Original Investigations

*Research Paper* ■

# Changes in Physicians' Computer Anxiety and Attitudes Related to Clinical Information System Use

STEVEN H. BROWN, MD, ROBERT D. CONEY, MD

**Abstract** **Study Overview:** Interns', anxiety about computer use ("computer anxiety") and their attitudes toward medical computer applications were determined by a standardized questionnaire. Participants were surveyed before and after three months of differential exposure to three clinical information systems (CISs), including one with provider-entered encounters.

**Population:** Fifty-one interns completed both surveys. Their average age was 27 years. Thirty-three percent were female, 7% were African American, and 8% were foreign graduates.

**Results:** The most common previous exposures to computers were for literature searching and retrieval of patient information (both 92%). Factors that commonly emerged as predictive of anxiety about computer use included self-rated skills, typing ability, and computer attitudes. Factors predictive of attitudes toward computers included self-rated skills, typing ability, maximal frequency of prior computer use, computer ownership, and computer anxiety. Factors that were not predictive of computer anxiety or attitudes toward computers included age, gender, and physician input of data.

**Conclusion:** Identification of markers for negative psychological reactions to computer use may allow development of interventions to improve acceptance of computer base patient records (CBPRs).

■ **J Am Med Informatics Assoc.** 1994;1:381–394.

Negative attitudes toward computers ("computer attitudes") and anxiety of physicians about their use ("computer anxiety") represent a potential barrier to computerization of the medical record. We examined the psychological reactions of physicians to computer use before and after the use of medical computing systems. The study goals were fourfold: first, to measure prior experiences with computers and computer anxiety and attitudes of postgraduate year 1 (PGY1) physicians at entry into a residency program; second, to measure computer anxiety and attitudes and changes in both of these areas following three months of clinical information system (CIS) use; third, to determine whether variables previously reported to be predictive of computer anxiety and attitudes were applicable to our subjects at baseline or after exposure to the CISs; fourth, to determine whether the extent of use of provider-entered encounters in the computer base patient record (CBPR) at Grady Memorial Hospital (THERESA, Medical Systems Development Corp., Atlanta, GA) affected computer anxiety or attitudes.

Affiliation of the authors: Division of General Medicine, Department of Medicine, Emory University School of Medicine, Atlanta, GA.

Presented at the AMIA Spring Congress, May 9–12, 1993, St. Louis, MO.

Correspondence and reprints: Steven H. Brown, MD, Room 215, Thomas K. Glenn Building, Department of Medicine, Emory University School of Medicine, 69 Butler Street, S.E., Atlanta, GA 30303. e-mail: litshb@unix.cc.emory.edu

Received for publication: 7/15/93; accepted for publication: 5/16/94.

## Background

Implementation of the CBPR is by all accounts an arduous endeavor. According to the 1993 Healthcare Information and Management Systems Society (HIMSS) survey,[1] nearly half of the respondents felt that implementation would not occur before the turn of the century, if at all. Twenty-three percent of the respondents to the HIMSS survey felt that the primary hurdle to widespread implementation was a lack of commitment from hospitals or the resistance of physicians and caregivers, while only 22% felt that the primary hurdle was a lack of technology.

It is reasonable to postulate that acceptance of CBPRs by physicians and other health care providers will be essential to successful widespread implementation. Physicians using the COSTAR ambulatory patient computerized medical record have been reluctant to use the system, nonreceptive to required training, and willing to terminate a session rather than to ask for help.[2] Negative attitudes and the resulting avoidance by residents and attending physicians were deleterious to the PROMIS system demonstration of 1976–77.[3] A disastrous example of negative impact was a 39% employee turnover rate documented in the eight months following implementation of a pharmacy system.[4] The strongest discriminator between the employees who stayed and those who left was a computer attitude inventory administered prior to system implementation.

Negative psychological reactions to computer use have been described in many ways. The terms computerphobia, computer aversion, computer anxiety, negative computer attitudes, and computer stress have all been given unique definitions. Computer attitudes address people's feelings about "the impact of computers on society and the quality of life."[5] For example, attitudes toward computerization of nursing have been measured using categories such as legal ramifications, quality of patient care, and capabilities of computers.[6]

Many feel that computer anxiety is a distinct construct. It has been defined as a "highly anxious response towards interaction or anticipated interaction with electronic data processing systems."[7] Computer anxiety has been contrasted to negative computer attitude as "a more affective response, such that resistance to and avoidance of computer technology are a function of fear and apprehension, intimidation, hostility, and worries that one will be embarrassed, look stupid, or even damage the equipment."[5]

Numerous studies can be found in the literature relating computer anxiety and computer attitudes to gender, age, prior computer experience, computer ownership, "math anxiety," and each other. A large

*Table 1* ■

Baseline Demographic Characteristics of the 74 Potential Initial Responders (Total Group), the 60 Initial Responders (First Survey), the 52 Interns Who Completed Both Surveys (Both Surveys), and the Eight Interns Who Completed Only the First Survey (Non-repeaters)

| | Total Group | First Survey | Both Surveys | Non-repeaters |
|---|---|---|---|---|
| Sample size | 74 | 60 | 52 | 8 |
| Age | | | | |
| Mean | 27 yr | 27 yr | 27 yr | 28 yr |
| Range | 24–33 yr | 24–33 yr | 24–32 yr | 24–33 yr |
| Gender | | | | |
| Male | 67% | 67% | 69% | 50% |
| Female | 33% | 33% | 31% | 50% |
| Race | | | | |
| Caucasian | 87.8% | 90% | 90% | 87.5% |
| African American | 8.1% | 6.7% | 6% | 12.5% |
| Asian | 4.1% | 3.4% | 4% | 0% |
| Medical school | | | | |
| Emory | 29.7% | 33% | 29% | 25% |
| All others in the United States | 86.5% | 91.7% | 96% | 62.5% |
| Foreign medical graduates | 13.5% | 8.3% | 4% | 37.5% |
| Training program | | | | |
| Internal medicine | 74.3% | 77% | 85% | 25% |
| Transitional | 25.7% | 23% | 15% | 75% |

NAME ____________________ AGE _____ SEX: M F

| | | | |
|---|---|---|---|
| 1. | Do you own a computer ? | Y | N |
| 2. | Do you touch type? | Y | N |
| 3. | Have you used a computer for: | | |
| | a. Test result retrieval | Y | N |
| | b. Literature search | Y | N |
| | c. Word processing | Y | N |
| | d. Entering patient info | Y | N |
| | e. Retrieving patient info | Y | N |
| 4. | Were you aware of the Grady Hospital computer system when you interviewed here ? | Y | N |
| 5. | Have you ever taken a computer course? | Y | N |

6. Was the Grady computer system a factor in your consideration of the Emory training program?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Positive | | Neutral | | Strongly Negative |

7. In the past, what is the most frequently you used a computer?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Never | Rarely | Monthly | Weekly | Daily |

8. How would you rate your computer skills ?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Lowest | | Average | | Highest |

**Figure 1** This questionnaire, which contains nine yes/no questions and three Likert-type questions, was used to determine the previous computer experience of residents.

body of literature also exists regarding the computer attitudes and computer anxiety of health care workers.[8–22] However, relatively few of these studies have included physicians,[18,20–22] and an even smaller number have made preimplementation and postimplementation measurements.[22] Data about physicians' attitudes toward computer applications in medicine and their computer anxiety will be needed as more institutions contemplate or actually implement CBPRs.

## Methods

### Overview

Interns matriculating into the internal medicine and transitional training programs at Emory University were queried at orientation about previous computer experience and then surveyed using an instrument composed of three sections: 1) a computer anxiety scale,[23] 2) a general perceived stress scale,[24] and 3) a measure of attitudes related to computer applications in medicine.

The interns then received their initial assignments to one of the three main teaching hospitals. Participants were resurveyed after three months of exposure to an extensive CBPR (THERESA, Grady Memorial Hospital); a system of intermediate scope [Decentralized Hospital Computer Program (DHCP), Decatur Veterans Affairs Medical Center], and/or a more limited information system at Emory Hospital. The second administration of the survey at three months was designed to take advantage of the differential exposures of the housestaff subjects to the three information systems. After that time, intern assignments changed to one of the other hospitals and exposures to the three computer systems began to equilibrate.

### Clinical Information Systems

The THERESA system is an extensive CPMR in active use at Grady Memorial Hospital.[25] Residents on the medicine service use the system for provider-entered encounters as well as for more traditional information retrieval. All admission histories, physical examinations, and problem lists are entered into the system by interns.

The system runs on five DEC VAX 8550s (Digital Equipment Corp., Maynard, MA) supporting 892 character-based and 445 X-windowing terminals. Ter-

*Table 2* ■

Abbreviations and Definitions of the Dependent Variables Used in Subsequent Correlation and Regression Tables

| Abbreviation | Definition |
|---|---|
| Anxiety 1 | Initial computer anxiety |
| Anxiety 2 | Follow-up computer anxiety |
| Anxiety change | Positive value = less anxiety |
| Attitude 1 | Initial attitude score |
| Attitude 2 | Follow-up attitude score |
| Attitude change | Positive value = better attitude |

minals are located in the physicians' offices, in the examination rooms, in the nursing charting rooms, and on the clerks' desks on medical wards, as well as in the emergency room.

As of April 1, 1994, there were 662,792 encounters, 98,493 patient problem lists containing 765,063 problem statements, 17,362,715 prescriptions, and 1,710,503 radiology reports in the system. There were also 309,770 transcribed documents such as discharge summaries, operative notes, endoscopy reports, and cardiac catheterization reports available on-line. Each medical or transitional intern is given a password and receives a one- to two-hour small-group training session prior to system use.

The intermediate-scope CIS to which the interns were exposed in this study was an implementation of the DHCP developed by the Department of Veteran's Affairs. The residents have the opportunity to use modules of the DHCP including laboratory, pharmacy, radiology, and health summary data as well as a housestaff manual. Orders can be reviewed, but they are entered by ward clerks. The system runs on a DEC VAX cluster with 650 terminals hospital-wide.

The third CIS involved in the study is at Emory University Hospital. Housestaff can access laboratory data or review current medications for their patients. The laboratory program (PathNet, Cerner, Kansas City, MO) runs on a DEC VAX 6420 and can be accessed through one of six lines from the hospital information system (HIS) network. Housestaff may also review current medications for their patients by querying the pharmacy departmental system [Medication Control System (MCS), Productive Data Management, Los Angeles, CA]. The system runs on an IBM ES 9000 (IBM, Armonk, NY) with approximately 500 terminals.

## Subjects

The Emory University internal medicine residency program is one of the largest in the country. Of the 74 interns who had attended orientation, 60 (81%) returned surveys and were included in the analysis of demographics and previous computer experiences. At three months, 52 of the initial responders completed the second administration of the survey (70% overall participation rate).

Table 1 shows the baseline demographic characteristics of the 74 potential initial respondents, the 60 initial responders, the 52 interns who completed both surveys, and the eight interns who completed only the first survey. The characteristics of the initial respondents were similar to those of the potential respondents except for a slightly lower representation of foreign medical graduates (8.3% vs 13.5%). The age, race, and gender characteristics of the 52 repeaters were essentially unchanged from those of the 60 initial responders. One intern, who was an extreme outlier with high computer anxiety on the second survey only (2.7 times the interquartile range beyond the third quartile), was eliminated from the analysis. This intern was a 28-year-old Indian woman who had graduated from a foreign medical school. She was in the preliminary medicine program and had not been assigned to Grady Memorial Hospital during the first three months. During further discussion she admitted that her universally polar answers were unreasonable. She was excluded from the study to prevent skewing of results. The remaining 51 interns with complete data sets comprised the study group.

## Hospital Assignments

The yearly hospital assignment schedule is made by the chief resident in medicine prior to the start of the academic year. The duration of an individual's exposure to the extensive CBPR is determined by the yearly schedule. Thirty of 52 (58%) of the study group interns fell into one of two classes: 1) those who used the extensive CBPR during all three months of the study period; and 2) those who had not been assigned to Grady Memorial Hospital for any portion of the study period. Intermediate levels of exposure occurred for 22 of 52 (42%) of the subjects.

The proportion of Emory graduates assigned to Grady Memorial Hospital did not differ from that of non-Emory graduates assigned to Grady Memorial Hospital (9/16 vs 19/35; chi-square test = 0.017, $p = 0.80$). This was considered a potential source of bias because all members of this subset had had previous exposure to the THERESA system for both data entry and data retrieval.

Crossover may have occurred because all interns spend one half day per week in the general medicine clinic at Grady Memorial Hospital. The extensive CBPR is presently used only for data retrieval in the medicine clinic.

### The Instrument

The previous computer experience of each resident was determined using a questionnaire consisting of nine yes/no questions and three Likert-type questions (Fig. 1). Previous computer experience included experiences specific to medical computing in addition to general computer experiences. The experience questionnaire was distributed during intern orientation only. Past experience was summarized into a single, ordinal variable for correlation and regression analysis. This was done by summing the yes answers (yes = 1, no = 0) to questions about the activities of test retrieval, literature searching, word processing, entering patient information, and retrieving patient information. The survey instrument was composed of 47 Likert-type questions measuring computer anxiety, attitudes toward computers in medicine, and general perceived stress levels. A brief verbal introduction to the study was given prior to the first administration of the survey. Complete written instructions were included on the cover page.

Computer anxiety was measured using the 1989 computer anxiety scale of Cohen and Waugh.[23] Since the 16 items are scored on a 1 to 5 basis, the lowest possible computer anxiety score for this instrument is 16 and the highest possible score is 80 (high scores indicate greater computer anxiety). During initial instrument development, when 152 graduate and undergraduate psychology students were studied, 16 Likert-type questions were found to have a reliability coefficient alpha of 0.948. Validity was confirmed by comparisons of computer anxiety measurements among groups and with previous computer experience.

The Perceived Stress Scale (PSS) developed by Cohen, Karmarck, and Mermelstein[24] comprised the second component of the current survey. It was designed to measure the degrees to which situations in one's life are appraised as stressful. This 14-item scale is composed of Likert-type questions with terms scored from 0 to 4. Thus, the lowest perceived stress score for the PSS is 0 and the highest possible stress score is 56 (higher scores indicate higher levels of perceived stress). This scale was tested by the developers on three populations, with coefficient alphas ranging from 0.84 to 0.86. They documented the validity of the PSS through its correlation to life-event scores, depressive and physical symptoms, use of health services, social anxiety, and smoking reduction maintenance.

The final element of the survey was composed of 17 Likert-type questions regarding attitudes toward the application of computers in medicine. Twelve of the questions were adapted from Stronge and Brodt's 1985 instrument measuring nurses' attitudes toward computerization.[6] The remaining questions were added by the investigators to address issues of concern to physicians. Each question was scored from 1 to 5, with 1 being strongly negative, 3 being neutral, and 5 being strongly positive. Total scores may range from 17 to 85, with a value higher than 51 indicating an average positive attitude and a value lower than 51 indicating an average negative attitude.

### Dependent Variables

Dependent variables examined in this study were computer anxiety and computer attitudes at baseline and following exposure to the CISs. Changes in computer anxiety and computer attitudes were also examined. Table 2 lists the abbreviations and definitions of the dependent variables used in subsequent tables.

### Predictor Variables

Variables reported in the literature to be predictive of computer anxiety or attitudes toward computers were collected in the present study to determine their

*Table 3* ■

Abbreviations and Definitions of the Predictor Variables Used in Subsequent Correlation and Regression Tables

| Abbreviation | Definition |
|---|---|
| Baseline | |
| Age | Subject's age in years |
| Sex | Subject's gender |
| Ownership | Computer ownership by subject (y/n) |
| Typing skills | Self-rated ability to touch-type (y/n) |
| Course | Any previous computer course (y/n) |
| Aware | Aware of extensive CBPR* before PGY1† (y/n) |
| Perc. stress 1 | Initial perceived stress score |
| Baseline Likert | |
| Self-rated skills | Subject's self-rated computer skills (1–5) |
| Factor | Was THERESA a factor in subject's program choice? (1–5) |
| Max frequency | Maximal frequency of computer use prior to PGY1 (1–5) |
| Experience | Composite score of previous computer experiences (1–5) |
| Follow-up | |
| Databases | Number of electronic H&Ps‡ done |
| Grady mo | Months exposed to extensive CBPR |
| Perc. stress 2 | Follow-up perceived stress score |

*CBPR = computer base patient record.
†PGY1 = postgraduate year 1.
‡H&Ps = histories and physical examinations.

| | Mean | Std.Dev. | Anxiety2 | Anxiety Change | Attitude1 | Attitude2 | Perc. Stress1 | Perc. Stress2 | Databases |
|---|---|---|---|---|---|---|---|---|---|
| Anxiety1 | 32.754 | 11.463 | 0.722** | 0.478** | -0.411** | -0.550** | -0.178 | 0.029 | -0.056 |
| Anxiety2 | 31.745 | 10.417 | | -0.249 | -0.299* | -0.680** | -0.153 | 0.191 | -0.072 |
| Anxiety Change | 0.725 | 7.756 | | | -0.226 | 0.099 | -0.052 | -0.203 | 0.016 |
| Attitude1 | 63.186 | 9.159 | | | | 0.564** | -0.021 | -0.104 | 0.175 |
| Attitude2 | 62.206 | 10.591 | | | | | 0.171 | -0.197 | 0.043 |
| Perc. Stress1 | 19.676 | 6.960 | | | | | | 0.527** | -0.034 |
| Perc. Stress2 | 22.235 | 7.168 | | | | | | | 0.007 |
| Databases | 44.333 | 35.655 | | | | | | | |
| Grady Mos | 1.667 | 1.178 | | | | | | | |
| Age | 26.804 | 1.822 | | | | | | | |
| Attitude Change | -0.980 | 9.311 | | | | | | | |
| Skill Change | 0.255 | 0.627 | | | | | | | |
| Sex | 0.706 | 0.460 | | | | | | | |
| Ownership | 0.353 | 0.483 | | | | | | | |
| Typing Skills | 0.686 | 0.469 | | | | | | | |
| Course | 0.627 | 0.488 | | | | | | | |
| Aware | 0.863 | 0.348 | | | | | | | |

| | Grady Mo | Age | Attitude Change | Skill Change | Sex | Ownership | Typing Skills | Course | Aware |
|---|---|---|---|---|---|---|---|---|---|
| Anxiety1 | 0.09729** | -0.015 | -0.221 | 0.164 | -0.360** | -0.305* | 0.070 | -0.191 | 0.091 |
| Anxiety2 | 0.081 | 0.058 | -0.480** | 0.010 | -0.166 | -0.224 | -0.066 | -0.003 | 0.139 |
| Anxiety Change | 0.014 | -0.086 | 0.335* | 0.204 | -0.309* | -0.123 | 0.190 | -0.233 | -0.037 |
| Attitude1 | 0.113 | 0.029 | -0.343* | 0.075 | 0.203 | 0.317* | -0.326* | 0.034 | -0.004 |
| Attitude2 | -0.003 | -0.143 | 0.583** | -0.061 | 0.107 | 0.291 | -0.152 | -0.074 | -0.008 |
| Perc. Stress1 | -0.225 | 0.058 | 0.215 | -0.219 | 0.148 | 0.053 | 0.293* | 0.370** | -0.106 |
| Perc. Stress2 | -0.173 | 0.219 | -0.122 | -0.143 | 0.024 | -0.131 | 0.142 | 0.226 | -0.232 |
| Databases | 0.770** | -0.046 | -0.122 | -0.043 | 0.055 | -0.099 | -0.198 | 0.005 | -0.019 |
| Grady Mos | | -0.022 | -0.114 | 0.036 | 0.037 | -0.070 | -0.157 | -0.046 | 0.033 |
| Age | | | -0.192 | -0.113 | 0.001 | 0.308* | 0.020 | 0.029 | -0.043 |
| Attitude Change | | | | -0.143 | -0.078 | 0.018 | 0.148 | -0.117 | -0.005 |
| Skill Change | | | | | 0.057 | 0.093 | 0.209 | -0.271 | -0.295* |
| Sex | | | | | | 0.207 | -0.065 | 0.037 | -0.007 |
| Ownership | | | | | | | 0.146 | -0.025 | 0.056 |
| Typing Skills | | | | | | | | 0.003 | 0.099 |
| Course | | | | | | | | | -0.072 |

**Figure 2** Results of pairwise correlation analysis for all study variables. Pearson correlation coefficients: $*p < 0.05$; $**p < 0.01$.

utility in our subject group. Other variables felt by the investigators to have potential predictive value were also collected. In Table 3 the abbreviations and definitions of the predictor variables investigated are presented. These abbreviations are used in subsequent tables.

Three predictor variables bear special mention. Number of histories and physical examinations entered electronically and months exposed to the extensive CBPR at Grady Memorial Hospital were included as predictor variables for the second measurement of computer anxiety and computer attitudes. These variables differ because it is possible to be assigned to a rotation at Grady Memorial Hospital that uses the extensive CBPR for data retrieval only. The PSS was included in the present study to examine the extent of general stress of our subjects and to determine the effects of this stress on computer anxiety and computer attitudes.

### Statistical Analysis

Survey results were entered into Paradox (Borland, Scotts Valley, CA) running on a Dell 450L PC (Dell, Austin, TX). Computer anxiety and computer attitudes for both the first and the second administrations were determined by scoring instrument subsections using published techniques. The scoring was performed using Paradox application language scripts. All further analysis of data was performed using SAS statistical software (SAS Institute Inc., Cary, NC). The reliability of each subsection was assessed by calculation of Cronbach's alpha coefficient.

Descriptive statistics for baseline demographics and previous experiences were calculated. Simple pairwise correlations between predictor and dependent variables were computed. Finally, linear regression analysis was performed to determine the relationships of predictor variables to baseline and follow-up computer anxiety and computer attitudes and to changes in computer anxiety and computer attitudes. Only initial survey factors were considered for inclusion in the models of initial anxiety and initial attitudes. The regression models that were developed were restricted to a maximum of five predictor variables each because of limitations imposed by our sample size of 51. This restriction creates more stable models, but prevents detailed evaluation of all of the possible interactions between predictor variables.

Continuous variables were tested in the models without change. Likert-type variables (self-reported skills, maximum frequency of prior use, prior use score, and THERESA as a factor in the decision to attend Emory) were found to have highly abnormal distributions, with many low-frequency cells, and were

*Table 4* ■

Results of the Correlation Analysis for Likert-scale Predictor Variables

| | Max Frequency | Self-rated Skills | Experience |
|---|---|---|---|
| Anxiety 1 | −0.437** | −0.549** | 0.072 |
| Anxiety 2 | −0.194 | −0.352* | 0.110 |
| Anxiety change | 0.365** | 0.320* | 0.039 |
| Attitude 1 | 0.087 | 0.170 | −0.003 |
| Attitude 2 | 0.139 | 0.245 | 0.053 |
| Attitude change | 0.073 | 0.111 | 0.063 |
| Stress 1 | 0.076 | 0.148 | −0.074 |
| Stress 2 | 0.240 | 0.177 | 0.191 |
| Stress change | 0.174 | 0.035 | 0.275 |
| Databases | 0.242 | 0.211 | 0.121 |
| Grady mo | 0.034 | −0.024 | −0.023 |
| Age | 0.124 | 0.284* | 0.029 |
| Ownership | 0.208 | 0.385** | 0.102 |
| Skills | 0.091 | 0.158 | −0.046 |

Pearson correlation coefficients: $^{*}p < 0.05$; $^{**}p < 0.01$.

converted to dichotomous variables by a median split.

With the above constraints in mind, the ten best regression models for each dependent variable were generated. Details of the best model, as determined by the $C_p$ criterion, are reported. The number of times a predictor variable appeared in any of the ten best models is also reported.

## Results

### Initial Experience

The 60 initial responders completed the questionnaire about previous computer experience. Thirty-eight percent of them were computer owners, 70% indicated that they could touch-type, and 57% had taken a computer course. Maximal frequencies of computer use prior to internship were daily (43%), weekly (27%), monthly (15%), rarely (13%), and never (2%). Self-rated computer skills were above average for 27% and below average for 25%.

The most common previous exposures to computers were for literature searching and retrieval of patient information (both 92%). Other exposures included word processing (88%), test-result retrieval (65%), and entry of patient data (57%).

Eighty-two percent of the initial respondents indicated that they had been aware of the extensive CBPR at Grady Memorial Hospital when they interviewed for internship. Seventeen percent reported that it had been a positive factor in their choices to come to this program. Seventy-three percent reported that the presence of the CBPR had not influenced them, and 10% reported that it had had a negative influence.

### Measurement of Baseline Computer Anxiety and Attitudes

The initial average computer anxiety score for the 51 members of the study group was 32.8 (SD 11.5). Cronbach's alpha coefficient for this sample was 0.955.

Baseline attitudes toward computers in medicine were generally favorable. The initial mean attitude score for the study group was 63.2 (SD 9.2). A score of 51 indicates an average neutral response. Cronbach's alpha coefficient was 0.90. The two most positive responses came to questions regarding an increasing role for computers in the practice of medicine in general and an increasing role for computers in the individual respondent's future practice of medicine. There was also a strong agreement with the statement that computers offered a "remarkable opportunity to increase the quality of patient care."[6] Respondents were, on the average, neutral with respect to looking forward to a totally paperless record, but they felt that the extensive CBPR was an asset to the residency training program.

### Measurement of Follow-up Computer Anxiety and Attitudes

Computer anxiety for the group ($n$ = 51) following three months of information system use was not different from baseline computer anxiety (32.8 $_{t0}$ vs 31.7 $_{t1}$; $p$ = 0.636; Cronbach's alpha coefficient = 0.940).

Likewise, attitudes toward computers in medicine for the group had not changed (63.2 $_{t0}$ vs 62.2 $_{t1}$; $p$ = 0.618; Cronbach's alpha coefficient = 0.927). The initial three most positive responses described above did not change. The greatest positive change was seen in the average response regarding looking forward to a totally paperless medical record. The greatest negative change (and the second greatest change overall) was a decrease in the average response about computers permitting doctors to spend more time on the professional tasks for which they were trained.

### Measurement of Changes between Baseline and Three-month Computer Anxiety and Attitudes

Although there was no difference in group average computer anxiety between administrations, changes were seen in individual measurements. Similarly, the average change in computer attitudes between the first and the second iterations was not statistically significant, but changes were found among individuals.

### Prediction of Baseline Computer Anxiety and Attitudes

Pairwise correlation analysis was performed for baseline computer anxiety. Factors found to be correlated with increased baseline computer anxiety were low self-rated computer skills ($p$ = 0.0001), low maximal frequency of prior computer use ($p$ = 0.0001), worse computer attitudes ($p$ = 0.0027), female gender ($p$ = 0.0096), and not owning a computer ($p$ = 0.0295). Full results are detailed in Figure 2 and Table 4.

Linear regression analysis was performed for initial computer anxiety, and the top ten computer-generated models were reviewed. The best model, chosen by the $C_p$ statistic, had an R-square of 0.552. The four individual factors included in the model were poor baseline attitudes ($p$ = 0.0002), unawareness of the CBPR prior to coming to this program ($p$ = 0.0025), low self-rated skills ($p$ = 0.0001), and a low score for prior experience with computers ($p$ = 0.0307). Other predictor variables that were not included in the single best model but that were represented in at least one of the ten other models were gender (three of ten models), maximal frequency of prior computer use (two of ten models), computer own-

*Table 5* ■

Initial Computer Anxiety Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 134.886 | 24.707 | 5.459 | 0.0001 |
| Attitude 1 | 1 | 0.2684 | −1.565 | 0.385 | −4.063 | 0.0002 |
| Aware | 1 | 0.1861 | −84.656 | 26.393 | −3.207 | 0.0025 |
| Attitude 1/Aware | 1 | 0.1867 | 1.324 | 0.412 | 3.215 | 0.0024 |
| Skills | 1 | 0.4206 | −15.191 | 2.658 | −5.716 | 0.0001 |
| Experience | 1 | 0.0996 | 5.509 | 2.469 | 2.231 | 0.0307 |

Analysis of variance: F value = 11.098; prob > F = 0.0001; R-square = 0.5522; adjusted R-square = 0.5024.

*Table 6* ■

Follow-up Computer Anxiety Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 32.265 | 9.589 | 3.365 | 0.0015 |
| Anxiety 1 | 1 | 0.3622 | 0.480 | 0.093 | 5.167 | 0.0001 |
| Attitude 1 | 1 | 0.0756 | 0.231 | 0.118 | 1.960 | 0.0559 |
| Attitude 2 | 1 | 0.2976 | −0.496 | 0.111 | −4.462 | 0.0001 |

Analysis of variance: F value = 30.981; prob. > F = 0.0001; R-square = 0.6641; adjusted R-square = 0.6427.

ership (one of ten models), and baseline perceived stress (one of ten models). Full results of the best regression model for initial computer anxiety are listed in Table 5.

Factors found to be correlated with poor baseline attitudes toward computer applications in medicine were high baseline anxiety ($p$ = 0.0027), ability to touch-type ($p$ = 0.0195), and not owning a computer ($p$ = 0.0233). Full results are detailed in Figure 2 and Table 4.

The best of the ten models of baseline computer attitudes generated by linear regression had an R-square of 0.365. Factors included in the model associated with worse attitudes were typing skills ($p$ = 0.0026), high baseline computer anxiety ($p$ = 0.0056), computer non-ownership ($p$ = 0.0209), and high maximal frequency of prior computer use ($p$ = 0.0949). The predictor variable of self-rated computer skills was not included in the best model of baseline computer attitudes, but it was included in six of the top ten models developed. Full results of the best regression model for baseline computer attitudes are listed in Table 8.

**Prediction of Follow-up Computer Anxiety and Attitudes**

Pairwise correlation analysis of the repeat measurements of computer anxiety was performed. Factors found to be correlated with high computer anxiety on the second administration were high computer anxiety score on first administration ($p$ = 0.0001), low computer attitude scores on first and second administrations ($p$ = 0.0332, and 0.0001, respectively), change in attitudes for the worse ($p$ = 0.0004), low maximal frequency of prior computer use ($p$ = 0.0117), and low self-rated skills ($p$ = 0.0319). Full results are detailed in Figure 2 and Table 4.

Linear regression analysis for computer anxiety on the second administration yielded a model with an R-square of 0.685. Factors contributing to the best model of follow-up computer anxiety were increased computer anxiety score on first administration ($p$ = 0.0002), low computer attitude score on first administration ($p$ = 0.0559), and low computer attitude score on second administration ($p$ = 0.0001). Variables not included in the single best model of three-month computer anxiety but of predictive utility in other models were change in attitude for the better (five of ten models), typing ability (four of ten models), previous computer experience score (three of ten models), awareness of the system prior to the start of the year (two of ten models), and general perceived stress at three months (two of ten models). Full results are given in Table 6.

Factors correlated with poor computer attitude on second administration were high computer anxiety on first and second administrations ($p$ = 0.0001 for both), poor computer attitude on first administration ($p$ = 0.0001), and not owning a computer ($p$ = 0.0385). Full results are detailed in Figure 2 and Table 4.

The best regression model created for computer attitude on second administration had an R-square of 0.650. Factors that carried over from pairwise correlations associated with poor computer attitude included high computer anxiety on second administration ($p$ = 0.0001) and poor attitude on first administration ($p$ = 0.0002). Other factors in the regression model included change in perceived stress level ($p$ = 0.0331) and frequency of prior computer use ($p$ = 0.0700) (Table 6). Gender was included in one of the top ten models created for follow-up computer attitudes.

**Prediction of Changes between Baseline and Three-month Computer Anxiety and Attitudes**

Factors correlated with change in anxiety for the better included high initial anxiety ($p$ = 0.0004), change in attitude for the better ($p$ = 0.0163), and female gender ($p$ = 0.0274). Full results are detailed in Figure 2 and Table 4.

The best of the ten models generated by linear regression analysis for change in computer anxiety had an R-square of 0.464. Factors contributing to this model were increased computer anxiety score on first ad-

*Table 7* ■

Change in Computer Anxiety Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 32.265 | 9.589 | 3.365 | 0.0015 |
| Anxiety 1 | 1 | 0.3991 | −0.520 | 0.093 | −5.587 | 0.0001 |
| Attitude 1 | 1 | 0.0756 | 0.231 | 0.118 | 1.960 | 0.0559 |
| Attitude 2 | 1 | 0.2976 | −0.496 | 0.111 | −4.462 | 0.0001 |

Analysis of variance: F value = 13.03; prob. > F = 0.0001; R-square = 0.4592; adjusted R-square = 0.4247.

ministration ($p = 0.0001$), low computer attitude score on first administration ($p = 0.0559$), and low computer attitude score on second administration ($p = 0.0001$). Variables found to have predictive value in other models included attitude change (five of ten models), typing ability (four of ten models), previous computer experience score (three of ten models), awareness of the system prior to the start of the year (two of ten models), and general perceived stress at three months (two of ten models). Full results are given in Table 7.

Items that correlated with change in attitude for the better included low anxiety on second administration ($p = 0.0004$), change in anxiety for the better ($p = 0.0163$), poor baseline attitude ($p = 0.0139$), and better follow-up attitude ($p = 0.0001$). Full results are detailed in Figure 2 and Table 4.

A multiple regression model was created for change in attitude, with an R-square of 0.569. The predictor variables included in the best model of change in attitude were the same as those in the best model of follow-up attitude: high computer anxiety on second administration ($p = 0.0001$), poor attitude on first administration ($p = 0.0002$), change in perceived stress level ($p = 0.0331$), and frequency of prior computer use ($p = 0.0700$). Again, gender was included in one of the ten best models of change in attitude, but not the single best model.

# Discussion

### Initial Experience of the Study Group

The initial respondents had had broad exposure to computers prior to internship. Only 2% had never used a computer. Almost all had done literature searches and retrieval of patient data.

Orr and Edelstein have suggested that the computer literacy of "the average medical student" is on the rise,[14] and that concerns about minimal computer competency may soon become less important. Our findings confirm this. They found a bimodal distribution of prior experiences, and felt that reliance on average scores may hide a subgroup needing improvement in skills. We did not find this pattern, but our composite experience score involved fewer variables. Our finding that males and females had had similar prior experiences was in agreement with their results.

### Computer Anxiety

The baseline computer anxiety score (32.8; SD 11.5) was similar to that reported for industrial–organizational psychology students (36.2; SD 14.3) and was lower than that reported for clinical psychology students (47.2; SD 14.4) in the initial description of the computer anxiety instrument.[23]

Three studies were found that systematically measured the computer anxiety of health care providers. Jacobson et al. found that nurses had "mild" anxiety using the COMPAS instrument. Wilson[9] applied the Computer Anxiety Index (CAIN) to nursing students and found an average score between the mean and upper third of scores of the normative population. Orr and Edelstein[14] found that the mean anxiety score on the CAIN for three successive classes of medical students approximated the normative mean. Our results are more like those found for medical students than those found for nursing students, although we employed different instruments to measure computer anxiety.

At three months, computer anxiety had not changed for the group; however, changes had occurred for individuals. The best regression model accounted for less than half of the variation in responses, implying that other factors important in the prediction of change in computer anxiety were not evaluated in this study.

### Attitudes toward Computers in Medicine

Attitudes of the group toward computer applications in medicine were generally favorable and did not change over time. Favorable attitudes of physicians toward computers in general have previously been mentioned by several authors.[26-29] Physicians have been found to have more favorable attitudes toward computers than do lawyers, but less favorable attitudes than do either certified public accountants or pharmacists.[30] Studies of attitudes following implementation of computer systems are less common. Gilhooly et al.[21] found no difference in the attitudes of nurses in Scotland after they had used an intensive care unit system for two months. Physicians' initial attitudes were positive in that study, but follow-up questionnaires were not administered. A study of nurses' attitudes following implementation of an acuity and order-entry system also found no difference after the initial period of use.[31] Alexander et al.[22] investigated physicians' attitudes following implementation of an automated drug review system. Although they found persisting positive attitudes about computers in general, the attitudes of those physicians who were required to complete lengthy data-input procedures had worsened.

Although the average attitude for our study group did not change after three months of CIS use, changes were seen for individuals. A regression model for change in attitude was created that accounted for just over half of the variation in responses (somewhat better than the model for change in computer anxiety). Number of databases entered was not an independent factor in models for attitudes toward computers in medicine. It was a common component in interaction terms, however. This contrasts with Alexander et al.'s[22] findings of worsened attitudes associated with lengthy data-input procedures.

## Roles of Specific Factors

***Gender.*** Simple pairwise correlation showed that female gender correlated with increased initial computer anxiety and change toward less computer anxiety. Regression modeling included gender as an independent factor in only two of the ten models created for baseline anxiety and in none of the models created for follow-up anxiety or change in anxiety.

We found no relationship between gender and computer attitudes by simple pairwise correlation. Gender was included as an independent factor in only three of 30 models created for attitudes toward computers in medicine. Despite minimal involvement as an independent predictive factor, gender appeared in interaction terms in 15 of 30 models. Gender may in fact be a proxy measure of other variables in the prediction of attitudes. If we can accept that computer anxiety and computer attitudes are essential components of computerphobia,[32] then these findings are in agreement with those from a meta-analysis of 81 studies by Rosen and Maguire.[33]

***Age.*** Age played no role in pairwise correlations with measures of attitudes and anxiety. It was not an independent variable or a part of an interaction term in any regression model. Although this is in agreement with the previously mentioned meta-analysis,[33] it may also reflect the narrow age distribution of our respondents.

***Self-reported skills.*** Self-reported skills emerged as one of the more important predictors of baseline computer anxiety and computer attitude. It was included as a significant independent variable in 16 of 20 regression models created for prediction of baseline attitude and computer anxiety.

The explicit inclusion of self-reported skills in studies of computer attitudes and computer anxiety is uncommon. Computer "self efficacy" was found to be predictive of computer anxiety by Gelberg.[34] Low efficacy expectation is offered as a central component in the social learning theory of computer aversion proposed by Meier.[35] Low efficacy expectation means that a person is doubtful about his or her ability to perform effectively. Subsequently, in the development of the computer aversion scale,[36] Meier felt that the concept of efficacy expectations was in need of further refinement. Not wishing to appear incompetent in front of patients has been offered as a reason for physicians to be uncomfortable with the COSTAR system.[37] A subscale of computer confidence is described in the computer attitude scale by Lloyd and Gressard.[38] The relation of these constructs to the single item of self-rated computer skills is un-

*Table 8* ■

Initial Computer Attitude Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 78.615 | 4.757 | 16.526 | 0.0001 |
| Anxiety 1 | 1 | 0.1553 | −0.313 | 0.108 | −2.908 | 0.0056 |
| Touch type | 1 | 0.1807 | −7.635 | 2.397 | −3.185 | 0.0026 |
| Ownership | 1 | 0.1107 | 5.737 | 2.398 | 2.392 | 0.0209 |
| Frequency | 1 | 0.0595 | −4.165 | 2.442 | −1.705 | 0.0949 |

Analysis of variance: F value = 6.603; prob. > F = 0.0003; R-square = 0.3648; adjusted R-square = 0.3095.

certain. Inclusion of this item in future studies may help to elucidate its predictive value.

*Maximal frequency of prior computer use.* Maximal frequency of computer use prior to internship was included in all three of the best models and in 19 of the top 30 regression models for computer attitude. It is possible that responses to this question may integrate past computer experiences as well as prior avoidance behaviors. The potential utility of this single item in the prediction of computer attitudes warrants continued investigation.

*Computer experience.* Several measures of self-reported past computer experiences were evaluated in this study. A single five-step categorical variable of past experiences was created because interactions and confounding effects were found between individual variables. The composite score for prior computer experiences was associated with computer anxiety in nine of 30 regression models. It was not included in any regression model for computer attitude. The association of prior computer experience with better attitudes toward computers and diminished computer anxiety has been widely discussed in the literature.

*Typing skills.* The self-reported ability to touch-type was retained as a significant contributor to regression models of follow-up and change in computer anxiety and initial computer attitude. The ability to type was associated with less computer anxiety. Interestingly, typing ability was associated with worse initial attitudes. We do not know how to explain this.

The barrier of "significant typing skills" to physicians" use of COSTAR system has been addressed by O'Dell et al.[2] However, O'Dell et al. felt that *lesser* typing skills were associated with worse attitudes and avoidance of the system. The finding that 70% of our initial respondents said they could touch-type is more encouraging than the assertion made by Tape et al.[37] that physicians generally have poor keyboard skills.

*Computer ownership.* Ownership had significant pairwise correlations with initial and follow-up attitudes and with initial anxiety. Computer ownership also contributed to regression models for initial attitude and anxiety. Ownership was associated with better attitudes and less anxiety.

### Effect of Use of THERESA on Computer Anxiety and Attitude

Provider-entered encounters are one of the essential differences between the THERESA system at Grady Memorial Hospital and the information retrieval systems at the other two institutions. Number of histories and physical examinations entered electronically was included as a measure of use of the extensive CBPR for data input.

Pairwise correlation found no relation of any dependent variable with number of histories and physical examinations entered or months at Grady Memorial Hospital. These variables were not independent factors in regression modeling for either computer attitude or computer anxiety.

It is notable that use of an electronic medical record for provider-entered encounters did not worsen attitudes toward computers in medicine. This challenges what is widely felt to be the conventional wisdom. Further insight can be derived from looking at the group's responses to individual questions. The attitude question with the greatest negative change was about computers permitting doctors to spend more time on professional tasks. Despite this, looking forward to a totally paperless medical record was the follow-up attitude question with the greatest positive change.

## Summary of Findings

Computer anxiety and attitudes toward computer applications in medicine were unchanged for the group after three months of CIS use. Despite this, changes in computer anxiety and computer attitudes did occur for individuals. Factors that commonly emerged as

*Table 9* ■

Follow-up Computer Attitudes Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 49.005 | 8.117 | 6.037 | 0.0001 |
| Anxiety 2 | 1 | 0.3733 | −0.515 | 0.098 | −5.234 | 0.0001 |
| Attitude 1 | 1 | 0.2913 | 0.456 | 0.105 | 4.349 | 0.0001 |
| Stress change | 1 | 0.0950 | −0.324 | 0.147 | −2.197 | 0.0331 |
| Experience | 1 | 0.0696 | 3.538 | 1.907 | 1.855 | 0.0700 |

Analysis of variance: F value = 21.856; prob. > F = 0.0001; R-square = 0.6552; adjusted R-square = 0.6253.

*Table 10* ■

Change in Computer Attitudes Regression Model

| Variable | DF | Sq. Partial Corr. Type II | Parameter Estimate | Standard Error | T for H0: Param. = 0 | Prob. > \|T\| |
|---|---|---|---|---|---|---|
| Intercept | 1 | | 49.005 | 8.117 | 6.037 | 0.0001 |
| Anxiety 2 | 1 | 0.3733 | −0.515 | 0.098 | −5.234 | 0.0001 |
| Attitude 1 | 1 | 0.3683 | −0.544 | 0.105 | −5.179 | 0.0001 |
| Stress change | 1 | 0.0950 | −0.324 | 0.147 | −2.197 | 0.0331 |
| Experience | 1 | 0.0696 | 3.538 | 1.907 | 1.855 | 0.0700 |

Analysis of variance: F value = 14.281; prob. > F = 0.0001; R-square = 0.5539; adjusted R-square = 0.5151.

being predictive of anxiety, attitudes, or change included self-rated skills, typing ability, computer ownership, maximal frequency of prior computer use, and prior experiences. Factors that contributed little included age, gender, and physician entry of data.

## Areas for Future Research

We can identify five areas for continued research to improve our ability to understand, predict, and affect computer anxiety and computer attitudes of physicians using CISs:

1. More refined assessments of attitudes and anxiety to permit appropriately targeted interventions.
2. Long-term follow-up of subjects throughout residency.
3. Further evaluation of self-reported skills versus actual skills as a predictor of computer anxiety and computer attitude.
4. Trials of techniques for encounter input other than typing to determine effects on follow-up attitude and anxiety.
5. Development and testing of interventions aimed at the reduction of anxiety and the improvement of attitudes.

The authors thank W. Scott Clark, PhD, for assistance with the statistical analysis.

*References* ■


1. J. C. Pollack Associates. Healthcare Information and Management Systems Society Annual Leadership Survey. 1993.
2. O'Dell DV, Tape TG, Campbell JR. Increasing physician acceptance and use of the computerized ambulatory medical record. In: Frisse ME, ed. Proceedings of the Sixteenth Annual Symposium on Computer Applications in Medical Care. Baltimore: American Medical Informatics Association, 1992:848–52.
3. Lundesgaarde HP, Fischer PJ, Steele DJ. Human Problems in Computerized Medicine. Lawrence, KS: University of Kansas Publications in Anthropology, 1981.
4. Kjerulff KH, Counte MA, Salloway JC. Attitudes toward computers and employee turnover during implementation of a pharmacy information system. In: Salamon R, Blum B, Jorgensen M, eds. Medinfo 86. Washington, DC: IFIP-IMIA, 1986:1046–51.
5. Heinssen RK, Glass CR, Knight LA. Assessing computer anxiety: development and validation of the computer anxiety rating scale. Comput Hum Behav. 1987;3:49–59.
6. Stronge J, Brodt A. Assessment of nurses' attitudes towards computerization. Comput Nurs. 1985;3(4):154–8.
7. Weinberg SB. Identification of computer anxiety (unpublished manuscript). Philadelphia: Saint Joseph University, 1980.
8. Jacobson SF, Holder ME, Dearner JF. Computer anxiety among nursing students, educators, staff, and administrators. Comput Nurs. 1989;7(6):266–72.
9. Wilson BA. Computer anxiety in nursing students. J Nurs Educ. 1991;30(2):52–6.
10. Scarpa R, Smeltzer SC, Jasion B. Attitudes of nurses toward computerization: a replication. Comput Nurs. 1992;10(2):72–80.
11. Burkes M. Identifying and relating nurse's attitudes toward computer use. Comput Nurs. 1991;9(5):190–201.
12. Thomas B. Development of a measure to assess attitudes toward computing in nursing. In: Greenes RA, ed. Proceedings of the Twelfth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1988:355–7.
13. Harsanyi BE, Kelsey CE. Attitudes toward computer technology between nursing and medical educators. In: Kingsland LC III, ed. Proceedings of the Thirteenth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1989:802–6.
14. Orr NA, Edelstein RA. Trends in measures of computer experience and computer anxiety for students in three successive medical school classes. In: Frisse ME, ed. Proceedings of the Sixteenth Annual Symposium on Computer Applications in Medical Care. Baltimore: American Medical Informatics Association, 1992:268–72.
15. Merrow SL. Graduate nursing students' knowledge of computer terminology and attitudes towards computers. In: Greenes RA, ed. Proceedings of the Twelfth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1988:350–4.
16. Anderson RM, Donnelly MB, Hess GE. An assessment of computer use, knowledge, and attitudes of diabetes educators. Diabetes Educator. 1992;18(1):40–6.
17. Kjerulff KH, Salloway JC, Counte MA. The impact of computer systems in a medical environment. Comput Med Imaging Graph. 1989;13(1):137–43.

18. Shumway JM, Jacknowitz AJ, Abate MA. Analysis of physicians', pharmacists', and nurses' attitudes towards the use of computers to access drug information. Methods Inf Med. 1990;29:99–103.
19. Calhoun M, Staley D, Hughes L, McLean M. The relationship of age, level of formal education, and duration of employment toward attitudes concerning the use of computers in the workplace. J Med Syst. 1989;13(1):1–9.
20. Campbell JR, Givner N, Seelig CB, et al. Computerized medical records and clinic function. MD Comput. 1989;6(5):282–7.
21. Gilhooly KJ, Logie R, Ross D, Ramayya P, Green C. Users' perceptions of a computerised information system in intensive care (ABICUS) on introduction and after 2 months use. Int J Clin Monit Comput. 1991;8:101–6.
22. Alexander MJ, Siegel C, Dlugacz Y, Fischer S. Post implementation changes in physicians' attitudes toward an automated drug review system. In: Dayhoff RE, ed. Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1983:660–3.
23. Cohen B, Waugh G. Assessing computer anxiety. Psychol Rep. 1989;65:735–8.
24. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24:385–96.
25. Walker HK, Camp HN, Brown SH. The THERESA online integrated medical record. Proceedings of the Fourteenth Annual Meeting of the Society of General Internal Medicine, 1991:52–3.
26. Startsman TS, Robinson RE. The attitudes of medical and paramedical personnel toward computers. Comput Biomed Res. 1972;5:218–27.
27. Melhorn JM, Legler WK, Clark GM. Current attitudes of medical personnel towards computers. Comput Biomed Res. 1979;12:327–34.
28. Teach RL, Shortliffe EH. An analysis of physician attitudes regarding computer-based clinical consultation systems. Comput Biomed Res. 1981;14:542–58.
29. Dlugacz YD, Siegel C, Fischer S. Physician-computer interaction. In: Heffernan HG, ed. Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1981:797–801.
30. Zoltan E, Chapanis A. What do professional persons think about computers. Behav Inf Technol. 1982;1(1):55–68.
31. Feeney S, Donovan A. Changes in attitudes towards computers during implementation. In: Kingsland LC III, ed. Proceedings of the Thirteenth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1989:807–9.
32. Rosen LD, Sears DC, Weil MM. Computerphobia. Behav Res Methods Instruments Comput. 1987;19(2):167–79.
33. Rosen LD, Maguire P. Myths and realities of computerphobia: a meta-analysis. Anxiety Res. 1990;3:175–91.
34. Gelberg SO. Relationships among vocational interests, gender, previous experience with computers, computer self efficacy, and math anxiety in predicting computer anxiety. Dissertation Abstracts Int. 1990;51(3):793a–4a.
35. Meier ST. Computer aversion. Comput Hum Behav. 1985;1:171–9.
36. Meier ST. Predicting individual differences in performance on computer administered tests and tasks: development of the computer aversion scale. Comput Hum Behav. 1988;4:175–87.
37. Tape TG, Givner N, Wigton RS, et al. Process in ambulatory care: a controlled clinical trial of computerized records. In: Greenes RA, ed. Proceedings of the Twelfth Annual Symposium on Computer Applications in Medical Care. Washington, DC: Symposium on Computer Applications in Medical Care, 1988:749–52.
38. Loyd BH, Gressard C. Reliability and factorial validity of the computer attitude scales. Educ Psychol Measurement. 1984;44:501–5.