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Unraveling Uses and Effects of an Interactive Health Communication System

Jeong Yeob Han, Ph.D. [Assistant Professor],

Department of Telecommunications, Grady College of Journalism and Mass Communication,
University of Georgia, 120 Hooper Street, Athens, GA 30602

Robert P. Hawkins, Ph.D. [Research Professor and Maier-Bascom Professor Emeritus],

School of Journalism and Mass Communication, University of Wisconsin–Madison

Bret R. Shaw, Ph.D. [Assistant Professor],

Department of Life Sciences Communication, University of Wisconsin–Madison

Suzanne Pingree, Ph.D. [Professor Emerita],

Department of Life Sciences Communication, University of Wisconsin–Madison

Fiona McTavish, M.S. [Deputy Director], and

Center of Excellence in Cancer Communication Research, University of Wisconsin–Madison

David H. Gustafson, Ph.D. [Research Professor]

Department of Industrial Engineering, University of Wisconsin–Madison

Jeong Yeob Han: jeonghan@uga.edu

Abstract

By developing a number of measures distinguishing amount, type of content, and when and how that content is used, the current study revealed effective patterns of use that are associated with quality of life benefits during an eHealth intervention. Results generally suggest that the benefits depend on how a patient uses the system, far more than on sheer amount of exposure or even what type of content is chosen. The next generation of eHealth system should focus on providing new and varying content over time, but even more on encouraging intensity of use and long-term commitment to the system.

The use of the Internet for health education has reached what many might consider a critical mass. According to the National Cancer Institute's Health Information National Trends Survey (Nelson et al., 2004), among women who have had breast cancer, the Internet is second only to their healthcare providers as a first choice for where they would go to obtain cancer information. As an increasing number of breast cancer patients turn to the Internet for health education and support, concern over its effect on their health behavior and quality of life has grown. Encouragingly, there is a growing body of evidence indicating that Interactive Health Communication Systems (IHCSs)—including the Comprehensive Health Enhancement Support System (CHESS)—which is the focus of this study, contribute to significant improvements in quality of life, participation in healthcare decisions, and effective use of healthcare services for those facing life-threatening illness or chronic disease (Gustafson et al., 2001, 2002, 2005; Hawkins et al., 1997). For example, in one intervention study, Gustafson et al. (2001) compared CHESS group to a control group and found that women in the CHESS group had significant benefits, including competence in

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dealing with health information, comfort in participating in their health care, and greater confidence in their doctor. Furthermore, a more recent study by Gustafson et al. (2005) focused exclusively on low-income breast cancer patients. When women from this study were compared to a low-income control group from another study, the CHESS group also expressed significant improvements in social support, reduction in negative emotions, participation in health care, and competence in dealing with health information.

However, effects of CHESS or any other IHCS are generally demonstrated through experimental designs in which a whole group given access to such a system is contrasted with a control group with or without access to traditional modes of information such as audiotapes, videos, or books (i.e., an “intention-to-treat” approach that treats all members of an experimental group as equally exposed to that intervention regardless of whether they actually used it or not). Although such designs do test efficacy, they typically do little to explain how the effects occur. That different designs or additional analyses are necessary to probe processes and provide explanations is commonly understood throughout research on interventions, but several particularly important issues with IHCSs, all centering around “use,” deserve special attention. Clearly, a first concern with an intent-to-treat approach is that only some patients employ a system at all, and presumably only those who do so could be affected. But even within those who do access an IHCS, defining what constitutes “use” and especially what aspects of use are efficacious are much more subtle problems.

One common approach, borrowed from mass communication, tests for a simple monotonic relationship between amount of use of a system and likely effects (Pingree et al., 1996; Shaw et al., 2007). An implicit assumption of such an approach may be that more use will produce better health outcomes because it represents exposure to more IHCS content. Such an approach has long been recognized as problematic for many, though not all, effects of mass communication (Salomon & Cohen, 1978; Hawkins & Pingree, 1981; but note Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002). As with traditional mass media, one key reason this overall monotonic approach has not worked well to explain effects of IHCS is because such systems typically contain a variety of content, some of which may be more beneficial than others, and thus an overall amount of use has little practical meaning (Chory-Assad & Tamborini, 2003; Johnson, Braima, & Sothirajah, 2000).

For example, a qualitative study of HIV/AIDS patients' CHESS use (Smaglik et al., 1998) noted that many users who spent the most time with the system actually benefited very little or not at all, because their use was exclusively concentrated in the bulletin-board Discussion Group feature. In contrast, those who improved most from pretest to post-test used the system much less overall, but use of information-based services was a far higher proportion of their overall use. Thus, one key question for large and complex IHCSs is just which parts are beneficial; perhaps only parts of the whole system are necessary and could be provided to patients more cost effectively than the whole program.

Smaglik et al. (1998) further noted that successful users seemed to be focused and systematic in pursuing topics across multiple CHESS services and over time, rather than browsing or using the system on only a few occasions. While that observation was based on system use by only a few patients, it does suggest that *how* a patient uses a system may also be quite important. After all, unlike traditional and linear mass media such as television and radio, web content is not delivered uniformly to users in separate units of time (Jung, Qiu, & Kim, 2001). That is, IHCS users effectively create the content they use through searching, selecting portions of content and not others, taking things in their own order, and sending/receiving messages, all in accordance with personal interests (Newhagen & Rafaeli, 1996). And although it would be difficult to track this in practice, it is also likely that patients do so

individually in changing ways corresponding to the shifting information and support needs posed by their individual disease and treatment progression.

In fact, this underscores the more general idea that any knowledge gleaned from an IHCS is only potential, and benefits are contingent upon the activities of the user. What patients actually do within an IHCS is of critical importance, since the IHCS's effectiveness will largely depend on users' efforts to actively locate desired content and then to utilize such information and support for decision making and coping with their illness (Turk-Charles, Meyerowitz, & Gatz, 1997). Thus, as part of an effort to understand uses and effects of an IHCS, the current study employs diverse measures of IHCS use, distinguishing amount, type of content, and when and how that content is used as predictors of quality-of-life benefits during a CHESS intervention. This line of research inquiry is both theoretically and practically valuable as it increases understanding about what makes IHCSs effective, and provide insights about how systems can be enhanced to more effectively help those facing life-threatening illnesses.

Potential Content Variation: CHESS service types and processes

In order to provide insights about how women diagnosed with breast cancer use and benefit from a particular IHCS, the CHESS "Living with Breast Cancer" program, types of CHESS services along with explanations about what makes these types of services theoretically distinct, was further explicated. But because this IHCS is a system of many resources, ranging across the full gamut of the breast cancer experience, and is typically used by a patient repeatedly over time, classifying content as one might within a typical mass medium (e.g., entertainment vs. information, comedy vs. drama vs. reality, or distinguishing which topic was the subject of the exposure) seems likely to be less useful. Instead, we distinguish between three functional roles the computer system plays for the user. Table 1 summarizes these classifications.

Information services

Information services within CHESS are similar to the primary communication strategy used in most health-education Web sites. They are *user-driven* in the sense that the user is the primary determinant of where the individual goes and what the individual sees, and the computer is largely passive in the delivery of information to the user. Examples of this would be Library Articles or Frequently Asked Questions where the user asks to see articles on certain topics, or Personal Stories where the user can read about the experiences and thoughts of other individuals who faced the same sorts of challenges. The user selects these services, indicates the kind of information the individual wants, and the computer delivers the information via text, audio or video files. Therefore, we expect that use of Information services may primarily encourage learning and psychological competence in dealing with information and health care providers.

Communication services

Communication services serve a conversational function in which the computer links people so that they can communicate with one another. In this strategy, the computer serves as a link between people so that interpersonal functions such as support, teaching, and conversation may occur. Research indicates that emotional, informational, and instrumental support from others can be valuable to people coping with a chronic illness (Gray, Fitch, Davis & Phillips, 1997). Patients can not only share information about their own experiences with breast cancer so other women know what to expect, but also receive strong support from others as a result of others expressing understanding and empathy (Preece & Ghazati, 2001).

In CHESS, Discussion Group is a text-based, asynchronous bulletin board allowing users to anonymously share information and support. Historically, the Discussion Group service has consistently been by far the most frequently used service within CHESS (McTavish, Pingree, Hawkins & Gustafson, 2003). Groups are monitored by a trained facilitator to ensure that discussions are supportive and do not contain unchallenged inaccurate or harmful information, though the facilitator does not take an active role in guiding the topics of communication and very rarely intervenes. Communication services also include the ability to ask questions of a Cancer Information Specialist trained by the National Cancer Institute and receive a response within 48 hours. The CHESS expert is highly responsive to the user's particular life context and takes into account specific patients' individuality by encouraging them to make sense of the information they share relative to their own health context and set of concerns (Siegel, 2005). The motivations sought in utilizing these services are "interpersonal communication" where users seek gratifications from interacting with others (Lin, 2006), which in this case are breast cancer patients or a cancer information expert.

Interactive services

Here the computer takes a more active role in guiding the user, making suggestions, offering feedback, identifying deficits, and attempting to shape the user's behavior. Interactive systems use data about individuals to offer more appropriate feedback because they appraise computer users' particular contexts and/or preferences, and are characterized by their responsiveness to user actions and states (Rafaeli, 1988). In addition, the computer possesses expert knowledge. That is, it not only knows what is important to monitor and learn relative to identified goals, but it typically possesses information about strategies or tactics needed to achieve those goals. As Sims (1997) writes, interactivity can be viewed as a function of input required by the learner while responding to the computer, the analysis of those responses by the computer and the nature of the action by the computer. Further drawing from the interactivity literature, these services are differentiated by taking into account earlier interactions with users (Rafaeli & Sudweeks, 1997), allowing the system to provide feedback that evolves over time along with patients' goals and health status. Interactive services in CHESS include the following: Action Plan that helps women make healthy lifestyle changes such as eating a healthy diet; Decision Aid that empowers them to make treatment decisions based on their own values and priorities; Health Tracking that tracks patients' symptoms and psychosocial status over time; and Journaling that guides users through a series of guided writing exercises intended to help them make sense of their cancer experience and improve their mental health.

Assessing Variation in "When" and "How" Used

Much of the research on media use behavior as selection and as activity has come from the uses and gratifications perspective. According to this tradition, people are assumed to be intentional, selective, and thus strategic in their use of media (Blumler, 1979; Rubin, 1983). If particular media or contents are perceived as meeting the need, this perception leads to patterns of media use, as certain needs lead to using some types of media and not others (Palmgreen, Wenner, & Rosengren, 1985), as well as to differences in activities (Blumler, 1979; Lin, 1993). Rather than focusing on the needs, an issue relevant to this study is how to appropriately measure patterns of media use, which are assumed to be linked to differential effects. Previous research on television studies have employed various measures of media use and found that general exposure measures are weak predictors of viewers' behaviors and cognitions as compared to measures of exposure to particular content (Johnson et al., 2000; Potter & Chang, 1990).

To continue pursuing such relationships between patterns of IHCS use and outcomes, what is needed is a more specific level at which users' attitudes and expectations could be expected to guide use and activity. First of all, one can imagine employing a wide variety of time units to assess when and how patients use an IHCS (e.g., seconds, minutes, hours, days, day parts, etc.). Hawkins and Pingree (1997) argued that making choices here requires an evaluation not just of time frames of “use” itself, but also of the life cycles and contexts of the processes involved in the lives of the users. In the case of breast cancer patients, the key time periods should correspond with meaningful psychological and physical events in the history of the disease. For example, if the issue is whether and how a breast cancer patient has received needed social support from an eHealth intervention, one might construct measures of a service use that offers social support based upon a minimum time unit that also corresponds to the pace of change in a breast cancer patient's situation (e.g., periods of treatment or recovery from surgery).

Furthermore, it would seem from the Smaglik et al. (1998) study that key aspects of “how” patients use an IHCS will have to do with measuring commitment to the system and intensity of system use. Since patients who improved their quality of life showed continuity or consistency in their use of an IHCS (Smaglik et al., 1998), commitment here refers to maintaining an ongoing relationship with the system by pursuing content or dialogue over time. Intensity of use, or degree of focus and involvement within the system, is also critical as active and involved use of CHES tools was found to be a successful usage pattern (Smaglik et al., 1998).

Research Question

Given consistent research showing aggregate benefits of CHES interventions and qualitative research both suggesting considerable variation between individuals in these benefits and pointing to focused use as a possible explanation, the present study explores just what patterns of use are beneficial. While there have been some studies differentiating measures of television use and format (e.g., Johnson et al., 2000), few studies have systematically examined the issue within the context of IHCS. In the original analysis for the dataset used in this study, four health outcomes (i.e., participation in healthcare, health information competence, negative emotions, and social support) showed statistically significant improvements from pre- to post-test, and this study intends to unravel effective usage patterns of IHCS that may account for those promising effects. Thus, this study poses the following questions:

RQ₁: Does total time spent in both CHES overall and the three types of CHES services predict improvements in health outcomes (i.e., participation in healthcare, health information competence, negative emotions, and social support)?

RQ₂: Do measures of commitment to an IHCS predict improvements in health outcomes (i.e., participation in healthcare, health information competence, negative emotions, and social support)?

RQ₃: Do measures of intensity of an IHCS use predict improvements in health outcomes (i.e., participation in healthcare, health information competence, negative emotions, and social support)?

Methods

Data

The data analyzed in this study were collected as part of a larger Digital Divide Pilot Project (DDPP), in which underserved women (i.e., income being at or below 250% of poverty; for a single woman < \$21,475/year, family of 4 < \$44,125/year) with breast cancer in rural Wisconsin and Detroit, MI, were given access to CHESS for 4 months (Gustafson et al., 2005). Originally, the DDPP study was intended to examine the feasibility of reaching underserved breast cancer patients with an eHealth system and determine how they use the system and what impact it had on them. Of those 341 eligible patients who were initially recruited, 286 joined the study and 55 refused. Once a patient was referred to the study, a research team member explained the purpose of the study, reviewed eligibility criteria with the patient, and explained the risks and benefits of being involved, including that they would need to fill out pretest and post-test surveys, and that their computer use would be monitored. Subjects were paid \$20 for each completed survey.

Pretest and 4-month posttest surveys were collected from a sample of 231 patients (81% return rate from 286 subjects). 62.3% of the participants were Caucasian, 35.9% African-American women, and 1.7% other minorities. The sample had a mean age of 51 years and more than half of them reported at least some college education. On average, they had been diagnosed approximately 4 months ($SD = 130$, $Range = 758$ all in days) before the start of the DDPP study with more than two thirds of them being in the relatively early stages (I or II) of cancer. In addition, only about two fifths of the women had private insurance and about a quarter of them lived alone. Patients were identified through a variety of sources, including the National Cancer Institute's Cancer Information Service, hospitals and clinics, public health departments, and the Medicaid program. They were eligible if they were at or below 250% of the federal poverty level, within one year of diagnosis or had metastatic breast cancer, were not homeless, and were able to read and understand an informed consent letter. Over 80% of those joining study did not have a computer at home and had very limited experience with both computers and the Internet. All study participants were loaned a computer and given dial-up Internet access for 4 months. They also received personal training to learn how to use the computer and the Internet, but the majority of time was spent on learning how to use CHESS. To accrue all of 231 patients, Detroit recruitment started in June 2001 and ended in April 2003, and rural Wisconsin recruitment began in May 2001 and ended in April 2003.

Developing CHESS use measures

To keep track of patients' CHESS use, a browser developed by the research team automatically collected use data on an individual keystroke level as participants used the system. This enabled the team to track the user's code name, date, time, and URL of every Web page requested from the Web server. While a variety of web use statistics including hits, page views, or number of sessions have been generated from logs files and used to describe use of a system (Pingree et al., 1996), researchers have often faced both conceptual and methodological difficulties in using those log files for understanding more comprehensive portraits of use patterns of a system (Kurth, 1993; Nicholas & Huntington, 2003).

As noted earlier, Hawkins and Pingree (1997) proposed that “meanings of ‘computer use’ (and use of other mass media) can be distinguished by the life cycles of the processes involved, with some taking on rather different meanings and especially different theoretical roles at different cycle lengths” (p. 6). For example, comprehension of specific items of content probably occurs in times bounded by the onset and offset of a page viewed, and

other processes may best be understood as stemming from particular use sessions (the time from logon to logoff), whereas forming a relationship with others using the same bulletin board likely extends over multiple sessions with the computer. Thus, the choice of a particular time unit should be based on the particular processes and constraints of the theory itself, so that a resulting 'use' measure represents meaningful cycles and contexts in the lives of the users.

Applying this logic to the current context of women living with breast cancer, time units should correspond with the occurrence of meaningful psychological and physical events, treatments, or any crises in the history of breast cancer. Certainly, those experiences can be highly stressful and pose persistent challenges to patients' psychological, physical, and functional health (Pozo-Kaderman, Kaderman, & Toonkel, 1999), including dealing with particular treatments and related symptoms, coping with negative emotions and depression, and facing stressful events of negative changes in appearance and possible early death. This is not a simple process, because such events do not always have clear time demarcations. For instance, changes in a breast cancer patient's quality of life result from ongoing processes that are not always easily associated with particular minutes, hours or even days of media use. And a unit of months or even years may be more appropriate for studying the management of a chronic illness or condition, or in examining effects that occur during survivorship after treatments are complete.

However, given the typical pace of events during the several months after initial breast cancer diagnosis, it would seem that individual weeks and their combinations are both psychologically meaningful to most people and roughly correspond to the pace of change in a breast cancer patient's situation during treatment. The periods for chemotherapy or radiation treatments, or recovery times from surgery, are commonly described in small numbers of weeks. Other research also found that breast cancer patients have adjusted well a few weeks after their last round of radiation therapy in terms of both emotional recovery and overall quality of life (Deshields et al., 2005). Therefore, we constructed measures below by aggregating CHES log data collected moment by moment up to week-long units.

Coding framework

To construct "use" measures for this study, every user's weekly time spent by each service entry (e. g., Questions & Answers, Instant Library, Resource Guide, Resource Directory, Web Links, and Personal Stories for Information services) were first summarized and then combined by broader service categories (i. e., Information, Communication, and Interactive services), so that the combined data indicated how much time patients spent in each service category in a given week (CHES service categories and entries are summarized in Table 1). The other building block for constructing measures of use began by simply noting whether or not a woman logged into the system at all each week.

From these, an index of total time a woman used CHES, as well as total time in each of the service categories was first created. To assess aspects of commitment to the system over time, several measures based on which weeks saw any CHES use was created. Both for CHES overall and the three categories, *Span of Active Use* was the number of weeks between first and last use of the system (range 0–16). Given past research showing that system use is usually heavy for a few weeks and then tails off rapidly (Gustafson et al., 2001, 2005), a longer span implies greater perceived usefulness of and continuing commitment to the system. But because Smaglik et al. (1998) also suggested that ongoing repeated use of the system was important, we also identified the longest stretch of *Continuous Weeks of Use*. As a final measure of commitment, measures that were the proportion of weeks during which the patient made any use of CHES (*Proportion of Span*

Active) were created. Finally, *Average Time per Week* tapped intensity of use by dividing total time by the number of weeks containing any activity.

It was originally intended to employ all four of these measures both for CHESS overall and for each of the service categories. While correlations between the Average time variables across categories were weak or at most moderate, very high correlations between the three Span variables ($.68 \leq r \leq .86$), between the three Continuous Weeks variables ($.47 \leq r \leq .56$), and between the three Proportion variables ($.39 \leq r \leq .49$) (see Table 3) were noted. In retrospect, this was not surprising given the nature of these measures, all derived from which weeks saw computer access. But because of this, only versions of these three measures for CHESS overall rather than the three content types were used, and only separate service categories for the Average Time measures were employed. When use measures were positively skewed, the logarithms (after adding 1 minute to all scores to eliminate non-loggable zeros) were used in the subsequent analyses, although means reported are still in the original metric.

Dependent variables

This study employed four primary health outcome measures: participation in health care, health information competence, negative emotions, and social support. These outcomes have been widely tested and demonstrated in terms of reliability, validity, and responsiveness to clinical change (Brady et al., 1997; Gustafson et al., 2001, 2002, 2005). See Appendix for the exact wording of all the items belonging to these scales.

Participation in health care—A 9-item scale (pretest $M = 3.05$, $SD = .56$; posttest $M = 3.26$, $SD = .52$; $|t| = 6.55$, $p < .001$) developed in previous research (Gustafson et al., 2001, 2005) measured women's comfort and confidence dealing with physicians, other medical personnel, and health-care situations. On a 5-point scale ranging from 0 = *disagree very much* to 4 = *agree very much*, respondents were asked whether they agreed or disagreed with statements such as, "I am comfortable discussing my treatment choices with my doctor". Those scores were averaged to construct an index for participation in health care (pretest $\alpha = .81$, posttest $\alpha = .85$).

Health information competence—Based on measures in previous studies (Gustafson et al., 2001, 2005), a health information competence scale (pretest $M = 2.37$, $SD = .69$; posttest $M = 2.86$, $SD = .60$; $|t| = 10.58$, $p < .001$) assessed a woman's perception of availability and use of health information (pretest $\alpha = .75$; posttest $\alpha = .79$). It was created using five items that asked, on a 5-point scale ranging from 0 = *never* to 4 = *always*, whether they agreed or disagreed with statements such as "I know exactly what it is that I want to learn about my health care".

Negative emotions—A 10-item negative emotions scale (pretest $M = 2.65$, $SD = .83$; posttest $M = 2.22$, $SD = .75$; $|t| = 7.88$, $p < .001$) used in previous CHESS studies (Gustafson et al., 2001, 2005) asked, on a 5-point scale ranging from 1 = *never* to 5 = *always*, how often patients had felt each of a number of emotional states during the past month (e.g., "angry") (pretest $\alpha = .91$, posttest $\alpha = .90$).

Social support—Social support (pretest $M = 2.93$, $SD = .87$; posttest $M = 3.05$, $SD = .79$; $|t| = 2.31$, $p < .05$) (Gustafson et al., 2001, 2005) was created using six items (pretest $\alpha = .87$, posttest $\alpha = .86$) that asked respondents, on a 5-point scale ranging from 0 = *not at all* to 4 = *very much* items such as "there are people I could count on for emotional support".

Results

As Table 2 shows, these low-income breast cancer patients averaged over 700 minutes on the system over the 4-month intervention, although the distribution was highly skewed by some very heavy users. When averaging only for weeks containing any use of the system, women spent about 75 minutes per week and the median user spent nearly 47 minutes per week, so that most women clearly made satisfactory use of the system. This use also represented substantial commitment, as they averaged about 8 weeks between first and last use of CHESS, about half the maximum possible, and their longest stretch of continuous use (adjacent active weeks) averaged more than 5. During weeks the women used CHESS, Communication services (primarily Discussion Group) accounted for most of time on the system (about 75%), and this also was highly skewed, with the mean nearly double the median. Use of Information services accounted for another 15% of the use, but this was much more normally distributed among the women. Interactive services averaged 8% of the women's time during active weeks, and this was again skewed by a minority of heavier users.

Table 3 presents zero-order correlations among all CHESS use measures and shows that most of them are moderately or highly correlated with each other. Correlations among total CHESS use statistics (i.e., Total Time, Average Time (week), Span of Use, Weeks of Continuous Use, and Proportion of Span Active) were moderate or high ($.19 \leq r \leq .92$) because patients spending more time in CHESS are also likely to use it for a longer period, in a continuing, and in a higher proportional way. In particular, correlations between Communication service use and measures of total CHESS use were also mostly significant and consistent, and this is because patients spent more of their time in Communication services than in the other two services combined (see Table 2). Average Time per Week was related for two of three combinations ($r = .26$ and $.44$) but not between Information and Communication ($r = .08$).

Because heavy users are likely to use more of any type of service, partial correlation analyses to examine the relative contributions of using categories of CHESS services were employed. That is, these correlations examine selectively using a service by controlling for overall CHESS use (as measured by total time spent in CHESS) (see Hawkins & Pingree, 1981 for a similar approach). Therefore, correlations in the middle and bottom sections of Table 4 reflect using more or less of CHESS services than one's overall level of use would predict. Additionally, for every partial correlation analyses reported here, a group of control variables such as age, education, race, private insurance, living alone, stage of cancer, number of days between diagnosis and CHESS intervention, and the pretest score of the dependent variable were included. Controlling the prior levels of dependent variables focuses the analysis on intervention-related change in levels of the dependent variables rather than on their absolute levels.

To begin with, the top row of Table 4 makes it clear that total time spent in CHESS was not significantly related to changes in outcome variables, indicating that total time with the system does not predict benefits. However, spending more or less time with the three types of CHESS services than expected from overall time with CHESS (i.e., selective use) was related to positive changes in outcomes: all three services for participation in health care, for Information and Interactive for health information competence, and only to Interactive for social support. None of these measures of selective use predicted change in negative emotions.

Despite a completely different conceptualization and metric, the three overall indices of commitment (Span of Weeks from first to last use, Number of Continuous Weeks, and

Proportion of Span Active) showed a similar and consistent pattern of significant relationships to improvements in three outcome measures: participation in health care, health information competence, and social support. These were significantly related in eight of nine instances (Span of weeks correlated $r=.09$, ns , with increase in social support). Notably, however, none of the measures of commitment were significantly related to decreases in negative emotions. Intensity of use, as measured by average time spent on CHESS during weeks of any activity, was significantly related only to health information competence ($r=.15$, $p<.05$). Because the Intensity measures were not highly correlated between the three CHESS service types, Table 4 also presents Intensity results separately for the three. The relationship to health information competence for overall intensity results from higher average times per week of Information ($r=.23$, $p<.01$) and Interactive ($r=.22$, $p<.01$) components of CHESS, but not for Communication ($r=-.08$, ns). Instead, relatively intense use of Communication, as indexed by higher average time per week, was significantly associated with reductions in negative emotions ($r=-.18$, $p<.05$).

Discussion

This study investigated how CHESS achieved quality-of-life effects for breast cancer patients by developing measures capturing important aspects of patients' use behaviors within the computer-based IHCS. Besides the typical measure of total amount of use, this study also investigated other types of IHCS use metrics including different types of content (Information, Communication, and Interactive), several different operationalizations of continuing commitment to using the system, and intensity of system use. Summarizing these findings gives insights into what it is about IHCS "use" that does and does not matter for improving quality of life for breast cancer patients. Despite past qualitative research on the limits of overall time of use, we were still surprised to find total time using the whole system (implicitly a measure of amount of exposure to system content) unrelated to changes in any of four outcome measures (See Chory-Assad & Tamborini, 2003 for a similar finding in television research). Apparently, despite a clear overall group advantage over controls that must stem in some way from what the system provided, some breast cancer patients might improve after relatively little time with the system, while others gain little from extensive use, leaving no overall impact of total time spent.

No effect of total time leaves the possibility that some kinds of content are more beneficial than others, which was pursued by separating use into three kinds of services. Because those who spent more time with each of Information, Communication, and Interactive services also used the system more overall ($.38 \leq r \leq .57$), total time of use had to be controlled, which has the useful effect of producing measures of *selectively* using more or less of that content than predicted by overall times. These results from the top of Table 4 require some care in interpretation. Since all three types of content are significantly positively related to increased participation in health care, this cannot just stem from the content per se—using more than predicted of one would necessarily have to be compensated by using less of one or both of the other two, given the correlations near zero for total time. Instead, it would seem that participation in health care was enhanced by positive selection itself. In contrast, experiencing improved social support does seem tied to a particular kind of content, though it was selectively using more of the Interactive features of the IHCS itself, rather than Communication with other patients or with a cancer information specialist.

Given this distinction between purely selective versus content-specific explanations, results for health information competence are intermediate and ambiguous, since more time with Information and Interactive services were related but Communication was not. It may simply be that the non-significant positive correlation ($r=.13$) for Communication is part of the same overall pattern of selection-regardless-of-content seen with participation with

health care. But the correlations for Information and Interactive content are considerably higher (both $r = .27$), which could also indicate that what content is actually experienced during this time matters as well.

Moving from content to measures of *how* patients used the system, the three alternative operationalizations of commitment were very similarly related to improvements in three of the outcome measures. Eight of nine correlations were significant for participation in health care, information competence, and social support. One could make an argument for the number of Continuous Weeks as the strongest indicator of commitment (average $r = .19$ vs. $.17$ for Proportion, and $.15$ for Span), but the real point here is that improvements in patient status were linked to a commitment to use the system over weeks of time, independent of how much time they spent on the system. Intensity of system use (minutes per active weeks) presents a clear contrast to the pattern discussed above, in that overall Intensity was positively related only to health information competence. Breaking this down by service type revealed that intensity of Information or Interactive content use was associated with increased competence, with no effect of how intensely Communication services were used. However, intense use of Communication was associated with decreased negative emotions, the only significant relationship for this outcome across all use measures tested, despite significant change in the overall group and consistent effects in experimental studies of this IHCS.

Overall, what the results most strongly say about effective IHCS is that it depends on *how* a patient uses the system far more than on sheer amount of exposure or even what type of content is chosen. Commitment consistently improved status on three of four outcomes. This commitment, of course, does not exist independent of content. Consider that as a woman experienced a breast cancer diagnosis, chose between treatment options, experienced surgery and follow-up treatment and their consequences and side effects, dealt with uncertainty and fears of many different kinds, and struggled to maintain personal relationships and find sources of support, her needs were intense, wide-ranging, and probably changed continually over time. In the context of a rich and integrated health care system such as CHES, different content within the system met the varying needs of patients at different phases (Walther, Pingree, Hawkins, & Buller, 2005). Thus, besides reflecting patient commitment to the system, these results very likely reflect exposure to more diverse kinds of help within the CHES system.

As a matter of policy for CHES and other IHCSs, achieving user commitment deserves attention on its own. Although CHES staff provided substantial training in how to use computers to access health information and support, a rich and varied system may still be difficult to navigate efficiently, especially for underserved patients who may also have limited computer experience. These results indicate that training should emphasize the benefits of continued and repeated use. More importantly, however, in the long run commitment will have to be stimulated by IHCS design itself. That is, developers clearly need to focus more on what commercial websites call “stickiness.” The next generation of systems should focus on providing new and varying content over time, but even more on providing continuity from session to session by providing queries and responses that ‘remember’ the user from session to session.

Results for selective use of content are also interesting and useful. For participation in health care, the predictor of improvement is a user's selection of something, with the nature of that something appearing less important. This is different from commitment, though it may be a good companion. Whereas commitment refers to aspects of returning to a system over time, selectivity is a content-based (albeit any content-based) focus within the system. It may well be that such selection leads to either greater attention to or involvement with the content

chosen and that these are what produce the greater benefits. However, for health information competence, it seems that the “what” of use matters because only information and interactive service use were significantly correlated with the outcome.

Although the commitment and selectivity results here are mostly just about the user's behavior rather than the nature of the system or its content, this should not be misunderstood. Any commitment or selection is necessarily a result of an *interaction* between users and what they find within system features and content. Continued use over weeks of time almost certainly results from the user finding either repeatedly rewarding similar content (perhaps continuing interaction with Discussion Group participants), or satisfying some particular need and then repeatedly finding newly-useful content as their needs evolve with the progression of treatment and recovery. However, intensity of use (a high average number of minutes for the weeks in which there was any use) should probably be understood somewhat differently. It is, after all, based on overall time, or amount of exposure to content. But by averaging only for weeks containing any use at all of the system, intensity measures more specifically tap the degree to which users do or do not spend concentrated amounts of time with portions of the system. Such concentration seems much more specific in its effects on some outcomes and not others, and by some CHES services and not others.

One further set of insights concerns the outcome measures employed here. Other aspects of patient behavior may well be affected by a particular IHCS, but those employed here had both shown significant effects and prior randomized-control trials of CHES (Gustafson et al., 1999, 2001), and significant pre-post improvement by the non-experimental trial with the same sample of disadvantaged women studied here (Gustafson et al., 2005). Increases in participation in one's health care (i.e., interactions with clinicians), a sense of competence about managing one's health both in crisis and in general, and experiencing greater social support were all associated with commitment to system use over time, and the first two also showed greater improvements for users more selective in general. Among these, the only clear link to specific content was for social support, where increases came with using more of CHES Interactive content than expected from the total time of use, which is a consistent finding from television studies supporting measures of exposure to particular content rather than overall exposure (Johnson et al., 2000; Potter & Chang, 1990). Although social support was initially expected to be stimulated by Communication content (largely a Discussion Group between patients, which accounted for the majority of overall system use time), it seems instead that the interactivity and social presence (Lee, 2004; Walther et al., 2005) provided by the back-and-forth feedback, and individual advice provided by these services was more important in accounting for social support.

The association between decreased negative emotions and more-intense use of Communication services was not surprising in itself—disclosure by writing has repeatedly been shown effective for dealing with emotional distress (Pennebaker, 1997; Shaw, Hawkins, McTavish, Pingree, & Gustafson, 2006). And women who disclose in CHES Discussion Groups typically receive prompt responses from others offering their own experiences, suggestions for coping techniques, and general emotional support (Shaw, McTavish, Hawkins, Gustafson, & Pingree, 2000). But it is revealing that it is intensity rather than selecting Communication content—apparently concentrating effort on these issues within a narrower range of weeks does matter. And the other surprising thing here is that this is the only predictor of decreased negative emotions that the current study was able to discern. Given how consistently this benefit has been reported in CHES studies, one has to suspect that other ways of measuring computer use remain to be discovered.

Of course, this study has several limitations. One limitation of this study is that the sample is comprised solely of underserved breast cancer patients. While this is a worthy population to identify effective use and impact of eHealth interventions for, and the sorts of processes examined here seem likely to replicate elsewhere, the degree of generalization to other populations remains to be tested. Second, due to the nature of correlational analysis, it should be also noted that this study cannot determine whether different patterns of an IHCS usage actually cause the changes in outcomes or are simply reflecting such changes. It is also possible that, for example, as their competence in dealing with information increases, they use Information services more intensely. However, not only the pretest scores but a number of background variables were controlled to rule out potential confounding effects from differences in baseline scores. Finally, while the three categories of services are theoretically distinct, future research should look more closely at what specific services within each category produce more or less benefits as this will provide more granular insights than those generated by this study.

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Appendix: Question Wording

Participation in health care, a 9-item scale. All items were scored on a 5-point scale ranging from 0 = *disagree very much* to 4 = *agree very much*.

1. I can manage my own care and be sure that the right treatment is given
2. I am comfortable discussing my treatment choices with my doctor
3. I am able to be assertive with my doctor
4. Having information about my breast cancer, treatment, and prognosis gives me a sense of control
5. I prefer to have all the details (including possible risks) regarding my breast cancer and treatment options
6. I feel comfortable in asking the physician or nurse a lot of questions
7. I feel confident in making decisions about my breast cancer
8. I have confidence in my doctors
9. I know what questions to ask my doctor.

Health information competence, a 5-item scale. All items were scored on a 5-point scale ranging from 0 = *never* to 4 = *always*.

1. I know exactly what it is that I want to learn about my health care
2. I can figure out how and where to get the information I need
3. Health information is more difficult for me to obtain than other types of information (reverse coded)
4. I am satisfied with the way I currently learn about health issues
5. I feel that I am in control over how and what I learn about my health.

Negative emotions, a 10-item scale. All items were scored on a 5-point scale ranging from 1 = *never* to 5 = *always*. How often patients had felt each of the following during the past month;

1. helpless
2. tense
3. loved/cared for (reverse coded)
4. angry
5. hopeless
6. worried
7. supported (reverse coded)
8. frustrated
9. sad
10. anxious

Social support, a 6-item scale. All items were scored on a 5-point scale ranging from 0 = *not at all* to 4 = *very much*.

1. There are people they could count on for emotional support
2. There are people who will help them understand things they are finding out about their illness
3. There are people they could rely on when they need help doing something
4. There are people who can help them find out the answers to their questions
5. There are people who will fill in for them if they are unable to do something
6. I am pretty much all alone (reversed).

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Biographies

Jeong Yeob Han (Ph.D., University of Wisconsin) is an Assistant Professor in the Department of Telecommunications and a faculty member with the Center for Health and Risk Communication at the University of Georgia. His research interests include the design and evaluation of interactive health communication campaigns, the benefits of online social support groups for cancer and other health-related cognitions and behaviors, and statistical methods and research design.

Robert P. Hawkins (Ph.D., Stanford University) is Professor Emeritus in the School of Journalism and Mass Communication and Research Professor with the National Cancer Institute-funded Center of Excellence in Cancer Communication Research at the University of Wisconsin-Madison. His research examines processes and effects of interactive health communication.

Bret R. Shaw (Ph.D., University of Wisconsin) is an Assistant Professor with the Department of Life Sciences Communication and a researcher with the National Cancer Institute-funded Center of Excellence in Cancer Communication Research at the University of Wisconsin-Madison. His recent research has focused on how people with chronic health conditions benefit from online support and tailored information systems.

Suzanne Pingree (Ph.D., Stanford University) is Professor Emerita in the Department of Life Sciences Communication and a researcher with the National Cancer Institute-funded Center

of Excellence in Cancer Communication Research at the University of Wisconsin-Madison. Her research examines processes and effects of interactive health communication.

Fiona M. McTavish (M.S., University of Wisconsin) is the Deputy Director of the Center for Health Enhancement Systems Studies at the University of Wisconsin - Madison. Her research focuses on how people use the web for information, support and decision making when faced with health issues.

David H. Gustafson (Ph.D., University of Michigan) is a Research Professor in the College of Engineering and Director of the National Cancer Institute's Center of Excellence in Cancer Communication at the University of Wisconsin-Madison. His research interests include decision, change and information theory applied to health systems and the design and evaluation of systems and tools to help individuals and organizations cope with major changes.

Table 1
CHESS service categories and entries

Service/Entries	Description
Information Services	
Questions & Answers	<ul style="list-style-type: none"> • short answers to hundreds of frequently asked breast cancer questions
Instant Library	<ul style="list-style-type: none"> • full articles on breast cancer topics
Resource Guide	<ul style="list-style-type: none"> • descriptions, identifying a good provider, being an effective consumer of key health services
Resource Directory	<ul style="list-style-type: none"> • descriptions of and ways to contact breast cancer and social service organizations
Web Links	<ul style="list-style-type: none"> • links to selected health and non-health Internet sites
Personal Stories	<ul style="list-style-type: none"> • real-life text and video accounts of how others coped with breast cancer
Communication Services	
Discussion Groups	<ul style="list-style-type: none"> • limited access, facilitated bulletin boards for small groups of patients and families
Ask an Expert	<ul style="list-style-type: none"> • confidential expert responses to patient questions
My Friend	<ul style="list-style-type: none"> • recently diagnosed users communicate with more experienced cancer survivors
Interactive Services	
Assessment	<ul style="list-style-type: none"> • emotional status measures; tailored advice on coping
Health Tracking	<ul style="list-style-type: none"> • tracks health status; links material addressing specific health concerns
Decision Aid	<ul style="list-style-type: none"> • options, values and consequences for key decisions
Action Plan	<ul style="list-style-type: none"> • examines plans for change; suggests ways to overcome obstacles
Journaling	<ul style="list-style-type: none"> • guides women through a series of guided writing exercises

Table 2
Descriptive statistics of CHESS use measures

	<i>Mean</i>	<i>Median</i>	<i>Std. Deviation</i>
Total CHESS use			
Time spent in CHESS (minutes)	730.90	218.51	1559.68
Average time per week (minutes)	75.14	47.73	102.42
Span of active use (last – first weeks)	8.36	8.00	6.13
Continuous weeks of use	5.07	3.00	5.21
Proportion of span active (weeks)	.80	1.00	.31
Individual CHESS service use			
Information:			
Average time per week (minutes)	13.53	10.11	12.90
Communication:			
Average time per week (minutes)	67.70	36.69	99.04
Interactive:			
Average time per week (minutes)	7.06	3.69	9.21

Table 3

Zero-order correlations among CHES use measures

	Total CHES use				Information		Communication		Interactive	
	Total time	Average time	Span	Continuity	Proportion	Total time	Average time	Total time	Average time	Total time
Total time	1									
Average time (week)	.92**	1								
Span of active use	.38**	.32**	1							
Continuous weeks	.54**	.47**	.78**	1						
Proportion of span active	.19**	.27**	.34**	.45**	1					
Total time	.38*	.43**	.61**	.56**	.38**	1				
Average time (week)	.14**	.21**	.01	-.01	.02	.81**	1			
Total time	.57**	.60**	.80**	.83**	.43**	.56**	.06	1		
Average time (week)	.61**	.68**	.42**	.54**	.06	.29**	.08	.92**	1	
Total time	.48**	.52**	.67**	.66**	.33**	.71**	.35**	.70**	.49**	1
Average time (week)	.23**	.37**	-.01	.07	.03	.40**	.44**	.20**	.26**	.82**

Note:

* $p < .05$

** $p < .01$

Table 4
Partial correlation analyses of CHESS service use predicting changes in patients' health outcomes^a

	Participation in health care	Health information competence	Negative emotions	Social support
Total Time Used				
All CHESS ^b	.07	.06	-.07	-.05
(Controlling for total time spent in all CHESS)				
CHESS Service Types				
Information ^b	.24 **	.27 **	-.06	.08
Communication ^b	.17 *	.13	-.09	.06
Interactive ^b	.18 **	.27 **	-.08	.15 *
Commitment/Intensity				
Commitment (All CHESS)				
Span of active use ^b	.21 **	.14 *	-.05	.09
Number of continuous weeks ^b	.22 **	.18 *	-.05	.17 *
Proportion of span active	.15 *	.22 **	.03	.15 *
Intensity (All CHESS)				
Average time spent per week ^b	-.03	.15 *	-.02	.06
Intensity (CHESS service types)				
Information				
Average time per week ^b	.03	.23 **	-.10	.06
Communication				
Average time per week ^b	-.07	-.08	-.18 *	-.10
Interactive				
Average time per week ^b	.03	.22 **	-.08	.11

Note:

^aFor all analyses, we controlled age, education, race, live alone, private insurance, stage of cancer, number of days between diagnosis and intervention, and pretest score of the dependent variable.

^bUse measures were log-transformed due to the positive skewness of the distribution.

*
 $p < .05$

**
 $p < .01$

$N = 179-220$.