Health Information Technology and Physician-Patient Interactions: Impact of Computers on Communication during Outpatient Primary Care Visits

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Abstract Objectives: The aim of this study was to evaluate the impact of introducing health information technology (HIT) on physician-patient interactions during outpatient visits.

Design: This was a longitudinal pre-post study: two months before and one and seven months after introduction of examination room computers. Patient questionnaires (n = 313) after primary care visits with physicians (n = 8) within an integrated delivery system. There were three patient satisfaction domains: (1) satisfaction with visit components, (2) comprehension of the visit, and (3) perceptions of the physician’s use of the computer.

Results: Patients reported that physicians used computers in 82.3% of visits. Compared with baseline, overall patient satisfaction with visits increased seven months after the introduction of computers (odds ratio [OR] = 1.50; 95% confidence interval [CI]: 1.01–2.22), as did satisfaction with physicians’ familiarity with patients (OR = 1.60, 95% CI: 1.01–2.52), communication about medical issues (OR = 1.61; 95% CI: 1.05–2.47), and comprehension of decisions made during the visit (OR = 1.63; 95% CI: 1.06–2.50). In contrast, there were no significant changes in patient satisfaction with comprehension of self-care responsibilities, communication about psychosocial issues, or available visit time. Seven months post-introduction, patients were more likely to report that the computer helped the visit run in a more timely manner (OR = 1.76; 95% CI: 1.28–2.42) compared with the first month after introduction. There were no other significant changes in patient perceptions of the computer use over time.

Conclusion: The examination room computers appeared to have positive effects on physician-patient interactions related to medical communication without significant negative effects on other areas such as time available for patient concerns. Further study is needed to better understand HIT use during outpatient visits.

Examination Room Computing

In August 2001, the IDS introduced the computer-based system into all the examination rooms of the four clinics. The system hardware consisted of a flat panel computer screen on an adjustable, multidirectional arm, a keyboard and mouse, and a wall-mounted central processing unit (CPU). The spatial relationship between the computer CPU and monitor, the examination table, and the physician’s chair varied in each examination room, depending in large part on the room’s pre-existing architecture. All physicians in the practice used the same examination rooms when seeing their patients; there were no systematic changes in examination room assignments after examination room computers were introduced.

Between the second and third observation periods, PCPs received training in how to integrate computers into the visit. The two-hour on-site workshop involved a didactic lecture on using the computer in an outpatient visit, group assessment of a videotape of an artificial visit, and a role-playing session. The workshop covered communication topics such as making a connection with the patient, making decisions collaboratively, establishing closure for the visit, and expressing empathy for the patient. All physicians in the study completed the training. In addition to the workshop, on-site technical support was available during all clinic hours from two part-time HIT staff persons (equal to one 100% full-time employee).

Population and Study Design

Working with leadership of the clinic and the HIT implementation team, we designed a three-period longitudinal study beginning with a baseline period (two months) before the introduction of examination room computers (P1) and two subsequent points: one month after (P2) and seven months after (P3) their introduction. We recruited PCP volunteers from the four clinics in the IDS. Eligible PCPs included physicians trained in internal medicine and family practice who provided primary care to a regular panel of adult IDS members. Eligible patient subjects included all regularly scheduled IDS members for the PCP. We obtained written consent from all patients, accompanying family members, staff, and physicians involved in the study. The Kaiser Foundation Research Institute Institutional Review Board approved the study.

During the study period between June 2001 and April 2002, there were 17 PCPs trained in internal medicine and family practice who provided care in four clinics at the study site. Of these 17 PCPs, eight agreed to participate in the study. Among patients, the overall participation rate among eligible subjects was 80%.

Data Collection

During one to two days per physician per observation period, research assistants approached all patients in each physician’s waiting room. We excluded patients receiving a gynecological examination during the visit. For each consenting patient, we administered pre- and postvisit patient questionnaires, videotaped physician-patient interactions, and videotaped the computer screen. For the videotapes, we mounted one digital video camcorder from the examination room ceiling corner; we used a second camcorder to capture the video feed between the computer and the computer monitor. In this article, we report only on findings from the questionnaires.

In our effort to minimize any intrusions on the medical visit, research assistants performed all the equipment setup, tape
changes, and clean up. Physicians, staff, and patients were not responsible for any part of the data collection. The cameras were minimally intrusive; a small red light indicated that the camera was recording. Noise from the cameras was negligible. Physicians, staff, and patients could either cover the camera lens using a special lens net or turn off the camera using a remote control at any point during the encounter.

Questionnaires
We pretested the written self-administered questionnaire to assess its general clarity and comprehensibility. After consenting to the study and before seeing the physician, subjects completed a one-page previsit questionnaire. Immediately after their visit, subjects completed a postvisit questionnaire, which assessed satisfaction with the visit, comprehension of diagnosis and treatment plan, satisfaction with examination room computer use, and sociodemographic characteristics. Subjects who were unable to fill out the questionnaire on site had the option of returning it by mail or completing it via telephone interview. Questionnaires were deliberately anonymous to encourage patient participation and candor.

Outcome Variables: Visit Satisfaction
Using items based in part on the Medical Outcomes Study,24 the survey questions addressed patient satisfaction with three visit-related domains: (1) visit components, e.g., overall visit satisfaction, PCP’s familiarity with the patient, communication about medical issues, communication about psychosocial issues, and time spent on patient concerns; (2) comprehension of the visit, e.g., understanding visit activities, such as diagnosis or treatment plans and determinations, and postvisit self-care needs, such as potential side effects or complications; and (3) examination room computing, e.g., impact of computer use on comprehension and personalization of care, visit efficiency and flow, and overall satisfaction with computer use (Table 1 for additional details on the wording of each item).24,25 Rather than create summary scores for each group of satisfaction measures (e.g., satisfaction with visit components or satisfaction with psychosocial communication), we present all scores individually to allow readers to interpret each item (Table 1). Responses were based on a six-point Likert scale, which ranged from 1 (excellent) to 6 (very poor), with an additional option of N/A (not applicable).

Statistical Analyses
The unit of analysis was the patient visit. We first compared characteristics of subjects in P2 and P3 with P1; then we evaluated all the satisfaction item responses in P2 and P3 with P1 (baseline), although the tables show both P2 vs. P1 and P3 vs. P1 comparisons.

Results
Eight PCPs and 313 patients participated in the study: 107 patients in the precomputer baseline period (P1), 81 in the first month after the computer introduction (P2), and 125 in the seventh month after the computer introduction (P3). Table 3 displays the characteristics of the patient subjects. The mean age was 55.2 years old (standard deviation [SD] = 16.5); 63.9% were female; 28.5% reported being in excellent or very good health; 75.4% reported being of white race/ethnicity; 31.6% reported having at least a college degree; 27.2% reported an annual household income of less than $35,000; and 79.9% reported having a previous visit with the PCP before the study visit. There were no statistically significant differences in patient characteristics across the three time periods. Table 4 displays the characteristics of the PCPs participating in all three study periods. The PCPs were evenly divided between the Departments of Family Practice and Internal Medicine; 62.5% were male; 62.5% reported being of white race/ethnicity, and 50% had 3+ years’ experience within the health system.

Patients reported that their physician used the computer in the examination room in 82.3% of visits: 84.1% and 81.3% of visits in P2 and P3, respectively. As expected, patient satisfaction with the physician’s use of the latest medical technology increased after the computer introduction with 35.4%, 55.7%, and 59.1% reporting “excellent” satisfaction in P1, P2, and P3, respectively (odds ratio [OR] = 1.71, 95% CI: 1.05–2.79 for P2 vs. P1; OR = 2.03; 95% CI: 1.47–2.80 for P3 vs. P1).

Postvisit Satisfaction with Visit Components
Overall Satisfaction
In general, patients reported high levels of satisfaction with the visit. Table 1 displays the percentage reporting “excellent” satisfaction with various visit-related items, i.e., a score of one out of six possible choices. There was a significant increase in the level of overall patient satisfaction with the PCP during the visit after the introduction of the computer into the examination room in the seventh month after introduction as compared with baseline, i.e., P3 vs. P1 (OR = 1.50, 95% CI: 1.01–2.22), adjusting for patient age, gender, self-reported health status, whether the visit was an initial visit, household income, and educational attainment, while allowing for clustering by physician. In addition, there was no significant drop
in overall satisfaction immediately after the computer introduction (P2 vs. P1).

**Familiarity and Medical Communication**

Compared with the baseline period, patients in P3 also were more likely to report that physicians were familiar with them as persons (OR = 1.60, 95% CI: 1.01–2.52) and familiar with their medical history (OR = 1.42, 95% CI: 1.03–1.96). Similarly, patients were more likely to be satisfied with the level of communication about their medical care, including the explanation of diagnoses and treatments (OR = 1.61, 95% CI: 1.05–2.47), their participation in the decision-making process (OR = 1.94, 95% CI: 1.12–3.38), and the focus on preventing illness and promoting good health (OR = 1.61, 95% CI: 1.07–2.43).

**Psychosocial Communication and Available Time**

Patients’ satisfaction with communication about psychosocial concerns was not significantly different after the computer introduction compared with the baseline: satisfaction with the personal manner of their PCP (P3 vs. P1, OR = 1.21, 95% CI: 0.70–2.09), with the PCP’s concern for their emotional and physical well-being (OR = 0.99, 95% CI: 0.55–1.79), and how carefully the PCP listened to you (OR = 1.02, 95% CI: 0.61–1.70).

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### Table 1  Patient Satisfaction with the Visit

<table>
<thead>
<tr>
<th>Satisfaction with Visit Components</th>
<th>Unadjusted % Reporting Excellent Satisfaction</th>
<th>P2 vs. P1</th>
<th>P3 vs. P1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1</td>
<td>P2</td>
<td>P3</td>
</tr>
<tr>
<td>Overall satisfaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your overall satisfaction with the PCP during the visit</td>
<td>55.3</td>
<td>66.7</td>
<td>62.8</td>
</tr>
<tr>
<td>Familiarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How familiar the PCP was with you as a person</td>
<td>47.7</td>
<td>63.5</td>
<td>58.6</td>
</tr>
<tr>
<td>How familiar the PCP was with your medical history</td>
<td>42.2</td>
<td>46.3</td>
<td>49.6</td>
</tr>
<tr>
<td>Medical communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanation of your diagnoses and treatments</td>
<td>47.1</td>
<td>61.2</td>
<td>61.3</td>
</tr>
<tr>
<td>How much you participated in your medical care decisions</td>
<td>35.4</td>
<td>31.8</td>
<td>41.7</td>
</tr>
<tr>
<td>Focus on preventing illness and promoting good health</td>
<td>47.6</td>
<td>61.5</td>
<td>59.6</td>
</tr>
<tr>
<td>Psychosocial communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The personal manner of the PCP</td>
<td>68.2</td>
<td>79.1</td>
<td>71.7</td>
</tr>
<tr>
<td>Concern for your emotional and physical well-being</td>
<td>59.0</td>
<td>62.7</td>
<td>60.0</td>
</tr>
<tr>
<td>How carefully the PCP listened to you</td>
<td>63.6</td>
<td>65.7</td>
<td>64.6</td>
</tr>
<tr>
<td>Available time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time spent discussing your main reason for the visit</td>
<td>52.9</td>
<td>62.7</td>
<td>57.9</td>
</tr>
<tr>
<td>Time spent discussing any emotional concerns</td>
<td>42.5</td>
<td>41.7</td>
<td>50.0</td>
</tr>
<tr>
<td>Time available to address all your concerns</td>
<td>47.7</td>
<td>47.8</td>
<td>54.5</td>
</tr>
<tr>
<td>Satisfaction with visit comprehension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehension: visit activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding your diagnosis or treatment plan</td>
<td>46.4</td>
<td>62.1</td>
<td>57.3</td>
</tr>
<tr>
<td>Understanding how diagnosis/treatment was determined</td>
<td>41.0</td>
<td>60.6</td>
<td>52.3</td>
</tr>
<tr>
<td>Comprehension: Self-care information</td>
<td>41.3</td>
<td>51.6</td>
<td>49.5</td>
</tr>
<tr>
<td>Understanding self-care needed to improve health</td>
<td>50.8</td>
<td>46.6</td>
<td>43.8</td>
</tr>
</tbody>
</table>

This table displays the unadjusted percentage of patients in each period who reported having excellent satisfaction with aspects of their visit and with the visit overall. The table also displays the odds of having a higher percentage of patients with excellent postvisit satisfaction during each of the postimplementation periods (P2 or P3) compared with the baseline period (P1). We calculated the odds ratios using ordinal logistic regression, which adjusted for age, gender, self-reported health status, previous visits, household income, and educational attainment and allowed for clustering by physician.

OR = odds ratio; CI = confidence interval; PCP = primary care physician.
Table 2 - Patient Perceptions of Computer Use during the Visit in the First and Seventh Months after Introduction

<table>
<thead>
<tr>
<th>Computer Satisfaction Item</th>
<th>% Reporting Totally Agree</th>
<th>P3 vs. P2</th>
<th>OR 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>The computer use helped me better understand what happened today</td>
<td>32.1</td>
<td>43.2</td>
<td>1.33</td>
</tr>
<tr>
<td>The computer helped the PCP know about all the things happening in my medical care</td>
<td>45.1</td>
<td>53.3</td>
<td>1.45</td>
</tr>
<tr>
<td>The computer helped the PCP make my care more personalized</td>
<td>42.3</td>
<td>47.3</td>
<td>1.23</td>
</tr>
<tr>
<td>The computer use helped the visit run in a more timely manner</td>
<td>34.6</td>
<td>50.0</td>
<td>1.76</td>
</tr>
<tr>
<td>The computer use fit well into the overall flow of the visit</td>
<td>51.9</td>
<td>54.9</td>
<td>1.19</td>
</tr>
<tr>
<td>Overall, I liked the way that the PCP used the computer in today's visit</td>
<td>50.0</td>
<td>55.6</td>
<td>1.26</td>
</tr>
</tbody>
</table>

This table displays the unadjusted percentage of patients in each period who totally agreed with statements about the quality of computer use during the visit. The table also displays the odds of having a higher percentage of patients reporting “totally agree” in the late postimplementation period (P3) compared with the early postimplementation period (P2). We calculated the odds ratios using ordinal logistic regression, which adjusted for age, gender, self-reported health status, previous visits, household income, and educational attainment and allowed for clustering by physician. OR = odds ratio; CI = confidence interval; PCP = primary care physician.

and physical well-being (P3 vs. P1, OR = 0.99, 95% CI: 0.55–1.79) or with how carefully the PCP listened to them (P3 vs. P1, OR = 1.02, 95% CI: 0.61–1.70).

There also were no significant differences in satisfaction with the amount of time available during the visit across the three study periods. For example, there were no statistically significant differences in satisfaction with time spent discussing the main reason for the visit (P3 vs. P1, OR = 1.18, 95% CI: 0.70–1.99), emotional concerns (P3 vs. P1, OR = 1.23, 95% CI: 0.74–2.05), or the total time available to address all concerns (P3 vs. P1, OR = 1.17, 95% CI: 0.70–1.95).

Patient Comprehension of the Visit

Table 1 displays patients’ satisfaction levels with their comprehension of the visit. Consistent with satisfaction regarding medical communication, patients at seven months reported having greater comprehension about their medical care during the visit, including understanding of their diagnosis or treatment plan (OR = 1.63, 95% CI: 1.06–2.50), and understanding how their diagnosis or treatment was determined during the visit (OR = 1.65, 95% CI: 1.09–2.50).

There were no significant differences in patient comprehension of medical advice at seven months after computer introduction compared with the baseline. For example, there were no statistically significant changes in understanding self-care activities needed to improve health (P3 vs. P1, OR = 1.29, 95% CI: 0.73–2.27) or knowledge of the potential side effects or complications associated with their treatments or diagnoses (P3 vs. P1, OR = 0.89, 95% CI: 0.53–1.50).

Patient Perceptions of Computer Use during the Visit

Patients reported positive overall impressions of examination room computer use during the visit. The majority of patients (85.4%) reported that they totally agreed (51.4%) or agreed (34.0%) that they liked the way that their PCP used the computer during the visit. In contrast, only 6.2% of patients reported that the computer use created a distraction during the visit; 3.8% and 7.7% in P2 and P3, respectively (p = 0.37 in both bivariate and multivariate analyses). Table 2 displays the changes in perceptions of computer use between P2 and P3. The only statistically significant change in patient perceptions from P2 to P3 was an increase in satisfaction with the computer’s effect on timeliness of visit activities (OR = 1.76, 95% CI: 1.28–2.42).

Discussion

In this longitudinal study of the impact of examination room computing on physician-patient interactions, overall visit satisfaction, satisfaction with the physician’s level of familiarity, communication about medical issues, and the degree of comprehension with decisions made during the visit all improved significantly by seven months after implementation. Surprisingly, we did not find that the enhanced medical communication “crowded out” discussions about psychosocial issues or time for patient concerns from the patient perspective, even during the period immediately after implementation. We also did not detect any significant changes in comprehension about post-visit needs or satisfaction with the physician’s personal manner, level of concern for the patient, or level of listening. Finally, we detected few changes in patient satisfaction, satisfaction with the physician’s level of familiarity, communication about medical issues, and the degree of comprehension with decisions made during the visit all improved significantly by seven months after implementation. Surprisingly, we did not find that the enhanced medical communication “crowded out” discussions about psychosocial issues or time for patient concerns from the patient perspective, even during the period immediately after implementation. We also did not detect any significant changes in comprehension about post-visit needs or satisfaction with the physician’s personal manner, level of concern for the patient, or level of listening. Finally, we detected few changes in patient satisfaction.
perceptions of computer use between one month and seven months after implementation.

We originally hypothesized that examination room computing might make the medical decision-making process more transparent and collaborative. In fact, patients reported that their physicians were more familiar with them, communication about medical care was better, and they understood and participated more in the medical decision-making process on average. Increases in satisfaction with the physician’s use of the latest technology and familiarity with patients were expected after implementation and serve as a validity check on patient perceptions.

The lack of change from baseline to P2 in satisfaction with available time during visits was surprising. We had anticipated that physicians might have difficulty integrating computer use into their workflow during the initial months, leaving less time for patient needs, i.e., the computer would distract the PCP from the patient. We also hypothesized that availability of computer-based information could place greater emphasis on the medical aspects of the visit, thereby limiting the amount of time available for psychosocial aspects of care; however, patient satisfaction levels do not indicate that either the distraction or crowd-out phenomenon occurred. It is possible that previous experience with the computer-based electronic health record system used in the clinic could account for the absence of patient dissatisfaction after implementation.

Although the findings are generally reassuring, the data suggest opportunities for improving physician-patient interactions. For example, the level of patient comprehension of postvisit needs did not change significantly despite improvement in comprehension about what happened during the visit. Patient perceptions of the quality of computer use also did not appear to change over time, suggesting that time alone might not improve the quality of use. It may be important to continue to monitor computer use well after the initial implementation. Further research is needed to better understand the learning curve associated with successfully integrating examination room computing into ambulatory visits.

Previous studies on the impact of examination room computers are mixed. A few studies have found that introducing computers into examination rooms had an adverse effect on physician-patient communication.\textsuperscript{18,19,23} For example, using videos of ambulatory care visits, Greatbatch et al.\textsuperscript{22} found that physicians tended to be preoccupied with computer tasks, which hindered the flow of communication with their patients. These studies may have had limited ability to differentiate between the effects of physicians learning to use computers and electronic health records in the examination room and the office and experienced computer users attempting to integrate computers into the examination room during outpatient visits. A number of studies have found that examination room computers do not diminish patient satisfaction.\textsuperscript{21,22–31} In some cases, computer use may actually improve certain aspects of physician-patient communication, such as physicians taking a more active role in clarifying information or encouraging patient questions, a finding similar to ours in this study.\textsuperscript{18}

Our findings might differ from other studies because we focused on sampling at three time points rather than a single cross-sectional sample. By measuring multiple time points for each physician, we were better able to control for individual physician behaviors. In addition, by including a second postimplementation period, we were able to account for changes that may have occurred due to greater physician experience in integrating the computer into the visit. Our study also gauged the quality of physician-patient interactions by querying patients directly about their satisfaction levels and separating the responses by measures expected to improve with greater computer availability and measures expected to worsen because of greater visit complexity or increased emphasis on medical information. Last, many previous studies were conducted in the late 1980s or early to mid-1990s, when computer systems might have been less user-friendly or physicians and patients less computer savvy.

This study has several notable limitations. First, this was an observational study that relied on a convenience sample of physicians and patients. Because participation in the study was voluntary, there is the potential for selection bias, e.g., early adopters or individuals more predisposed to favor computers in the examination room may be more likely to participate. The observation process and especially the videotaping also could have influenced behavior or perceptions. The study, however, focused on relative changes over time; there is no reason to expect that there would be differential effects across the three time periods.

In addition, we studied a small number of PCPs who practiced in a single clinic, within a single, integrated system. We had limited power to detect small change in our outcomes; nevertheless, we found several significant findings consistent with our hypotheses. We also relied on patient perceptions and did not attempt to directly assess areas such as patient comprehension of self-care practices. Moreover, the setting, types of physicians, and previous experience of all the physicians with the electronic health record may limit the generalizability of these findings to other contexts. We also could not adjust for any secular trends in satisfaction or in ambulatory visits, given the absence of a concurrent control group. To our knowledge, however, there were no such changes during the study period at this clinic. Finally, we did not adjust the statistical analyses for multiple comparisons.\textsuperscript{26}

In conclusion, this early study suggests that soon after the introduction of HIT into examination rooms, physicians used the computers in the majority of ambulatory care visits and that these activities appeared to have positive effects on several aspects of physician-patient interactions including overall visit satisfaction, satisfaction with the physician’s level of familiarity, communication about medical decisions, and
patient understanding of the medical decisions. There did not appear to be significant negative effects on other aspects of the relationship such as communication about psychosocial needs or available time for patients’ concerns. Although these findings are generally positive, much additional research is needed to confirm and elaborate on these findings, and much opportunity remains for improving the quality of physician-patient communication and for improving the integration of computers into the clinical interaction.

References

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