School of Medicine
Oregon Health Sciences University

CERTIFICATE OF APPROVAL

This is to certify that the MPH thesis of

Philip D. Marshall MD

has been approved

[redacted]

Homer L. Chin, MD, Committee Chair

[redacted]

Merwyn Greenlick, Ph.D.

[redacted]

John Mullooly, Ph.D.

[redacted]

Thomas Becker, MD, Ph.D.

Richard Maurer, Associate Dean for Graduate Studies

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Abstract

Objective

The objective of this study is to examine the attitudes of clinicians in community practice who use a comprehensive outpatient Electronic Medical Record (EMR) system. Clinician attitudes toward the effects of the EMR on patient care, as well as their reactions to the use of a read-only Results Reporting and an online charting and ordering system are evaluated. The effect of an EMR system on clinician job satisfaction is also examined. Finally, the characteristics of clinicians that can be used to predict higher opinions of the EMR's effects on patient care and job satisfaction is examined.

Methods. A cross-sectional study using a survey of Kaiser Permanente Northwest clinicians was performed. In addition, interviews were conducted with the physician leaders of the clinical departments at Kaiser Permanente Northwest. Clinician attitudes were measured regarding the effects of a read-only "results reporting" system and an online charting and ordering system on the overall quality of patient care, various other care-related indices, and their job satisfaction.

Results Most clinicians feel that the outpatient Electronic Medical Record has improved the overall quality of patient care, with 72% reporting an improvement with the use of a "results reporting" system, and 60% reporting an improvement with the use of the online charting and ordering system. The difference in the responses for these two components is significant ($p<.001$). On average, clinicians perceive that using the EMR has resulted in improvements in the quality of the patient-clinician interaction, their ability to provide clinical preventive services, their ability to coordinate the care of patients with other departments, their ability to detect medication errors, the timeliness of referrals, and their ability to act on test results in a timely fashion. Clinicians perceive that their job satisfaction has improved as a result of using a "results reporting" system, but not with the use of an online charting and ordering system. Certain clinician characteristics, including their self-reported ability to type, their overall job satisfaction and the length of time using the EMR system can be used to predict clinicians' perceptions of how the EMR system affects the quality of patient care.

Conclusion Clinicians perceive an improvement in patient as a result of using an outpatient Electronic Medical Record system. Clinicians have higher opinions, however, of the effects of a "results reporting" system compared to an online charting and ordering system. The use of a "results reporting" system is also associated with perceived improvements in clinician job satisfaction.

Introduction

A growing list of physician practices and health systems are implementing outpatient Electronic Medical Record (EMR) systems. The decision to purchase these systems, however, is often based on their proposed administrative benefits rather than their benefits to clinicians. A growing body of literature suggests these systems can improve patient care, but these studies have usually addressed the effects of specific technologies, such as reminder systems or clinical practice guideline systems, in academic environments. Few published data have addressed the attitudes of clinicians in community practice toward a comprehensive outpatient EMR system and its effects on patient care. More information is needed, too, about which components of EMR systems have the greatest perceived effect on patient care, the clinician characteristics that predict higher estimations of EMR effects on patient care, and the impact of these systems on clinician job satisfaction.

The objective of this study is to examine the clinician attitudes in community practice experienced in the use of a comprehensive outpatient EMR system. A cross-sectional study was performed through a survey of the physician and non-physician providers of Kaiser Permanente Northwest (KPNW), and interviews of the KPNW clinical department leaders. KPNW is a large, vertically-integrated group model health maintenance organization that has been using an outpatient EMR system since 1991. The EMR in use at KPNW now includes a "results reporting" (RRS) component and an online charting and ordering component.

Using the survey instrument, clinician opinions were collected regarding the effects of the RRS component and the online charting and ordering component on patient care and their job satisfaction. In addition, a variety of clinician demographic and computer-related attributes were collected.

The analysis of the survey results includes the frequency of responses to questions regarding the effects of the EMR on patient care and job satisfaction, as well as the comparison of the responses for the RRS and online charting and ordering components. In addition, the demographic and computer-related characteristics of respondent clinicians were evaluated with regard to their value in predicting clinician opinions. The analysis of the survey results and the results of the interviews provide the basis for this report.

The existing wealth of knowledge and experience of Kaiser Permanente Northwest clinicians in the use of a comprehensive EMR offers a unique opportunity to investigate clinician attitudes surrounding the use of these systems. The results of this evaluation should greatly enhance our understanding of how clinicians perceive the clinical effects of the outpatient EMR. A better understanding of clinician attitudes toward the effects of the EMR on patient care, the differences in attitudes toward a read-only system and an online charting and ordering system, and the self-reported effects of using these systems on job satisfaction should substantially improve our appreciation for the effects of these systems. Examining the attributes of clinicians which are associated with higher opinions of the effects of the EMR on patient care could help identify those individuals who can be identified as being supportive of the use of EMR systems, as well as those clinicians who may need more help in adopting the system. A greater understanding of those experienced in the use of an outpatient EMR should result in improved sensitivity and attention to the

concerns and needs of community clinicians looking to adopt these systems for their own practices.

This study was approved by the Committee for the Protection of Human Subjects at the Kaiser Permanente Center for Health Research in Portland, Oregon.

Background

Kaiser Permanente Northwest is a vertically-integrated group model health maintenance organization serving over 430,000 members in Oregon and Southwest Washington. From 1991 to 1994, the Kaiser Permanente Northwest (KPNW) outpatient Electronic Medical Record system underwent the first of two developmental phases. In the first phase, a "results reporting" system (RRS) was implemented throughout the division. RRS is a read-only computerized reporting system allowing clinicians to review laboratory tests, dictated reports, prescriptions, appointments, admission data, patient demographics, and immunizations. KPNW clinicians interact with RRS on desktop computers using single keystroke navigation via a telnet connection to the RRS repository. The RRS repository receives regular data downloads from the following databases: Transcription, Immunizations, Tumor Registry, ADT (Admission, Discharge and Transfer), Appointments, Patient Demographics, Laboratory, Outpatient Pharmacy and Patient Allergies. RRS is available to KPNW clinicians from outpatient offices, hospitals, home, and wherever a modem connection can be established with the KPNW network. Response time for RRS is sub-second, and "it's unfaltering reliability has made it the 'workhorse' system for access to patient information."[1] Prior to the implementation of RRS, the paper-based record, including printed lab results and dictated reports, was being used by KPNW clinicians for all patient visits. Prior to RRS, the medical chart was unavailable in approximately 25% of next-day and urgent patient visits.[2]

The second Electronic Medical Record (EMR) implementation phase began in 1994 when clinicians began using EpicCare, an advanced outpatient electronic charting and ordering system developed by Epic Systems of Madison, Wisconsin. Clinicians use

EpicCare to enter encounter notes, enter prescriptions for the pharmacy, order lab and diagnostic tests, construct problem and current medication lists, enter diagnoses, and make patient referrals. EpicCare also incorporates guidelines for medication ordering, referrals, and test ordering. EpicCare is available on the same desktop computers as RRS, but requires a separate login. Clinicians generally type their own encounter note into EpicCare immediately following the patient visit or at the end of the day. EpicCare offers charting shortcuts, including templates and encounter forms, which allow clinicians to document progress notes with less effort than having to type the note entirely in free text. In addition to these personal shortcut options, EpicCare has been customized for each department, allowing clinicians to choose orders and medications that are most frequently used in their department. Most KPNW clinicians were using RRS at the time they began using EpicCare. Until very recently, admission data, dictated reports, and lab data were available only on RRS, and most clinicians continue to use RRS for these functions[1].

Currently, all clinical departments except Emergency Services are using EpicCare for all patient visits, resulting in over 3 million patient encounters currently in the EpicCare database. Previous studies from KPNW have examined the early utilization of RRS[3], and the early effects of EpicCare on physician productivity[2]. A complete description of these systems has been published in the winning submission for the 1998 Davies Award, an award given yearly by the Computerized Patient Record Institute to the organization showing the most advanced implementation and use of an outpatient EMR system [1].

Examining the attitudes of KPNW clinicians offers a unique opportunity because the attitudes of clinicians experienced in the use of comprehensive outpatient EMR

systems have seldom been studied. There is an extensive body of literature on attitudes of clinicians toward computers, however[5-12]. The literature pertaining to physician attitudes and acceptance of computerized systems has been conveniently summarized by Cork and others.[5] Cork and colleagues have created a survey instrument that measures the attributes of computer use, self-reported computer knowledge, computer feature demand, and computer optimism of academic physicians.[5] This instrument may be useful in determining the future use of computer systems by clinicians. As expressed by Cork and colleagues "...it is important to develop methods for understanding and accurately measuring attributes of physicians and other health professionals that may predict their acceptance and mode of use of computer systems and thus guide the design of such systems."[5] An improved understanding of the clinician attitudes toward EMR systems, and the clinician characteristics that are most predictive of acceptance, will allow for improved strategic planning and training efforts by organizations planning to implement such systems.

Previous studies evaluating computer acceptance by clinicians have addressed the importance of clinician practice patterns[6] and clinician attitudes. Counte and colleagues found that attitudes toward computers in general, personality attributes (including change orientation) and their feelings of role ambiguity helped explain the variability in responses of hospital employees to the implementation of a medical information system [7,8]. Teach and Shortliffe found that acceptance of a computerized consultation system was associated with physician specialty, but not associated with the number of years in practice or the amount of previous computer experience[9]. Efforts to examine the importance of attitudes and personal characteristics of clinicians in the use of computer systems have been

conducted primarily in the inpatient setting. Because the outpatient setting is the environment in which most patients receive care, it is necessary to improve our understanding of what factors are important to the acceptance of an EMR in this setting.

In evaluating the attitudes of clinicians experienced in the use of EMR systems, Anderson and colleagues have found that physicians' attitudes toward computers were associated with their use of hospital information systems[10]. Tierney and colleagues examined the acceptance of computerized order-writing by medical students and residents[11], and Brown and colleagues examined the predictability of resident's psychological reaction to computers by using computer-related and personal characteristics, including the clinician's computer ownership status and self-reported ability to type[12].

Substantial literature addresses the information needs of physicians, including the information needs of physicians in the ambulatory care setting.[13] Evidence suggests that traditional medical records in the outpatient setting are inadequate in meeting the information needs of clinicians.[14-16] Little information exists, however, on whether read-only systems or online charting and ordering systems are more helpful to clinicians. Aydin and others have examined the ability of clinicians in a busy ambulatory practice to type their own chart notes.[15] Tang and others have evaluated the desire of clinicians to have access to various EMR capabilities, although online charting was not addressed[16]. Weir and colleagues have summarized the differences in physician attitudes among institutions that had successful implementation of an online order-entry system and institutions that did not.[17] They found that those physicians associated with an institution successfully

implementing an online ordering system had higher opinions of the positive impact, potential savings and decreased errors offered by the system.

Another factor that has long been considered a potential contributor to the acceptance of an EMR system by clinicians is overall job satisfaction[7,8]. However, just as job satisfaction can impact the acceptance of an EMR system, so too can the substantial workflow and organizational issues surrounding the implementation of an EMR system substantially affect clinician job satisfaction. Review of the literature failed to reveal any citations pertaining to the effect of EMR systems on job satisfaction.

The potential of EMRs to positively affect patient care will not be realized unless clinicians perceive that the systems are adding value to their work[18]. As stated by Glyn Hayes, "If there is no perceived benefit from the (EMR) the clinician will prefer to retain the paper record...The system has to provide some 'added value' during that encounter if the clinician is to be persuaded to use it."[18] Perhaps the most important "added value" of an EMR is its contribution to improved patient care.

Studies examining the effects of Electronic Medical Record systems on patient care have addressed (1) their potential for enhancing the availability of important clinical information such as laboratory and diagnostic test results[19,20], (2) the effectiveness of specific decision-support tools on patient care outcomes [21-35], and (3) the use of practice databases to characterize patient populations and predict patient outcomes[36-39]. James Anderson has provided an excellent review of the potential advantages of the EMR for patient care, as well as the barriers to EMR implementation and possible methods of changing physician practice behavior[40].

Other proposed benefits of EMR systems for patient care include the ability to reduce the number of medication dosing errors, drug reactions, and drug-drug interactions[41]. EMR systems may also enhance communications necessary for the coordination of patient care between primary and specialty care departments[42]. The benefits of the EMR are also being extended directly to patients, enabling providers to print patient education material and personalized patient information[43]. The outpatient EMR system in use at KPNW offers many of these proposed benefits to patient care.

Methods

This cross-sectional study was performed using semi-structured interviews and a survey of KPNW clinicians. The clinicians participating in this study include physicians (MD, DO, and DPM) and affiliated clinicians (Physician Assistants, Nurse Practitioners, Optometrists, and mental health professionals). Interviews were conducted with physician leaders of the clinical departments and consisted of 10 open-ended questions about the effects of the EMR on patient care. These semi-structured interviews allowed for greater insight into the ways in which the EMR system is affecting clinicians' lives and work. These interviews were recorded and transcribed. Representative quotations from the interview transcripts are located in the Discussion section below and Appendix 2.

Also, the *Electronic Records and Patient Care* survey--consisting of 65 questions relating to demographic and background information, computer experience, and perceptions of the impact of the EMR on patient care--was distributed to all KPNW clinicians who work half-time or more with KPNW and who use both RRS and EpicCare (all clinicians except those in Emergency Services). The survey is presented in Appendix 1.

The survey was a culmination of the interviews and previous survey studies. The survey instrument is comprised of background questions, including questions on age, gender, clinical department, professional title (Physician or Affiliated Clinician), and length of time working in their current clinical department. The survey is also comprised of computer-related questions, including length of time using EpicCare, the amount of time needed to become proficient using EpicCare following training, comfort level with computer technology prior to using EpicCare, their self-reported ability to type, and

computer ownership. Information was obtained from Northwest Permanente on the age, gender, clinical department, and professional title of all clinicians eligible to complete the survey. This information was provided without personal identifiers, and respondents were not asked to provide their names on the survey in order to maintain a high level of confidentiality. The characteristics available for all KPNW clinicians were compared to those of the respondents to determine the degree of generalizability of the results to the entire KPNW medical group. Mean age was compared between respondents and all KPNW clinicians using a one-sample t test. The percentage of males vs. females, and the percentage of physicians vs. affiliated clinicians were compared for respondents and non-respondents using a chi square analysis. A chi square analysis was also performed to determine if the respondents were different from non-respondents with regard to their distribution among primary care, medical subspecialty, surgical subspecialty, and mental health departments.

Overall job satisfaction was also measured. This job satisfaction measure has been used in previous surveys of KPNW clinicians and has been found to effectively discriminate between groups with different levels of job satisfaction.[44] This measure asks physicians (clinicians) "If you were to choose your occupation over again, would you still become a physician (clinician), or would you choose some other occupation?" The ordinal response scale asks respondents to choose one of five responses: 1= Definitely choose to become a physician (clinician) 2= Probably choose to become a physician (clinician) 3= Not Sure 4= Probably choose some other occupation, or 5= Definitely choose some other occupation.

In order to test the hypothesis that clinicians perceive an improvement in the overall quality of care they give their patients as a result of using the EMR system, clinicians were asked to assess how RRS and EpicCare (separately) have affected the overall quality of care on a five-point comparative scale using the following possible responses: "1= much worse," "2= worse," "3= same," "4= better," and "5= much better." The implied comparison is with the time before the EMR component was implemented. The responses for RRS and EpicCare were compared using a paired-samples t test. A Pearson's correlation coefficient was analyzed to determine the degree to which respondents gave the same responses for both EMR components.

Linear regression was used to determine which of the demographic and computer-related variables listed above are predictive of clinician attitudes toward the effect of RRS and EpicCare on the overall quality of patient care (self-reported time needed to become proficient using EpicCare was not used as a predictor variable for the responses to RRS). These variables were entered stepwise in blocks into the regression model, with age entered in block 1, self-reported ability to type, comfort with computers, and computer ownership status in block 2, department type and professional title in block 3, length of time needed to become proficient using EpicCare in block 4, and length of time using EpicCare and overall job satisfaction entered in block 5. This order of variable entry was decided upon based on the temporal influence that these variables potentially had on clinician attitudes, as well as for the purpose of grouping similar variables. For example, the clinician's department was most likely a potential influence prior to their use of EpicCare, however the clinician's experience with computers was possibly an influence prior to his/her joining the department.

Department type was entered into the linear regression analysis as a binary variable (primary vs. specialty care). The length of time using EpicCare was felt to potentially predict responses not only for EpicCare, but also for RRS. The reasons for the inclusion of this predictor in the RRS model include: using EpicCare may significantly increase the level of computer-use proficiency and willingness to use clinical computing applications, including RRS. Also, using EpicCare, which requires more time and effort than RRS, may increase clinicians' appreciation for the contribution of the read-only RRS system on patient care.

Other patient care issues potentially affected by both EpicCare and RRS and addressed by the survey are the quality of the patient-clinician interaction and the ability to provide clinical preventive services (e.g., screening, counseling and immunization). The responses to the survey questions addressing these issues are compared for RRS and EpicCare using the paired-samples t test.

The patient care-related topics addressed by the survey were determined by first reviewing the potential benefits proposed in the medical literature for EMR systems, then deciding which of these issues could be affected by the EMR systems at KPNW. Many of these are primarily addressed by EpicCare (e.g., adherence to clinical practice guidelines, detection of medication errors, coordination of patient care with other departments, and patient referral) or primarily by RRS (e.g., ability to act on test results in a timely fashion). To test the hypothesis that clinicians perceive an improvement in these care-related areas using these systems, the mean responses to these survey questions for EpicCare or RRS were compared to a mean of 3.0, or "Same," using a one-sample t test. A single survey question was used to measure attitudes relating to each of these care-related topics, except

for medication errors, which represents a composite score for the EMR's effects on detection of medication dosing errors and detection of drug-drug interactions / drug allergic reactions.

Clinicians were using RRS at the time EpicCare was implemented, therefore the perceived effect of EpicCare on patient care might represent the perceived incremental benefit of EpicCare over having only RRS (even though the purpose and capabilities of RRS and EpicCare are quite different) Because of this, making a direct comparison of attitudes toward the two systems is difficult. Because it is an objective of this study to determine the relative opinions of clinicians toward RRS and EpicCare, clinicians were asked to rate the relative benefit to patient care and effort required to use these systems on a 10-point scale. The horizontal, numerical scale options range from 1= very little benefit (effort) to 10= a great deal of benefit (effort). The mean benefit scores and the mean effort scores are compared for RRS and EpicCare using a paired-samples t test. In addition, the mean benefit / effort ratio was calculated for each system for each respondent, then averaged for all respondents. The mean benefit / effort ratios for RRS and EpicCare were then compared using a paired-samples t test.

The responses of clinicians to the survey question "How has your job satisfaction been affected by using EpicCare (RRS)?" are reported using the five-point comparative scale ranging from "much worse" to "much better" described earlier. The mean responses for RRS and EpicCare are compared using a paired-samples t test.

Linear regression was used to determine which independent variables, including the background and computer-related variables described earlier, are associated with the perceived impact of the EMR on clinician job satisfaction. A stepwise model in which the

independent variables were entered in blocks was again used, with age entered in block 1, self-reported ability to type, comfort with computer technology, and computer ownership status entered in block 2, department type and professional title entered in block 3, (length of time needed to become proficient using EpicCare following training) entered in block 4, and length of time using EpicCare entered in block 5.

Results

Nineteen of 27 physician leaders were interviewed (70%), including five primary care physicians and 14 specialty care physicians. Four hundred forty-nine clinicians returned the surveys for a response proportion of 60%. Of the respondents reporting their professional title, 299 (68%) are physicians, and 143 (32%) are affiliated clinicians. Table 1 shows the background and demographic characteristics of the respondents.

The average age of respondents was 46 years (range 27-68 years), compared to 47 years for all KPNW clinicians ($p=.002$). There were no significant differences between respondents and non-respondents in the percentages of physicians vs. affiliated clinicians, or gender. Although there is no difference between respondents and non-respondents with regard to the percentage in primary vs. specialty care departments, when the specialty care departments are subdivided into medical subspecialties, surgical subspecialties and mental health, the lower-than-expected response from the surgical subspecialties and a higher-than-expected response from mental health clinicians contribute to a significant difference between respondents and non-respondents ($p<.001$).

The survey results detailing the attitudes of KPNW clinicians toward how EpicCare and RRS have affected the overall quality of patient care are presented in Figure 1. Sixty percent of respondents felt that using EpicCare has improved the overall quality of care, compared to 32% who felt that care has not been affected and 8% who felt care is worse (mean response = 3.67). Seventy-two percent of respondents felt that RRS has improved the quality of patient care, compared to 27% who felt care has not been affected and 1% who felt care is worse (mean response = 3.93). When the responses to the two

systems are compared, the results for RRS are significantly higher than those for EpicCare ($p<.001$).

The results of the linear regression analysis using the independent variables described above to predict the opinions of clinicians regarding the effects of EpicCare on overall quality of patient care are presented in Table 2. The variables that were found to significantly predict higher opinions of the effects of EpicCare on the overall quality of patient care include a higher self-reported ability to type, less time needed to become proficient using EpicCare following training, greater length of time using EpicCare, and a higher overall job satisfaction. These variables account for approximately 8% of the variance in the dependent variable. The Pearson's correlation coefficient (r) between the self-reported ability to type and time needed to become proficient using EpicCare was 0.229 (n.s.). Of the predictor variables, self-reported ability to type was the greatest contributor, accounting for nearly half of the overall variance accounted for by the model. Age, comfort level with computers, owning a computer, department type, and job title (physician vs. affiliated clinician) were not predictive of clinician responses.

In predicting the response of clinicians to the effects of RRS on the overall quality of patient care (Table 3), the independent variables listed above accounted for approximately 7% of the response variance. A higher self-reported ability to type, a greater length of time using EpicCare, and higher overall job satisfaction are predictive of higher opinions of the effects of RRS on the overall quality of patient care. Again age, comfort level with computers, owning a computer, department type, and job title were not predictive of responses. There is similarity between the two regression models, with the same variables predictive of attitudes toward both systems, except the length of time

needed to become proficient using EpicCare which was not included in the RRS model. (In fact, the length of time needed to become proficient using EpicCare is not predictive of responses to RRS, with a Beta value of -0.008 and a significance level of 0.891). The Pearson correlation coefficient (r) for responses to EpicCare and RRS is 0.572, indicating that approximately 1/3 of the variance in the responses toward one system is accounted for by responses to the other system.

The responses of clinicians to the effects of the EMR on quality and content of their patient-clinician interaction are presented in Figure 2. Thirty eight percent of clinicians felt that EpicCare has improved the quality and content of their patient-clinician interaction, compared to 38% who felt EpicCare has had no effect and 24% who felt that their interaction has worsened as a result of using EpicCare (mean = 3.19). Forty-five percent of respondents felt that RRS has improved the quality and content of their patient-clinician interaction, compared to 51% who felt RRS has had no effect and 4% who felt this interaction has worsened as a result of using RRS (mean = 3.49). The differences between the responses for EpicCare and RRS are again significant ($p<.001$).

On average, KPNW clinicians felt that EpicCare and RRS have improved their ability to provide clinical preventive services (Figure 3), with forty-three percent of respondents feeling that EpicCare has improved their ability to provide clinical preventive services. However, 53% felt that EpicCare has not affected this ability (mean = 3.48). Forty-seven percent of respondents felt that RRS has improved their ability to provide clinical preventive services, compared to 52% who felt that RRS has not affected this ability (mean = 3.60). The opinions of the effects of RRS are significantly higher than those for EpicCare ($p=.002$).

When asked about specific benefits of EpicCare (Figure 4), 82% of respondents felt that EpicCare has improved their ability to coordinate the care of patients with other providers and departments (mean = 4.12), and 63% felt that EpicCare has improved the timeliness of patient referrals (mean = 3.81). Although only 29% of respondents felt that EpicCare has improved their ability to adhere to clinical practice guidelines (compared to 68% who felt this ability has not been changed, mean = 3.32), 61% felt that EpicCare has improved their ability to detect medication errors, including dosing errors, adverse drug reactions and drug-drug interactions (mean = 3.55). Regarding RRS, 74% of respondents felt that RRS has improved their ability to act on test results in a timely fashion (mean = 4.01) (Figure 5). The test statistics and significance levels for all t tests are reported in Table 4. The mean responses for all questions reported above are significantly higher than a mean of 3.0 or "Same."

The relative benefit to patient care and effort required to use RRS and EpicCare are reported in Table 5. Clinicians were asked to report the benefit of RRS and EpicCare to patient care on a scale from 1 to 10 (10=a great deal of benefit). The mean response for RRS was 7.3, and 6.9 for EpicCare ($p<.001$). When asked to report the effort required to use RRS and EpicCare on a scale from 1to 10 (10=a great deal of effort), clinicians report a mean score of 3.0 for RRS and 5.9 for EpicCare ($p<.001$). The benefit / effort ratio was calculated for RRS and EpicCare for each respondent. When these ratios are averaged, the mean benefit / effort ratio for RRS is 3.1 and 1.8 for EpicCare ($p<.001$).

The response of clinicians to how their job satisfaction has been affected by using EpicCare is presented in Figure 6. Thirty-four percent of respondents felt that EpicCare

has improved their job satisfaction, 34% felt that EpicCare has had no impact on their job satisfaction and 32% felt their job satisfaction has worsened with the use of EpicCare. The mean response of clinicians (3.02) was not significantly different from 3.0 or "Same" ($p=0.739$). The results of the linear regression for predicting these responses are presented in Table 6. The length of time needed to become proficient using EpicCare following training, the clinician's professional title, and the clinician's self-reported ability to type are predictive of clinicians' opinion of the effect of using EpicCare on their job satisfaction. The shorter time needed to become proficient using EpicCare following training, being an affiliated clinician, and greater self-reported typing skills are predictive of higher opinions of the effects of using EpicCare on job satisfaction. These three variables account for approximately 11% of the variance in clinician responses, with the length of time needed to become proficient using EpicCare as the greatest contributor to the model.

When the opinions toward how EpicCare has affected job satisfaction are addressed separately for physicians and affiliated clinicians, the mean response for physicians (2.89) is not significantly different from 3.0 or "Same" using a one-sample t test ($p=.075$). The mean response for affiliated clinicians (3.25), however, is significantly higher than 3.0 ($p= .002$).

In contrast to the responses for EpicCare, 55% of respondents felt that RRS has improved their job satisfaction, with 42% feeling their job satisfaction has not been affected by using RRS (mean = 3.64). Again, the difference in the mean responses to EpicCare and RRS are significant ($p<.001$). The linear regression analysis results, shown in Table 7, show that only the length of time using EpicCare is a significant predictor of

clinician responses, with the longer amount of time on EpicCare predictive of higher opinions of the effect of RRS on their job satisfaction. This variable accounts for 6% of the variance. When the length of time using EpicCare is divided into quartiles (< 12 months, 12-17 months, 18-23 months, and over 23 months), the association between the perceived effect of RRS on job satisfaction and the amount of time using EpicCare is consistent (Table 7).

Discussion

The purpose of this study was to examine the attitudes of clinicians in community practice experienced in the use of a comprehensive outpatient EMR system. Understanding the perceived benefits of EMR systems to patient care should help encourage the diffusion of these systems. Evaluating the differences in the perceived impact of a read-only "results reporting" system and an online charting and ordering system may help clinicians to prioritize the implementation of these different EMR components. Examining the attributes of clinicians which are associated with higher opinions of the effects of the EMR on patient care could help identify those individuals who will be "champions" of the EMR system, as well as help identify those clinicians who may need more help in using the system.

On average, KPNW clinicians feel that both the RRS and EpicCare components of the comprehensive outpatient EMR system at KPNW improve the quality of patient care. This is true of clinicians' opinions pertaining to how the EMR system has affected the overall quality of patient care as well as the quality and content of their patient-clinician interaction. On average, KPNW clinicians also believe these systems have improved their ability to provide clinical preventive services. On average, KPNW clinicians feel that EpicCare has improved their ability to adhere to clinical practice guidelines, to detect medication errors, to coordinate patient care, and the timeliness of referrals. KPNW clinicians also feel that RRS has improved their ability to act on test results in a timely fashion, and that RRS has improved their job satisfaction.

In the words of KPNW clinicians:

"Results Reporting was a gift from God. It was what I had been waiting for for years."

"With EpicCare, care can now be more specific, more guided, more timely and more appropriate."

"When patients feel that you are informed they feel amazingly secure. When you know what happened in their primary care visit that morning, or if you have a complex case, they like to know that there is a team approach to taking care of them. We don't hear 'God, why don't you guys talk to each other' any more."

Evidence from both the survey and the interviews demonstrate that RRS is perceived to benefit patient care and job satisfaction more than EpicCare. This is true even though clinicians have to log into RRS several times a day (EpicCare and RRS have separate logins, and RRS automatically logs out after a short period of being idle). Clinicians also believe that RRS is more beneficial to the patient-clinician interaction despite the ability in EpicCare to print personalized visit summaries and patient instructions. This may be a result of the belief by many clinicians that electronic charting takes away from the time they are able to spend in the exam room. Clinicians on average have positive opinions, too, about how these systems affect their ability to provide clinical preventive services, although the majority of respondents have not witnessed an improvement in this area. It should be noted that RRS and EpicCare do not have the same capabilities with regard to providing clinical preventive services. RRS allows for

clinicians to review screening test results and clinical preventive services that have been completed. EpicCare allows for clinicians to order clinical preventive services. The difference in the responses between EpicCare and RRS are not as significant as with the other results listed above, but indicate that opinions are still higher for RRS. This could indicate that clinicians feel that being able to review the preventive services' results is more important than the ability to order them.

The opinions of the RRS system are high, yet it has fewer capabilities than EpicCare and does not have the decision support functions designed to enhance decisions and improve patient care. This suggests that despite the decades of interest in and development of complex charting and ordering systems with built-in decision support functions, the ability to simply review a patient's medication history, diagnostic test history, admission and visit history, and dictated reports continues to be the most important function of an EMR system. Perhaps the differences in attitudes between the two systems will lessen when EpicCare has been in use as long as RRS. The initial findings of a recent KPNW pilot study indicate that having EpicCare terminals in the exam rooms may also substantially improve clinician opinions of EpicCare[45]. For now, the speed and information provided by RRS and the data entry required to use EpicCare appear to contribute to more favorable opinions of RRS.

In the words of one KPNW physician:

"People are spending more time at work, and even though the value of the record is good, a lot of people feel that we are spending too much time entering data into EpicCare."

"It has erased all the personality that medical records have. You can't tell who has written what. Everyone is now putting in "canned" material. The meaning of the chart note has been diluted. We want to be able to communicate what we feel is good medicine, but now we are putting important information among a bunch of unimportant information. Part of it is defensive, but I think the completeness is standing in the way of communicating what is helpful."

Many factors can affect the opinions of clinicians toward an EMR system, including their previous computer experience, their ability to type, their ability to adapt to change, the amount of training and support they've received, and the experience they've gained from using the EMR. Many of these factors were examined to determine which characteristics are most predictive of higher opinions of these systems.

Contrary to the popular belief that age is associated with clinician attitudes toward electronic systems, age was not associated with a difference in responses to any of the questions described in this study. Rather, the length of time using EpicCare, self-reported ability to type, and overall job satisfaction are predictive of positive attitudes toward the contributions of both EpicCare and RRS to improved patient care. The reasons for including the time on EpicCare as a predictor for opinions toward RRS include: 1) using EpicCare may significantly increase the level of proficiency and willingness to use all clinical computing applications, including RRS, and 2) using EpicCare, which requires a great deal more time and effort than RRS, may increase clinicians' appreciation for the contribution of the simpler RRS on patient care. The time needed to become proficient on EpicCare was also predictive of responses toward EpicCare, suggesting that the training

and support necessary for early adoption of these systems may be crucial to the lasting opinions of these systems.

Although age has been found in previous studies to *not* be associated with the acceptance of healthcare information systems by clinicians, there has been a persistent belief that higher age is associated with lower acceptance of these systems. Age was therefore included as a potential predictor variable. Because gender has not been found in previous studies to predict acceptance of healthcare information systems, it was not included as a potential predictive variable. Although there is little precedent for including questions about professional title, length of time using the EMR system, and self-reported time needed to become proficient using the EMR system, each of these items was felt to potentially contribute to the opinions of the EMR system at KPNW. Because of the large utilization of non-physician providers at KPNW, this study provided a unique opportunity to measure the attitudes of these affiliated clinicians as well. As mentioned previously, the time needed to become proficient using the EMR system was felt to capture the importance of early training and support during early use of the system as a possible predictor of clinician attitudes.

Measuring clinicians' overall job satisfaction and their self-reported ability to type may help those hoping to implement EMR systems to identify clinicians who could participate as "champions" during system implementation, helping other clinicians in the adoption of these systems. By the same token, those with lower overall job satisfaction and lower self-reported ability to type could be identified for more intensive training and support.

The results of this study are supportive of the notion that intense training and support used to enhance the clinician's early proficiency using the system may be crucial to clinicians' future attitudes toward the system. The results also show that the longer clinician's use the system, the higher their perceived benefits from the system.

With regard to job satisfaction, the clinician's overall job satisfaction has been recognized to be a significant predictor of adoption of electronic systems. This study reinforces that notion, as our overall job satisfaction measure was predictive of clinician attitudes toward how both RRS and EpicCare affect the quality of patient care. Previous to this study, however, there has been little evidence for how job satisfaction is affected by the use of EMR systems. There are substantial administrative and workflow issues introduced by the implementation of an outpatient EMR system, and it is not surprising that job clinician satisfaction is affected. Although clinicians' job satisfaction was not measured over time to look at the isolated effect of the EMR system, the results of this study suggest that EMR systems can significantly impact job satisfaction. The use of RRS is perceived to have improved clinician job satisfaction, with 97% of respondents being neutral or positive on this point. The use of an online charting and ordering system, however, is perceived by an equal number of clinicians to impact job satisfaction both positively and negatively. In fact, 39% of physicians (compared to 20% of affiliated clinicians) believe that EpicCare has either made their job satisfaction worse or much worse. Job satisfaction is a result not only of the clinician's opinion of the quality of his work, however, but also of his quality of life. The results of this study show that the quality of clinicians' work is perceived to have improved as a result of using RRS and EpicCare, but the clinicians' overall happiness or fulfillment at work was not addressed.

Perhaps if these issues had been addressed, a greater understanding for why many clinicians express dissatisfaction with using EpicCare could have been achieved. One factor which can impact the level of happiness at work is the amount of time the clinician is required to spend at the office. The online charting and ordering system is perceived to add time to the clinicians' normal clinic day (41 minutes on average, compared to an average of 1 minute saved/ day using RRS), which undoubtedly is associated with negative opinions of the system. Many clinicians (57%) attempt to decrease the amount of time required to use EpicCare by dictating all or some of their chart notes, as well as using keyboard and system shortcuts such as templates and encounter forms.

The regression analyses show that being an affiliated clinician is associated with higher opinions for how EpicCare affects their job satisfaction. This may reflect the fact that affiliated clinicians see cases that are less complex and are able to use the EpicCare shortcut features more often, lessening the amount of time added by EpicCare to the affiliated clinicians' day. In fact, affiliated clinicians feel that EpicCare adds approximately 31 minutes/ day on average compared to the 46 minutes/ day on average perceived by physicians. On the other hand, the difference in attitudes between physicians and affiliated clinicians may reflect the challenges that the implementation of a charting and ordering system make to the physician's sense of autonomy and the proprietary nature of their chart note. Medical training has traditionally reinforced these values in physicians, and perhaps a new, more "open and connected" medical training paradigm is needed. Perhaps affiliated clinicians find the EpicCare system to be an empowering or "equalizing" force, enabling them to have access to the same information available to physicians, and making them more confident in their decision-making.

The qualitative portion of this study provided a level of understanding of the opinions of KPNW clinicians critical to the development of the survey instrument. It was apparent through the interviews that despite any attempts to focus the discussion on the perceived effects of the EMR system on patient care, clinicians invariably preferred to focus on the impact of these systems on their job satisfaction and their lives. From this experience it became clear that the perceptions of how these systems affect the quality of patient care and how these systems affect the clinicians' lives are very closely linked. It was for this reason that the job satisfaction measures were included as a central focus of the survey and this paper.

Study Limitations

With a salaried clinical staff of over 750 and the close relationship of Northwest Permanente to Kaiser Permanente Health Plan, KPNW does not represent the average community medical practice. This study does not address the additional difficulties encountered when implementing an EMR in clinician practices with multiple payer contracts and fee-for-service billing. Therefore, this study may not be generalizable to many medical practice environments, and should be interpreted with this in mind. More work is needed to understand the attitudes of clinicians toward EMR systems in practice models that are less fully integrated.

Because there has been little effort in the past to examine clinician attitudes toward their experiences in using an outpatient EMR system, many questions in our survey have had little precedence. Some questions, including those pertaining to the ability to type, the overall job satisfaction measure, and previous computer experience and comfort have been validated in prior studies. The validity of most of the questions used in our survey, however, has yet been determined.

Some potentially important factors in predicting clinician attitudes were not addressed by our survey. There is some evidence that measures of orientation toward change and measures of the desire for routine or structure in the daily lives of clinicians can be predictive of successful implementation of an EMR system[6-7]. Counte found that individuals who are less adaptable and have greater feelings of role ambiguity may need more time and support during training and implementation[6-7]. Measuring these attributes may have yielded even greater insight into the factors which are predictive of clinicians' attitudes toward these systems. In addition, the factors which were found to be predictive

of clinician attitudes were factors that appear to be related to their "comfort" level with computers, including the length of time using the system, the ability to type, and the time needed to become proficient using the system. However, the clinician's self-reported comfort level with computers and computer ownership status were not associated with their attitudes. Perhaps there are other, more sensitive measures of comfort with computer technology that could be used to determine those with different levels of comfort. Perhaps if respondent clinicians were asked how they actually use their computers, such as for Web access, Spreadsheet and Word Processing, rather than simply asking if they own a computer, this would have helped to discriminate between different levels of comfort.

As mentioned earlier, the distribution of respondents among specialties was significantly different among respondents than non-respondents due to a greater-than-expected response from mental health professionals and a lower-than-expected response from surgical subspecialists. When the responses for mental health and surgical specialists are compared for each of the survey questions listed above, however, only the mean responses pertaining to the effect of EpicCare on the ability of the clinician to coordinate the care of patients with other departments and providers are different. Mental health professionals have a higher opinion of EpicCare than surgical specialists in its ability to enhance this aspect of patient care. If the distribution of respondents among specialties would have been identical to the entire KPNW medical group, however, the mean response to this question would not have been significantly different than the responses obtained ($p=.183$).

Because clinicians were using RRS at the time EpicCare was implemented, the perceived effect of EpicCare on patient care might represent the perceived incremental benefit of EpicCare over having only RRS. Unfortunately, it was not possible to perform a randomized crossover study in which one group of clinicians began using RRS then EpicCare, and another group began using EpicCare then RRS. In my work as a KPNW physician, my interviews with the clinical service chiefs, and my discussions with other KPNW providers, there appears to be a clear concept of RRS and EpicCare among clinicians as being two separate systems, each with its own uses and capabilities. Few clinicians use EpicCare for lab result review, for example. Therefore, although the direct comparison of the responses toward how RRS and EpicCare have affected patient care and job satisfaction may be questioned, I believe this comparison to be valid.

With regard to how similarly and separately clinicians feel about RRS and EpicCare, the results of the survey likely represent opinions that are 1) similar for both systems because they are both computing applications that require some computer skill, and 2) separate for each system because the systems are of a very different design, and clinicians think about and use each system separately. Asking clinicians to compare having only EpicCare with having only the paper chart (similarly to asking them about the impact of RRS compared to the paper chart) would have been confusing because none of our clinicians used EpicCare prior to having RRS. Because it is an objective of this study to determine the relative opinions of clinicians toward RRS and EpicCare, clinicians were asked to rate the relative benefit to patient care and effort required to use RRS and EpicCare on a 10-point scale. This measure should be more effective in directly

comparing the two systems than the other survey questions, although the issue of comparing the benefits of EpicCare to RRS remain.

Conclusions

Clinicians perceive a significant improvement in patient care as a result of using an outpatient Electronic Medical Record system. They perceive this improvement to be greater with the use of a "results reporting" system than with an online charting an ordering component, although both are perceived to significantly improve patient care. A clinician's self-reported ability to type and their overall job satisfaction may be used to predict how clinicians' will perceive the clinical effects of an EMR.

Clinicians also perceive an improvement in their job satisfaction as a result of using a "results reporting" system, but not with the use of an online charting and ordering system. The results of this study indicate that the most important capability of an electronic record system continues to be its ability to retrieve critical information, such as lab results, prescribed medications, and dictated reports, at the point of care. A "results reporting" system may be the best initial choice, given the lower cost and apparent positive impact of these systems.

References

1. Chin HL, Krall MA, Dworkin L, Wallace P, Brannon, M, Weiss D, McClure P, Roberston N. The Comprehensive Computer-based Patient Record in Kaiser Permanente of the Northwest. Winning submission for the 1998 Nicholas E. Davies Award for Excellence in Computer-Based Record Systems.
2. Results of a KPNW internal study conducted in 1990 by the Department for Quality Management.
3. Krall MA, Mysinger T, Pearson J. Utilization and effects of a Results Reporting system in an HMO. Proc AMIA Spring Congress 1993.
4. Krall MA. Acceptance and Performance by Clinicians Using an Ambulatory Electronic Medical Record in an HMO Proc AMIA Ann.Fall Symp 1995: 708-11.
5. Cork RD, Detmer WM, Friedman CP, Development and Initial Validation of an Instrument to Measure Physicians' Use of, Knowledge about, and Attitudes Toward Computers. JAMIA. 1998;5:164-76.
6. Aydin CE, Forsythe DE, Implementing Computers in Ambulatory Care: Implications of Physician Practice Patterns for System Design. Proc Annu Symp Comput Appl Med Care 1997: 677-681
7. Counte MA et al, Implementation of a medical information system: evaluation of adaptation. HCM Review; Summer 1983: 25-33.
8. Counte MA et al, Adapting to the Implementation of a Medical Information System: A Comparison of Short versus Long-Term Findings. J Med Systems; 11: 11-20.

9. Teach RL, Shortliffe EH, An analysis of Physician Attitudes Regarding Computer-Based Clinical Consultation Systems. Computers and Biomedical Research; 14: 542-558.

10. Anderson JG, et al. Evaluating physician use of a hospital information system. Proc Annu Symp Comput Appl Med Care 1989: 52-56.

11. Tierney WM et al, Medical Students' and Housestaff's Opinions of Computerized Order-Writing. Academic Medicine; 69: 386-389.

12. Brown SH, Coney RD, Changes in physicians' computer anxiety and attitudes related to clinical information system use. JAMIA; 5: 381-94.

13. Tang PC et al, Clinician Information Activities in Diverse Ambulatory Care Practices. Proceedings 1996 AMIA Ann. Symposium: 12-16.

14. Covell DG, et al, Information Needs in Office Practice: Are They Being Met? Ann Intern Med; 103: 596-599.

15. Aydin CE, Forsythe DE, Implementing Computers in Ambulatory Care: Implications of Physician Practice Patterns for System Design. Proc Annu Symp Comput Appl Med Care 1997: 677-681

16. Tang PC, et al, Traditional Medical Records as a Source of Clinical Data in the Outpatient Setting. AMIA Ann. Fall Symp. 1994: 575-579

17. Weir C, et al, Sussessful Implementation of an Integrated Physician Order Entry Application: A Systems Perspective. Proceedings 1995 AMIA Ann. Symposium: 790-794.

18. Hayes GM. Medical Records: Past, Present, and Future. Proc AMIA Ann.Fall Symp 1996: 454- 458

19. McDonald CJ, Tierney WM. Computer-Stored Medical Records. Their Future Role in Medical Practice. JAMA 1988; 259: 3433-3440.

20. Tierney WM, McDonald CJ, Martin DK, Hui SL, Rogers MP. Computerized Display of Past Test Results. Annals of Internal Medicine 1987; 107: 569-574.

21. Overhage JM et al, Computer Reminders to Implement Preventive Care Guidelines for Hospitalized Patients. Arch Intern Med; 156: 1551-1556.

22. McDonald CJ, et al, Reminders to Physicians from an Introspective Computer Medical Record. Annals of Internal Medicine; 100: 130-138.

23. Ornstein SM, et al, Implementation and Evaluation of a Computer-based Preventive Services System. Family Medicine; 27: 260-266.

24. Ornstein SM, et al, Computer-Generated Physician and Patient Reminders. J Fam Practice; 32: 82-89.

25. Litzelman DK, et al, Requiring Physicians to Respond to Computerized Reminders Improves Their Compliance with Preventive Care Protocols; J Gen Internal Med; 8: 311-317.

26. Safran C et al, An Electronic Medical Record that Helps Care for Patients with HIV Infection. Proc Annu Symp Comput Appl Med Care 1994: 224-228;

27. Rind DM et al, Effect of Computer-Based Alerts on the Treatment and Outcomes of Hospitalized Patients. Arch Intern Med; 154: 1511-1517.

28. Safran C et al, A Clinical Trial of a Knowledge-Based Medical Record; MEDINFO 95 Proceedings; 1995: 1076-1080

29. McDonald CJ et al, The Promise of Computerzed Feedback Systems for Diabetes Care. Annals Intern Med; 124: 170-174.

30. McDonald CJ, Protocol-Based Computer Reminders, the Quality of Care and the Non-Perfectability of Man. New England J Med; 295: 1351-1355.

31. Barnett GO et al, Quality Assurance through Automated Monitoring and Concurrent Feedback Using a Computer-Based Medical Information System. Medical Care; 16: 962-970.

32. Schriger DL, Implementation of Clinical Guidelines Using a Computer Charting System. JAMA; 278: 1585-1590.

33. Lobach DF, Electronically Distributed, Computer-Generated, Individualized Feedback Enhances the Use of a Computerized Practice Guideline. Proceedings 1996 AMIA Ann. Symposium; 493-497.

34. Johnston ME et al, Effects of Computer-based Clinical Decision Support Systems on Clinican Performance and Patient Outcome. Ann Intern Med; 120: 135-142.

35. Elson, RB, Connelly, DP, Computerized Patient Records in Primary Care. Arch Fam Med; 4: 698-705.

36. Tierney W, Takesue BY, Vargo DL, Zhou X. Using Electronic Medical Records to Predict Mortality in Primary Care Patients with Heart Disease. J Gen Intern Med 1996; 11: 83-91.

37. Safran C, Chute CG. Exploration and Exploitation of Clinical Databases. Intl J Bio-Med Computing 1995; 39: 151-156.

38. Chute CG. Clinical Data Retrieval and Analysis. Ann N Y Acad Sci 1992 Dec 17;670:133-4.

39. Tierney WM, McDonald CJ. Practice Databases and Their Use in Clinical Research 1991. Statistics in Medicine; 10: 541-557.

40. Anderson JG, Jay SJ, Schweer HM, Anderson MM. Why doctors don't use computers: some empirical findings. JR Soc Med. 1986;79:142-4.

41. Anderson JG, Jay SJ, Anderson M, Hunt TJ. Evaluating the potential effectiveness of using computerized information systems to prevent adverse drug events. Proc AMIA Ann.Fall Symp 1997: 228-32.

42. Branger PJ, van der Wouden JC, Schudel BR, Vergoog E, Duisterhout JS, van der Lei J, van Bemmel JH. Electronic communication between providers of primary and secondary care. BMJ 1992; 305: 1068-1070.

43. Tang PC, Newcomb C, Gorden S, Kreider N. Meeting the Information Needs of Patients: Results from a Patient Focus Group. Proc AMIA Ann.Fall Symp 1997; 672-676.

44. Stamps PL, Boley Cruz NT, Issues in Physician Satisfaction: New Perspectives. AnnArbor, MI: Health Administration Press, 1994: Table D15.

45. Internal communication with Homer Chin, MD, Assistant Regional Medical Director, Clinical Information Systems, Northwest Permanente.

PATIENT CARE AND ELECTRONIC RECORDS SURVEY

Section 1

1. Age: ..... _____ Years

2. Gender: ..... Female ☐ 1 Male ☐ 2

3. Department: ..... _____

4. Position: ..... MD/DO/DPM ☐ 1 Affiliated Clinicians ☐ 2

5. Length of time with your current department: ..... _____

6. Length of time using EpicCare: ..... _____

Section 2

7. If you were to choose your occupation over again, would you still become a physician, or would you choose some other occupation?

Definitely choose to become a physician ☐ 1
Probably choose to become a physician ☐ 2
Not sure ☐ 3
Probably choose some other occupation ☐ 4
Definitely choose some other occupation ☐ 5

8. How long did it take you to become proficient using EpicCare following training?

Less than one month ☐ 1
One to three months ☐ 2
Three to six months ☐ 3
Over six months ☐ 4

9. How would you characterize your comfort level with computer technology *before* using EpicCare?

Very uncomfortable ☐ 1
Uncomfortable ☐ 2
Average ☐ 3
Comfortable ☐ 4
Very comfortable ☐ 5

10. How would you characterize your comfort level with using EpicCare *now*?

Very uncomfortable ☐ 1
Uncomfortable ☐ 2
Average ☐ 3
Comfortable ☐ 4
Very comfortable ☐ 5

11. How would you characterize your comfort level with using Results Reporting *now*?

Very uncomfortable ☐ 1
Uncomfortable ☐ 2
Average ☐ 3
Comfortable ☐ 4
Very comfortable ☐ 5

12. How would you characterize your ability to type *before* using EpicCare?

- Very poor ☐ 1
- Poor ☐ 2
- Average ☐ 3
- Good ☐ 4
- Very good ☐ 5

13. How would you characterize your ability to type *now*?

- Very poor ☐ 1
- Poor ☐ 2
- Average ☐ 3
- Good ☐ 4
- Very good ☐ 5

14. Do you dictate notes?

- Dictate all notes ☐ 1
- Dictate consults and extensive notes only ☐ 2
- Dictate consults only ☐ 3
- No dictation ☐ 4

15. How has EpicCare affected the amount of time you spend in the office during a normal clinic day compared to before you began using EpicCare?

- I spend more time in the office ☐ 1
- I spend the same amount of time ☐ 2
- I spend less time in the office ☐ 3

How much (minutes) _____ 1

16. How has Results Reporting affected the amount of time you spend in the office during a normal clinic day compared to before you began using Results Reporting (or compared to relying entirely on paper charts)?

- I spend more time in the office ☐ 1
- I spend the same amount of time ☐ 2
- I spend less time in the office ☐ 3

How much (minutes) _____ 1

17. How has your job satisfaction been affected by using EpicCare?

- Much worse ☐ 1
- Worse ☐ 2
- Same ☐ 3
- Better ☐ 4
- Much better ☐ 5

18. How has your job satisfaction been affected by using Results Reporting?

- Much worse ☐ 1
- Worse ☐ 2
- Same ☐ 3
- Better ☐ 4
- Much better ☐ 5

19. Do you own a computer? ..... Yes ☐ 1 No ☐ 2

20. If available, would you have preferred to complete this questionnaire on our Kaiser Permanente Intranet site? ..... Yes ☐ 1 No ☐ 2

Section 3

21. How have the following patient care issues been affected as a result of using Results Reporting **(RRS)** and EpicCare?

		Much worse	Worse	Same	Better	Much better	Unsure
a. The overall quality of health care that you give your patients	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
b. Your ability to adhere to clinical practice guidelines	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
c. The quality and content of your patient-clinician interaction	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
d. Your ability to provide clinical preventive services (screening, counseling, immunizations)	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
e. Your ability to detect medication dosing errors	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
f. Your ability to prevent drug allergic reactions or drug-drug interactions	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
g. Your ability to act on test results in a timely fashion	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
h. Your overall diagnostic accuracy	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
i. Your ability to coordinate the care of a patient with other departments and providers	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
j. The timeliness of referring/referral	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
k. Your ability to care for acute problems or conditions	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
l. Your ability to care for chronic problems or conditions	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
m. Your overall work efficiency	RRS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
	EpicCare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

22. Please indicate if you agree that the following electronic medical record capabilities will be important in the future.

	Strongly agree	Agree	Unsure	Dis-agree	Strongly disagree
a. Analyzing your patient population (panel)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b. Comparing your patient outcomes with your colleagues (inter-provider variability)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c. The use of clinical practice guidelines to help guide patient care	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d. Ordering lab and diagnostic tests yourself	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e. Electronic mail with patients	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f. Video communication (telemedicine) with patients	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g. Printing patient instructions	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

22. Continued

	Strongly agree	Agree	Unsure	Dis-agree	Strongly disagree
h. Accessing your patient records from home	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
i. Computer recognition of your voice for data entry or dictation (voice recognition)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
j. Using the World Wide Web for sharing clinical information	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
k. Patients' ability to access their own medical record electronically from home	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

23. Please circle the numbers below which best represent the effort it takes to use RRS and EpicCare.

	Very little effort									A great deal of effort
RRS	1	2	3	4	5	6	7	8	9	10
EpicCare	1	2	3	4	5	6	7	8	9	10

24. Please circle the numbers below which best represent the benefit of RRS and EpicCare to patient care.

	Very little benefit									A great deal of benefit
RRS	1	2	3	4	5	6	7	8	9	10
EpicCare	1	2	3	4	5	6	7	8	9	10

25. This system is worth the time and effort required to use it

	Disagree	Neutral	Agree
Results Reporting	☐ 1	☐ 2	☐ 3
EpicCare	☐ 1	☐ 2	☐ 3

26. What further changes in our outpatient record system would benefit your clinical care?

27. Please enter any other comments below.

Thank you very much for completing this survey.

Appendix 2

"From the customer standpoint, I can answer their questions immediately with the record in hand."

"It(EpicCare) has had a devastating affect on physician life. When we first began, it was taking about an hour and a half more, just in the morning, to complete the work. Now it takes about 45 minutes more in the morning and evening. It has created a race during the day. It becomes a race of don't hurt the patient, get the job done, and complete your day. When morale drops, customer service drops. The people I'm working with are less happy. There is a feeling of depression in the medical group at large. When you are hurting yourself, it is hard to go into a patient room smiling, and there may be an erosion of confidence of the patient in the clinician. We are in a market where we need key elements of customer service. How you go about doing your job is how you continue to attract your patients, and we've lost sight of that."

"The ordering and the referral process are easier. Before EpicCare, sometimes all we had to see a patient was a little white piece of paper but no chart, so I think it's much more of a leap for primary care than it has for specialty care."

"If I ask a patient a question, sometimes they ask "Well isn't that in your computer?" I've never heard a negative comment from the patients about the computerized record system."

"I think there is a lot of potential benefit to using these systems to look at patient population data and inter-provider variability."

"The fewer guidelines the better as far as I am concerned."

"We've got physicians who are being paid large sums of money for data entry, and often the data is incorrect."

"The ease of having the information may not be balanced by the quality of the information."

"I personally do certain things better than I ever did before, and the potential is exciting."

Table 1 Characteristics of Survey Respondents (N=449)

Characteristic	**n***	**Mean ± S.D., or %**
Age	432	46 years ± 7 years
Gender	438	62% Male
Professional Title	299	68% Physicians
	143	32% Affiliated Clinicians
Department Type	177	43% Primary Care
	68	17% Medical Specialty
	84	21% Surgical Specialty
	81	20% Mental Health
Time needed to become proficient	148	33% < 1 month
using EpicCare following training	149	34% 1-3 months
	83	19% 3-6 months
	65	15% > 6 months
Self-reported ability to type	98	22% Very Good
	135	30% Good
	125	28% Average
	75	17% Poor
	16	4% Very Poor
Self-reported comfort level with	49	11% Very Comfortable
computer technology	114	25% Comfortable
	113	25% Average
	98	22% Uncomfortable
	74	17% Very Uncomfortable
Amount of time using EpicCare	435	19 months ± 10 months
Time with current clinical department	438	9 years ± 7 years
Own a computer	448	Yes = 85%

* Some numbers do not total 449 due to missing values.

Table 2 Factors Predictive of Clinician Attitudes Toward the Effects of EpicCare on Patient Care

Dependent Variable: The perceived effect of using EpicCare on the overall quality of patient care				
Predictor Variables	Beta *	Δ in R^2 when variable added	p value	Included In Final Model
Age	.040		.430	
Self-Reported Ability to Type	.146	.038	.005	X
Comfort with Computers	.009		.868	
Own a Computer	.036		.481	
Being in a Primary Care Department	.033		.587	
Being a Physician vs. an Affiliated Clinician	-.048		.361	
Length of Time needed to become proficient using EpicCare	-.196	.019	<.001	X
Length of time Using EpicCare	.144	.017	.007	X
Overall Job Satisfaction	.100	.007	.048	X

Final Model Adjusted R^2 = .081

*These values represent the standardized regression coefficients for the variables included in the final regression model, and the Beta In values for those variables not included in the final model. The Beta In values for the variables not included in the final model represent the additive contribution to the model when these variables are added individually to the final model.

Table 3 Factors Predictive of Clinician Attitudes Toward the Effects of RRS on Patient Care

Dependent Variable: The perceived effect of using RRS on the overall quality of patient care

Predictor Variables	Beta *	Δ in R^2 when variable added	p value	Included in Final Model
Age	.029		.571	
Self-Reported Ability to Type	.112	.015	.028	X
Comfort with Computers	.026		.609	
Own a Computer	.006		.902	
Being in a Primary Care Department	.009		.877	
Being a Physician vs. an Affiliated Clinician	-.038		.470	
Length of time Using EpicCare	.164	.034	.001	X
Overall Job Satisfaction	.194	.025	<.001	X

Final Model Adjusted R^2 = .074.

*These values represent the standardized regression coefficients for the variables included in the final regression model, and the Beta In values for those variables not included in the final model. The Beta In values for the variables not included in the final model represent the additive contribution to the model when these variables are added individually to the final model.

Table 4. Test Statistics and Significance for survey results for EpicCare and Results Reporting

Survey Question	EpicCare vs. RRS (paired samples t test)			EpicCare Mean vs. "3.0= Same" (one sample t test)				RRS Mean vs. "3.0= Same" (one sample t test)			
	Test Statistic (t)	N	Sig.	Test Statistic (t)	Mean	df	Sig	Test Statistic (t)	Mean	df	Sig
• Effect on Overall Quality of Patient Care	-6.560	419	<.001	15.636	3.67	427	<.001	25.624	3.93	424	<.001
• Effect on Patient-Clinician Interaction	-7.087	414	<.001	4.084	3.19	422	<.001	13.846	3.49	420	<.001
• Effect on Ability to Provide Clinical Preventive Services	-2.947	362	<.001	12.266	3.48	370	<.001	15.544	3.60	366	<.001
• Effect on the ability to adhere to clinical practice guidelines				9.53	3.32	385	<.001				
• Effect on the ability to detect medication errors				15.487	3.55	348	<.001				
• Effect on the ability to coordinate patient care with other departments and providers				32.43	4.12	423	<.001				
• Effect on the Timeliness of Referrals				20.329	3.81	408	<.001				
• Effect on the ability to act on test results in a timely fashion								26.694	4.01	389	<.001
• Effect on job satisfaction	-12.742	422	<.001	0.333	3.02	432	.739	18.1	3.64	427	<.001

Table 5 Relative Effort and Benefit of EMR Components

	EpicCare Mean ± S.D.	**RRS** Mean ± S.D.	P value[Ψ]
***Benefit to patient care**	6.9 ± 2.2	7.3 ± 2.0	<.001
***Effort required to use system**	5.9 ± 2.6	3.8 ± 2.2	<.001
#Benefit / Effort ratio	1.8 ± 1.8	3.1 ± 2.6	<.001

*Maximum possible score = 10 (great deal of Effort or Benefit)

Represents the average of the individual ratios of benefit / effort provided by cinicians, NOT the ratio of the average benefit and effort scores shown above.

Ψ From paired-samples t test

Table 6 Factors Predictive of Clinician Attitudes Toward the Effects of EpicCare on Job Satisfaction

Dependent Variable: The Perceived Effect of Using EpicCare on Job Satisfaction				
Predictor Variables	Beta*	Δ in R^2 when variable added	p value	Included in Final Model
Age	.046		.347	
Self-Reported Ability to Type	.104	.008	.040	X
Comfort with Computers	.053		.309	
Own a Computer	.007		.888	
Being in a Primary Care Department	.014		.785	
Being a Physician vs. an Affiliated Clinician	-.168	.025	.001	X
Length of time needed to become proficient using EpicCare	-.234	.072	<.001	X
Length of Time Using EpicCare	.034		.523	

Final Model Adjusted R^2 = .105

* These values represent the standardized correlation coefficients for the variables included in the final regression model, and the Beta In values for those variables not included in the final model. The Beta In values for the variables not included in the final model represent the additive contribution to the model when these variables are added individually to the final model.

Table 7 Factors Predictive of Clinician Attitudes Toward the Effects of EpicCare on Job Satisfaction

Dependent Variable: The Perceived Effect of Using RRS on Job Satisfaction				
Predictor Variables	Beta*	Δ in R^2 when variable added	p value	Included in Final Model
Age	.091		.070	
Self-Reported Ability to Type	.058		.253	
Comfort with Computers	.040		.433	
Own a Computer	.021		.679	
Being in a Primary Care Department				
Being a Physician vs. and Affiliated Clinician	-.014		.788	
Length of Time Using EpicCare	.248	.059	<.001	X

Final Model Adjusted R^2 = .059

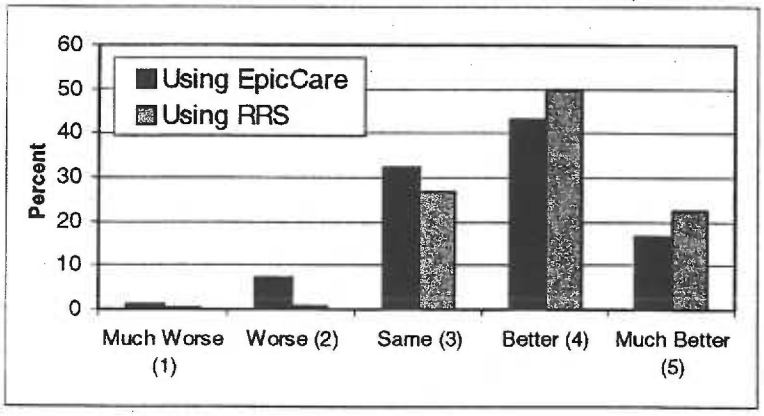
* These values represent the standardized regression coefficients for the variables included in the final regression model, and the Beta In values for those variables not included in the final model. The Beta In values for the variables not included in the final model represent the additive contribution to the model when these variables are added individually to the final model.

Table 8. Perceived Effect of Using RRS on Job Satisfaction by Length of Time Using EpicCare

Quartile of Length of Time Using EpicCare	n	Mean Response*
1	153	3.4
2	95	3.6
3	74	3.7
4	92	3.9

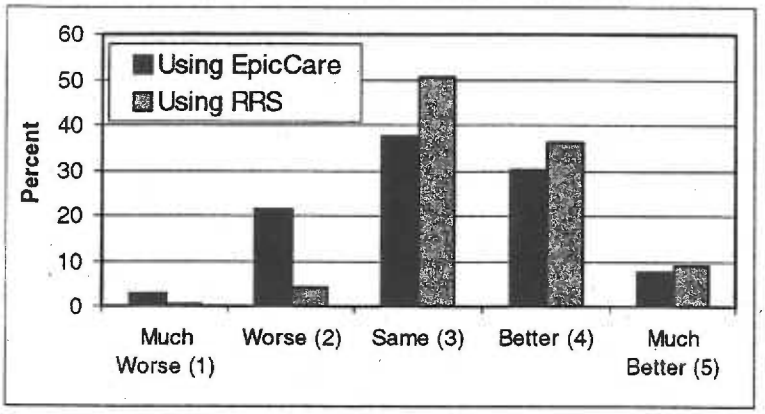
*The possible responses include 1=Much Worse, 2=Worse, 3=Same, 4=Better, 5=Much Better.

Figure 1. "How has the overall quality of health care that you give your patients been affected as a result of using RRS and EpicCare?"



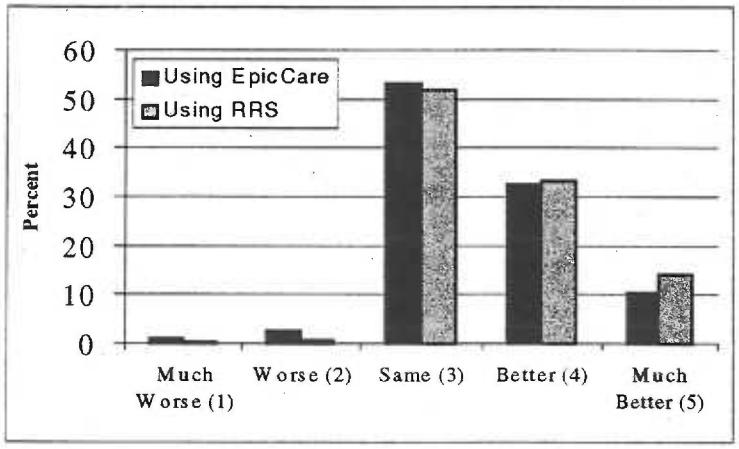
P<.001 EpicCare vs. RRS (paired samples t test)
The mean response for EpicCare= 3.67, RRS=3.93

Figure 2. "How has the quality and content of your clinician-patient Interaction been affected as a result of using RRS and EpicCare?"



P<.001 EpicCare vs. RRS (paired samples t test)
The mean response for EpicCare= 3.19, RRS=3.49

Figure 3. "How has your ability to provide clinical preventive services been affected as a result of using RRS and EpicCare?"



p=.002 EpicCare vs. RRS (paired samples t test)
The mean response for EpicCare= 3.48, RRS=3.60

Figure 4. Clinician Opinions of the Effects of EpicCare on Patient Care

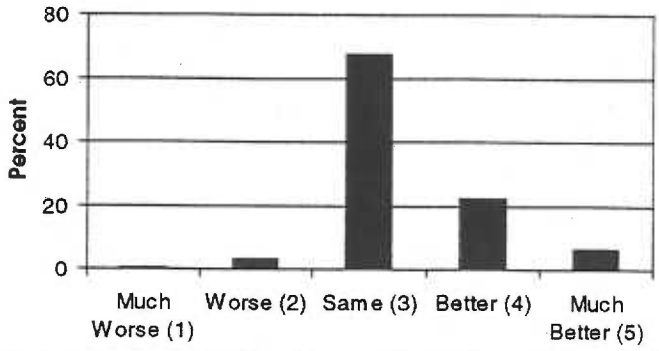
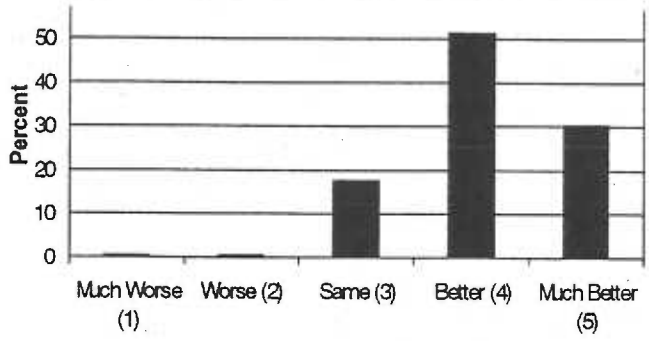
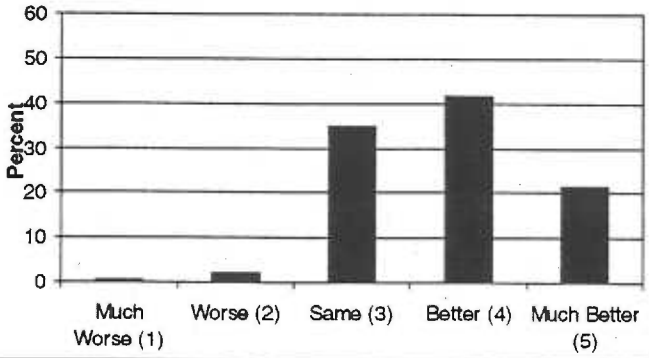
"Your ability to Adhere to Clinical Practice Guidelines Using EpicCare" Mean = 3.32	
"Your Ability to Detect Medication Errors Using EpicCare" Mean = 3.55	
"Your Ability to Coordinate Patient Care with Other Departments and Providers Using EpicCare" Mean = 4.12	
"The Timeliness of Referring/ Referrals Using EpicCare" Mean = 3.81	

Figure 5. "How has your ability to act on test results in a timely fashion been affected as a result of using Results Reporting?" Mean= 4.01

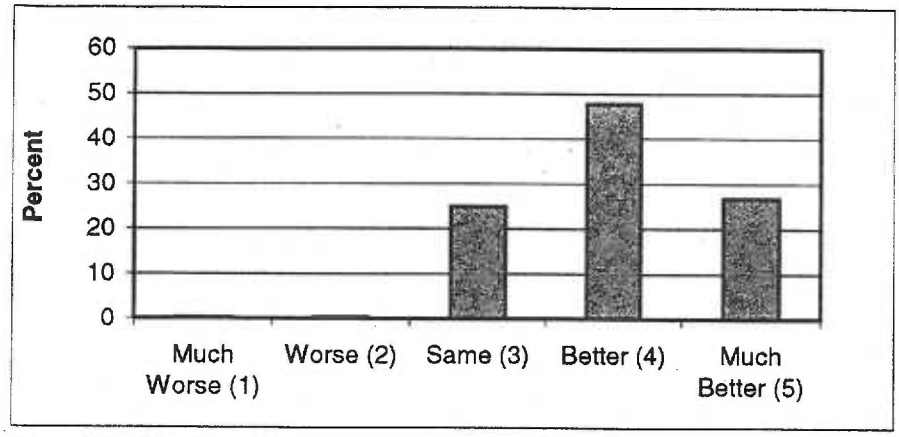
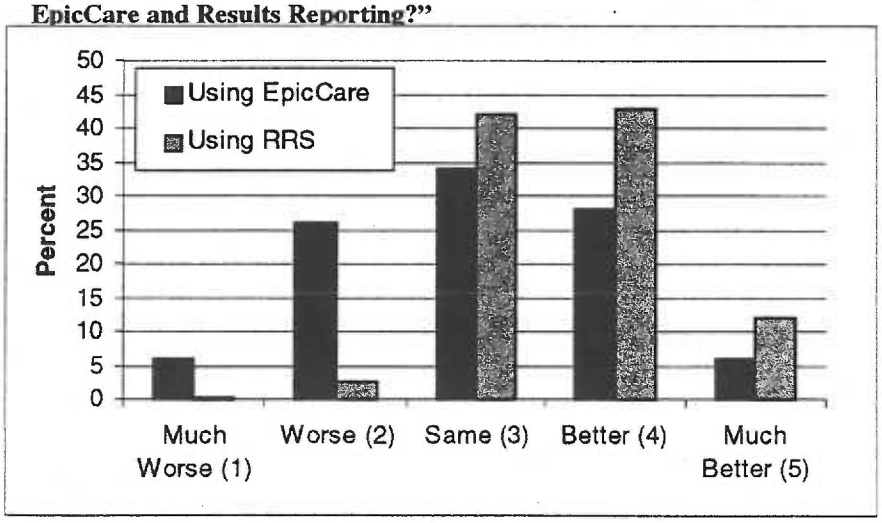


Figure 6. "How has your job satisfaction been affected by using EpicCare and Results Reporting?"



P<.001 EpicCare vs. RRS (paired samples t test)
The mean response for EpicCare= 3.02, RRS=3.64