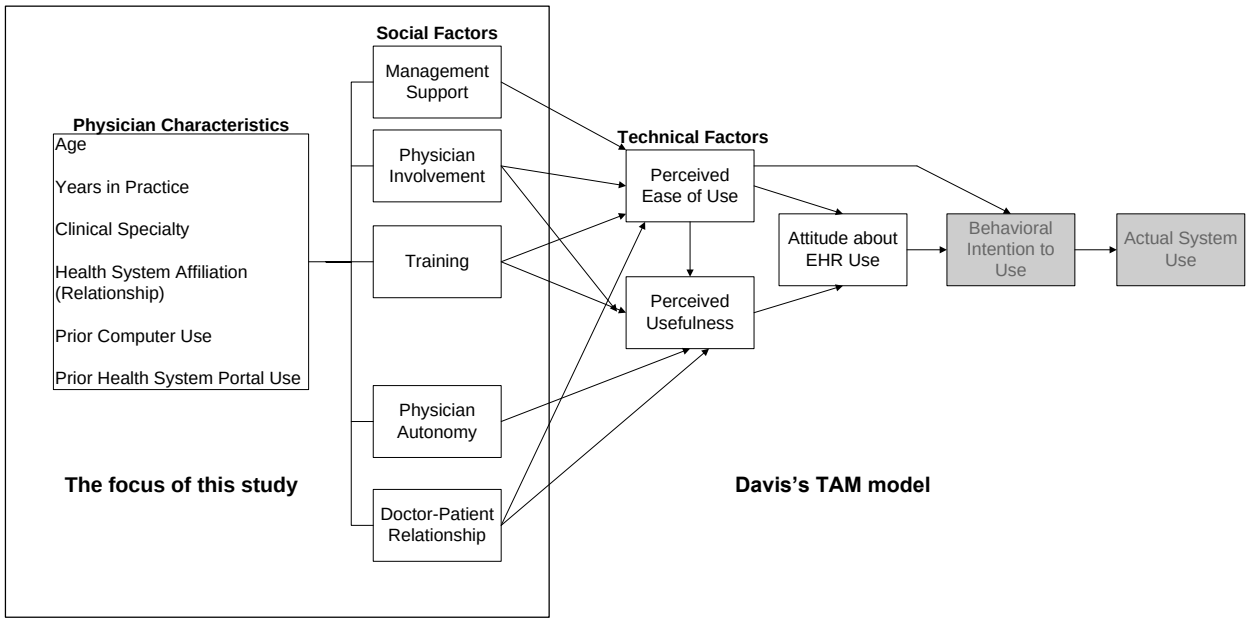


Figure 2
Proposed EHR Acceptance Model



Note: "Behavioral intention to use" and "actual system use" are part of the TAM theoretical model but were not measured in this study.

Figure 3
Proposed Conceptual Path Model

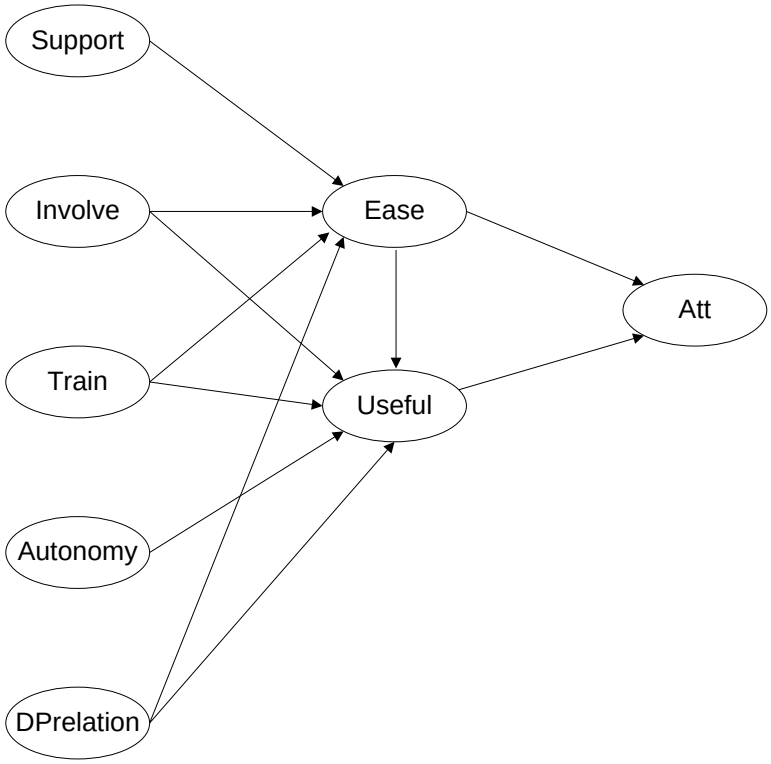


Figure 4
Standardized Direct Effects

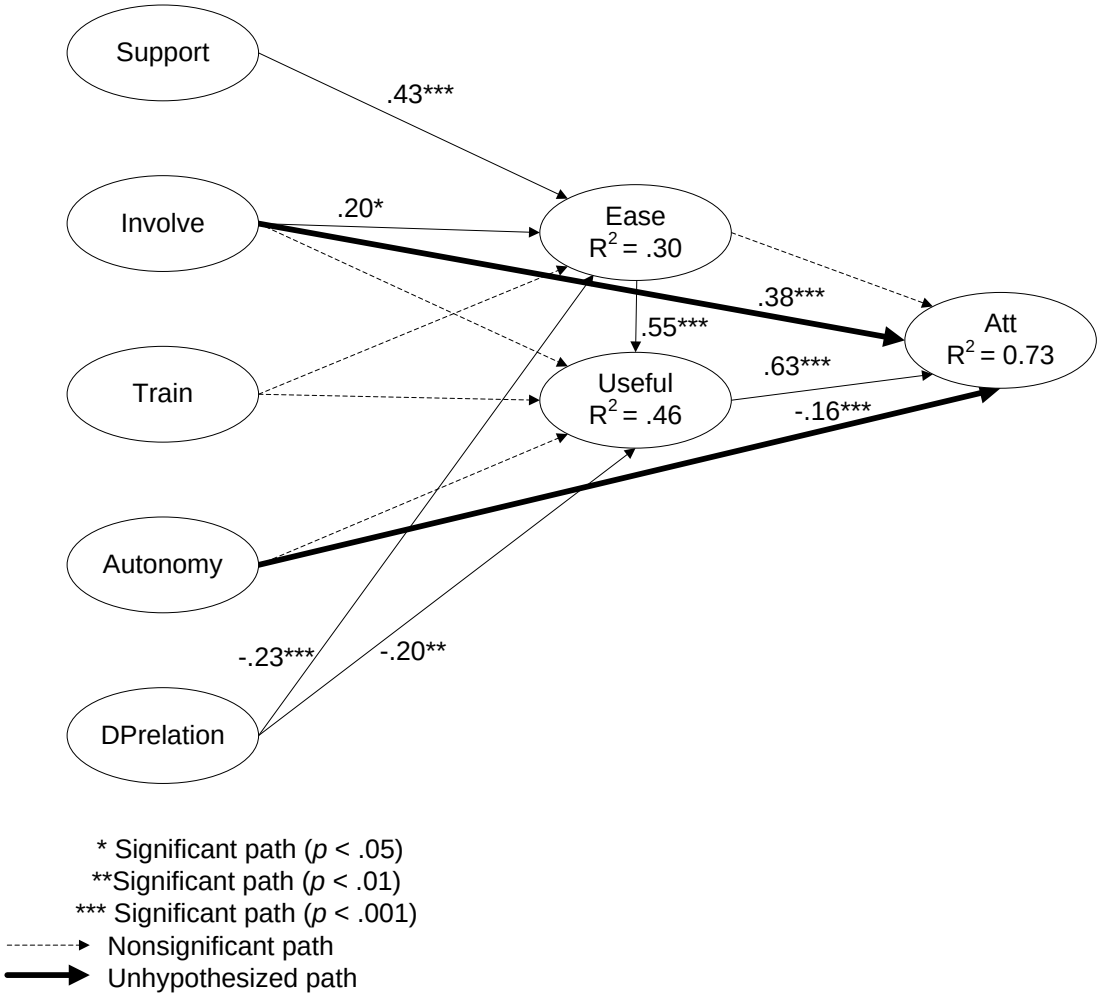


Table 1
Standardized Total Effects

Causal Path	Path (Regression) Coefficient
SUPPORT → EASE	.43***
DPRELATION → EASE	-.23***
INVOLVE → EASE	.20*
TRAIN → EASE	-.09
EASE → USEFUL	.55***
DPRELATION → USEFUL	-.33**
SUPPORT → USEFUL	.24
INVOLVE → USEFUL	.15
TRAIN → USEFUL	.03
USEFUL → ATT	.63
INVOLVE → ATT	.47
EASE → ATT	.34
DPRELATION → ATT	-.21***
AUTONOMY → ATT	-.16***
SUPPORT → ATT	.14***
TRAIN → ATT	.02

* $p < .05$
** $p < .01$
*** $p < .001$

Table 2
Variance Explained in Dependent Variables

Variable	R^2
Perceived ease of use ("Ease")	.30
Perceived usefulness ("Useful")	.46
Attitude about EHR use ("Att")	.73

Table 3
Recommended Goodness-of-Fit Measures

Recommended Index	Recommended Value	Reference	Obtained Value
χ^2 *Relative χ^2 (χ^2 / df)	Relative χ^2 < 3.0	Kline	2.01
Tucker-Lewis Index (TLI) *AKA Nonnormed fit index (NNFI)	.90 or above acceptable fit	Garson, Gefen et al., Kline	.91
Comparative Fit Index (CFI)	.90 or above	Garson, Gefen et al., Kline	.91

Sources: Garson, G. D. "Structural Equation Modeling." Available at http://www2.chass.ncsu.edu/garson/pa765/structur.htm (accessed April 7, 2008);

Gefen, D., D. W. Straub, and Marie-Claude Boudreau. "Structural Equation Modeling and Regression: Guidelines for Research Practice." *Communications of the Association for Information Systems* 7 (2000). Available at http://cais.aisnet.org/ (accessed February 22, 2008).

Kline, R. B. *Principles and Practice of Structural Equation Modeling*. 2nd ed. New York: Guilford Press, 2004.