Journal of Health Communication
International Perspectives

ISSN: 1081-0730 (Print) 1087-0415 (Online) Journal homepage: http://www.tandfonline.com/loi/uhcm20

How Cancer Patients Use and Benefit from an Interactive Cancer Communication System

Jeong Yeob Han, Robert Hawkins, Timothy Baker, Dhavan V. Shah, Suzanne Pingree & David H. Gustafson

To cite this article: Jeong Yeob Han, Robert Hawkins, Timothy Baker, Dhavan V. Shah, Suzanne Pingree & David H. Gustafson (2017): How Cancer Patients Use and Benefit from an Interactive Cancer Communication System, Journal of Health Communication, DOI: 10.1080/10810730.2017.1360413

To link to this article: http://dx.doi.org/10.1080/10810730.2017.1360413

Journal of Health Communication, 00: 1–8, 2017
Copyright © Taylor & Francis Group, LLC
ISSN: 1081-0730 print/1087-0415 online
DOI: https://doi.org/10.1080/10810730.2017.1360413

Routledge
Taylor & Francis Group

How Cancer Patients Use and Benefit from an Interactive Cancer Communication System

JEONG YEOB HAN[1], ROBERT HAWKINS[2], TIMOTHY BAKER[2], DHAVAN V. SHAH[2], SUZANNE PINGREE[2], and DAVID H. GUSTAFSON[2]

[1]*Department of Advertising and Public Relations, Grady College of Journalism and Mass Communication, University of Georgia, Athens, Georgia, USA*
[2]*Center for Health Enhancement Systems Studies, University of Wisconsin-Madison, Madison, Wisconsin, USA*

Despite the mounting evidence of efficacy of eHealth interventions, their mechanisms of action remain unknown. The current study analyzed patient log data as each patient engaged in an eHealth system called the Comprehensive Health Enhancement Support System (CHESS) and reports on how patients engage with different combinations of eHealth services over time. Newly diagnosed breast cancer patients ($N = 443$) were given access for 6 months to one of four different configurations of CHESS: (1) Information, (2) Information and Support, (3) Information, Support, and Coaching (Full CHESS), and (4) Full CHESS and Mentor. Besides a baseline survey, three follow-up posttests were administered. Action log data on how patients engaged with the CHESS were also collected and merged with surveys to examine how patients benefit during the cancer experience. The findings suggest that usage patterns were not competitive, implying that cancer patients' access to more complex tools generates more use with their time spreading out over the diverse services. Despite overall decline in usage rates, it was less severe in Full CHESS and Mentor condition, suggesting that communication functions drive long-term engagement with the system. Notably, the strongest relation between use and cancer information competence appeared late in the follow-up period.

Our society is moving to a new era where patients play an active role in their health care and decision-making. The patient-centered healthcare paradigm is well reflected in an announcement of "meaningful use" stage 2 standards by the Centers for Medicaid and Medicaid Services (U.S. Department of Health & Human Services, 2012). While the stage 1 standard focused on the collection, sharing, and management of electronic health records (EHR), stage 2 includes new guidelines intended to "promote patient engagement by giving patients secure online access to their health information" (U.S. Department of Health & Human Services Web site, 2012). Access to their EHR can potentially provide many beneficial outcomes for patients, including improvement in their health situation and knowledge, participation in healthcare decisions, and effective use of healthcare services. However, this potential depends on how effectively the EHR and other eHealth resources are used. Simply concluding that any emerging communication technology will be valuable can pose a real problem for developing better resources and enhancing benefits for patients (Baker et al., 2011).

Interactive cancer communication systems (ICCSs) represent one effort to build up the foundation for electronic medical communication systems such as the EHR. ICCSs are usually Internet-based eHealth resources, which provide information about cancer and its treatment, and other support functions, including emotional coping, behavior change, social support, and decision-making assistance (Baker et al., 2011). Most ICCSs are typically complex, particularly ones that intended to be user-centered, and rely on the interplay between individuals and interactive tools. Recent research has focused on adoption (van den Berg, Peters, Kraaijeveld, Gielissen, & Prins, 2013; van Gemert-Pijnen, Kelders, & Bohlmeijer, 2014), implementation (Baker, Gustafson, & Shah, 2014; van den Berg et al., 2013), and evaluation of patient-centered eHealth systems (Badr, Carmack, & Diefenbach, 2015; Sieverink, Kelders, Braakman-Jansen, & van Gemert-Pijnen, 2014; van den Berg et al., 2013; van Gemert-Pijnen et al., 2014), as well as mental and psychosocial benefits for individuals when interventions incorporate the varied eHealth resources and tools (van Gemert-Pijnen et al., 2014). Despite mounting evidence of their efficacy, less is known about when and under what conditions specific eHealth resource contribute to beneficial outcomes for patients, especially when combined with other useful resources and tools, one of the key features of ICCSs. To advance our understanding of the mechanisms of action, this study explores (a) how patients respond to different configuration of an ICCS and its content, and (b) how they obtain psychosocial benefits from varied ICCS resources. The current research addresses these questions by analyzing survey and action log data collected from two large clinical trials using an ICCS called the Comprehensive Health Enhancement Support System (CHESS).

Address correspondence to Jeong Yeob Han, Department of Advertising & Public Relations, Grady College of Journalism and Mass Communication, The University of Georgia, Athens, GA 30602-3018, USA. E-mail: jeonghan@uga.edu

eHealth Intervention and Its Evaluation

There is a body of evidence signifying that eHealth resources and tools contribute to various encouraging outcomes for women with breast cancer (Han et al., 2009; Gustafson et al., 2001; van Gemert-Pijnen et al., 2014; Ventura, Öhlén, & Koinberg, 2013). In an integrative review of supportive eHealth interventions for patients diagnosed with cancer, Ventura et al. (2013) found that, despite differences in design, implementation, and evaluation across eHealth services, such interventions generally contribute to positive outcomes for individuals with different needs. Previous studies regarding the efficacy of ICCSs have also documented significant improvements in emotional/functional well-being, coping, participation in healthcare decisions, and effective use of healthcare services for those facing life-threatening or chronic disease (Gustafson et al., 2008; Hawkins et al., 2010, 2010).

While research attention has been paid to the adoption (van den Berg et al., 2013; van Gemert-Pijnen et al., 2014), implementation (Baker et al., 2014; van den Berg et al., 2013), and evaluation (Badr et al., 2015; Ventura et al., 2013) of eHealth systems, it often fails to identify how individuals actually use such systems for health care and benefit from them. Effectiveness of eHealth systems is generally validated through experimental designs where an experimental group given access to such systems is compared with a control group without access or with access to different modes of information acquisition such as Internet, videos, or books. Even though such designs do test effectiveness, they typically do not explain how the effects take place or how individuals respond differently to often very complicated eHealth components. Thus, additional analyses are required to probe mechanisms and offer explanations, paying particular attention to a key issue around “actual use” of eHealth systems (Han et al., 2009; Han et al., 2010; Jones, Weiner, Shah, & Stewart, 2015; van Gemert-Pijnen et al., 2014). Such insight is of critical importance since the efficacy of ICCSs or any other systems will mainly rest on each individual’s effort to locate desired content corresponding to his or her specific needs (Turk-Charles, Meyerowitz, & Gatz, 1997).

Encouragingly, recent studies began to examine how patients interact with eHealth systems using an assessment of actual use in the context of depression (van Gemert-Pijnen et al., 2014), cardiac disease or diabetes (Jones et al., 2015), cancer survivorship (van den Berg et al., 2013), and breast or prostate cancer Han, 2011; Han et al., 2009; (Ruland et al., 2013). Earlier, Han and colleagues (2009) developed a number of use measures distinguishing amount, type of content, and when and how that content is used and examined how different patterns of use were associated with quality of life benefits during an eHealth intervention. Extending the line of inquiry, the current study aims to fill the gap in research by examining differential uses and effects when providing users different configurations of ICCS components.

ICCS Use and Its Effects on Psychosocial Health Outcomes

Past research documented that *information seeking*, “the purposive acquisition of information from selected information carriers” (Johnson, 1997, p.26), could enhance better coping with disease-related challenges and adopting healthy behaviors (Johnson, 1997). Research has also supported that use of online health information and support services through searching and browsing behaviors enhances the overall quality of life and reduces emotional and psychological problems for women living with breast cancer (Han, 2012). Given that online environment typically requires users to click, select, and comprehend the hypertext links and contents, encouraging user activity and selectivity has been regarded as key factors in successful eHealth campaigns using more complex eHealth systems (Han, 2012).

In this regard, the uses and gratifications perspective provides a useful framework for research on eHealth resource use and subsequent effects. According to this perspective, individuals are purposeful, selective, and strategic in their choice and use of media and content (Blumler, 1979; Rubin, 1983). If certain eHealth tools are perceived as fulfilling the need, this perception leads to amount and/or patterns of use, as particular needs lead to using some forms of tools /content but not others (Han, 2012; van Gemert-Pijnen et al., 2014), as well as to differences in usage (Ruland et al., 2013). Yet, several studies on the use of eHealth systems have been published, with relatively few studies paying attention to the possibility that differential use of eHealth systems can lead to difference in health outcomes (for example, van Gemert-Pijnen et al., 2014). Given eHealth systems typically include more than one resource, it is necessary to explore which component(s) are most effective by linking usage of specific component to patient’s outcomes.

Research Questions

The purpose of this study is to investigate how cancer patients engage with different ICCS tools and obtain benefits from them. Therefore, issues pertinent to the current study are (1) how individuals respond to different configuration of an ICCS and its content, thus leading to difference in use activity, and (2) how such use activity explains differential effects on its users. Given a body of research indicating aggregate benefits of eHealth interventions and previous research both suggesting substantial difference between individuals in these benefits and pinpointing ‘use’ as a conceivable explanation, our first research question examines differences in use across the four conditions where cancer patients receive an access to a whole or part of CHESS services (RQ1): (1) CHESS Information, (2) CHESS Information + Support, (3) CHESS Information, Support, and Coaching (or Full CHESS), and (4) Full CHESS + Mentor (detailed description regarding these four conditions is provided in Methods section). Next, to tap another aspect of differential usage from ICCS tools, the second research question examines whether the four conditions differ in terms of their pattern of change in use over time (RQ2). Finally, we propose the third research question to examine how cancer patients’ engagement with overall and particular service types related to their perceived health benefit of cancer information competence (RQ3).

Methods

Study Overview

The data analyzed in the current study were collected as a part of two larger clinical trials in which women with breast cancer were given access to different configurations of ICCS tools. CHESS was chosen as the ICCS for study because, compared to other candidate ICCSs, it contains a comprehensive range of services, permitting suitable services coverage, and there is evidence to support that its services are of high quality, and contribute to improvements in knowledge, quality of life, coping, healthcare decisions, and effective use of healthcare services (Gustafson et al., 2008; Hawkins et al., 2010, 2010). The breast cancer module within CHESS is an Internet-based integrated eHealth system that provides patients and their families with a range of conceptually distinct services: Information, Support, and Coaching. This integrated system of services is one that offers a spectrum of eHealth resources and services that provide not only (a) wide range of information that the user is interested in, but also (b) interpersonal links that patients can communicate about their symptoms and experiences with providers. It also combines (c) the computer-user collaboration where the computer is programmed with expert information, and guide and teach the user in a collaborative manner. Unlike a broader concept of integrated eHealth systems that aims to bridge gaps between healthcare sectors, healthcare professionals, and patients with the use of technology, the current system is designed to integrate multiple eHealth resources and tools into a comprehensive delivery systems for information and support, with services complementing each other and together attempting to speak to almost all the needs of breast cancer patients (Baker et al., 2011).

More specifically, CHESS Information services offer a great volume of breast cancer-related information and their content comprises brief, easy-to-understand extracts with regard to living with breast cancer, along with articles and guides. CHESS Support services provide a conversational forum where patients can communicate via the computer to share their own breast cancer experiences with other women and a cancer expert and learn what to anticipate, but also to receive informational and/or emotional support from others as a result of expressing understanding and empathy (Han et al., 2011). In CHESS Coaching services, the computer uses data about individuals to provide tailored feedback by appraising users' specific contexts and/or preferences (see Baker et al., 2011 for more detailed discussions on each service). Both clinical trials employed all or part of CHESS services, along with the Internet control condition.

The first clinical trial (Baker et al., 2011) randomly assigned breast cancer patients to either the Internet control condition or to one of three versions of an ICCS, which employed a stacked design of three CHESS services (Clinicaltrials.gov, NCT00468741): (1) CHESS Information, (2) CHESS Information + Support, and (3) CHESS Information, Support, and Coaching (or Full CHESS). The second clinical trial (Hawkins et al., 2011) employed a 2 × 2 design using the Internet control and Full CHESS conditions, with the other element being providing a Cancer Information Mentor or not (Clinicaltrials.gov, NCT00468468): (1) Internet only, (2) Mentor only, (3) Full CHESS, and (4) Full CHESS + Mentor. The Mentor was a qualified information specialist with the Cancer Information Service. She could help interpret information for patients and also refer them to other publicly available resources, through scheduled phone calls. For the Full CHESS + Mentor condition, she can access a summary of the individual's recent CHESS use and any concerns reported to CHESS and the information was used to assess the patient's knowledge and make tailored advices. She could also refer women to particular services or other resources within the system (Hawkins et al., 2011).

Across two experimental studies, the four conditions received an access to a whole or part of CHESS services: (1) CHESS Information, (2) CHESS Information + Support, (3) CHESS Information, Support, and Coaching (or Full CHESS), and (4) Full CHESS + Mentor. This study analyzes those conditions to examine how cancer patients respond to different configurations of ICCS services.

Study Procedures

Study recruitment was conducted at three cancer institutions: Hartford Hospital's Helen and Harry Gray Cancer Center, The University of Texas M.D. Anderson Cancer Center, and the University of Wisconsin Paul P. Carbone Comprehensive Cancer Center. Recruitment was conducted for two different studies that shared two experimental conditions (the Internet control and the Full CHESS conditions). Of the 1034 women approached for study participation, and the 630 screened, consented, and randomized to the six conditions across the two studies, 443 were assigned to the four conditions of the present study (see Figure 1 for Consort Diagram). Eligibility criteria for both studies required that participants were more than 17 years old, within 2 months of a diagnosis of primary breast cancer or recurrence at the time of recruitment, and able to read and understand English (Baker et al., 2011; Hawkins et al., 2011). Once a patient was referred to the study, a research team member explained the purpose of the study, reviewed eligibility criteria with the patient, explained the risks and benefits of being involved, including that their computer use would be monitored, obtained written consent, and provided patients the baseline questionnaires. Every woman participated in the study was provided no-cost access to the Internet and any patient who did not have access to a computer with Internet capability was provided a computer and access by the research program. Every study participant received personal training on how to use the CHESS system or Google's Web search engine depending on group assignment. Besides the baseline survey, three follow-up posttest surveys were administered to participants at 6 weeks, 3 months, and 6 months. Recruitment started on April 1, 2005, and ended on May 31, 2007 (see Baker et al., 2011; Hawkins et al., 2011; for detailed descriptions of the original clinical trials).

Study Measures

The current study analyzes both survey and action log data to examine how cancer patients engage with (and benefit) from different configurations of an ICCS. The action log data files include the unique identifier for each action, individual participant's online handle and numerical ID, and the date, time, URL of every web page requested, and text or data inputs (Han, 2011). This data collection system automatically track usage data on an individual keystroke or click level, which enabled us to monitor usage level for each participant over a period of 6 months. Using the log data, this study creates the number of pages requested as a measure of engagement with the system to gauge how cancer patients use and benefit from different configurations of CHESS services. The flexibility of ICCSs as a communication medium and content system means that, unlike

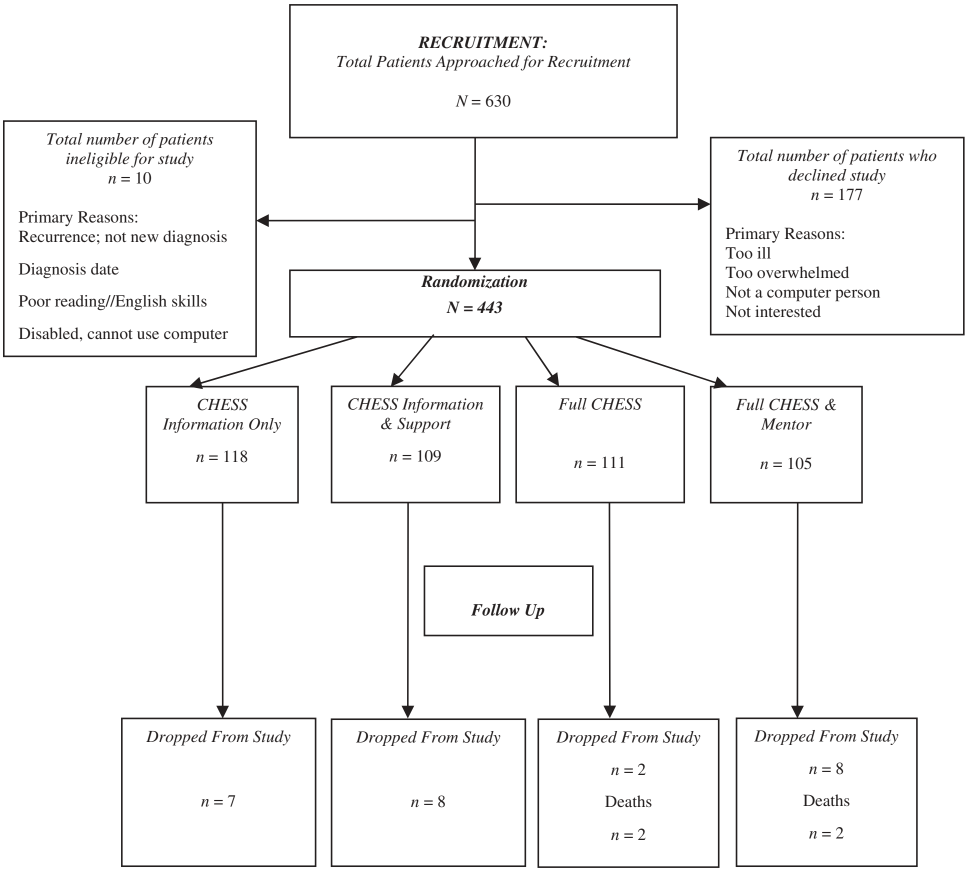

Fig. 1. Consort diagram. Recruitment sites: UW Comprehensive Cancer Center, M.D. Anderson Cancer Center, Hartford Hospital; recruitment dates: April 1, 2005–May 31, 2007.

traditional and linear mass media such as television and radio, its content is not used in fixed time units (Han et al., 2009), although sheer amount of time may be used as an indicator of amount of exposure to its content. A relatively independent indicator is the number of pages requested with the ICCS, because this suggests ongoing usefulness of and involvement with the ICCS, particularly if these requests are distributed across calendar time. We attend to this indicator as it reflects user's engaging activity more accurately than simple time spent since it could better gauge user actions and choices of their own in accordance with their interests.

Next, the data were combined with survey data to examine how engaging with different CHESS services relates to a psychosocial health outcome, cancer information competence. This outcome measure was chosen to reflect effects that were both proposed by earlier research (Baker et al., 2011; Hawkins et al., 2011) and that were predicted to reflect benefits from all three major service types and a Mentor (some of the other outcomes were focused on particular service types). This cancer information competence scale was assessed using five items used in past CHESS studies (Cronbach's $\alpha = .80$) and it measured patients' perceived capability to obtain and utilize the cancer-related information they felt in need of (Baker et al., 2011). The baseline survey also included demographic factors (i.e., age, education, and minority status) and a disease-related measure (i.e., number of days since cancer diagnosis). Two factors of participants' comfort using a computer and the Internet were also included in the study.

Statistical Analysis

First, in order to examine differences in use across the four conditions, analyses of covariance were conducted in which age, education, minority status, days since diagnosis, and computer/Internet experience served as covariates. Separate tests were conducted at 6 weeks, 3, and 6 months time points. Post-hoc comparisons were performed using the Bonferroni adjustment for multiple comparisons. Second, to examine whether the four conditions differ in terms of their pattern of change over time, repeated measures analysis of variance was conducted across the three time periods (i.e., 0–6 weeks, 6 weeks–3 months, 3–6 months) and the dependent variables being the pages requested overall, and for Information services (the only shared service across all conditions), for each condition. We tested for differences amongst conditions over time with regard to linear and quadratic power polynomials. Analyses included the same covariates from previous analyses. Finally, partial correlation analyses were conducted to examine how cancer patients' engagement with overall and particular service types related to their perceived cancer information competence at three different time points. We included the same covariates from previous analyses, along with the pretest score of the cancer information competence.

Results

Table 1 provides demographic characteristics of the sample. Using one-way analysis of variance, the groups did not differ from each other on any of the demographic characteristics ($p > .23$ in all cases).

Comparing Usage Across Conditions

RQ1 examines differences in use across the four conditions where cancer patients receive an access to a whole or part of CHESS services. Table 2 shows the general pattern of overall increased use at each time with access to an increased number of services. However, CHESS Information only condition produced significantly lower use scores when compared with the other three conditions, especially with regard to overall CHESS use ($p < .05$). Comparing each type of CHESS service use across conditions, however, did not reveal any significant effects out of group comparisons. Thus, adding more service tended not to reduce use of any particular service, despite the greater number of services available.

Pattern of Usage Over Time in Each Condition

RQ2 examines whether the four conditions differ in terms of their pattern of change in use over time. We tested this idea for overall CHESS and Information services since they are shared across the four conditions. The F values for tests of within-subjects contrasts are presented in Table 3. Overall, the results suggest a pattern of linear decrease in overall CHESS and

Table 1. Baseline characteristics for participants: Mean and (SD)

	CHESS Info only ($N = 118$)	CHESS Info + Support ($N = 109$)	Full CHESS ($N = 111$)	Full CHESS + Mentor ($N = 105$)
Age (years)	52.2 (9.8)	50.6 (10.8)	50.9 (9.0)	52.7 (9.4)
Education	5.1 (1.4)	4.8 (1.5)	4.9 (1.4)	5.0 (1.4)
Minority	12%	15%	10%	12%
Days since diagnosis	44.6 (29.1)	51.3 (30.3)	42.9 (24.8)	44.0 (27.6)
Computer comfort	3.1 (1.0)	3.1 (1.1)	3.2 (0.9)	2.9 (1.1)
Internet comfort	3.0 (1.1)	3.0 (1.2)	3.1 (1.1)	2.9 (1.2)

Note: Response scales were, for Education: 1 = *did not complete Junior High*; 2 = *did not complete High School*; 3 = *High School degree*; 4 = *some college*; 5 = *Bachelors degree*; 6 = *some graduate school*; and 7 = *graduate degree*. For Income: 1 < \$20 K; 2 = \$20 K to \$40 K; 3 = \$40 K to \$60 K; 4 = \$60 K to \$80 K; 5 = \$80 k to \$100 K; and 6 > \$100 K. For Comfort with Computer and the Internet: 0 = *not at all comfortable*, 1 = *a little bit comfortable*, 2 = *somewhat comfortable*, 3 = *quite comfortable*, 4 = *very comfortable*.

Table 2. Comparing usage over time across conditions

Condition and time	CHESS Info only ($N = 118$)	CHESS Info + Support ($N = 109$)	Full CHESS ($N = 111$)	Full CHESS + Mentor ($N = 105$)
All CHESS				
6 W	13.17^{a}	80.58^{b}	83.84^{b}	89.28^{b}
3 M	16.66^{a}	115.26^{b}	131.84^{b}	142.11^{b}
6 M	17.82^{a}	139.78^{b}	166.36^{b}	179.63^{b}
Information Services				
6 W	13.17	13.97	17.51	17.62
3 M	16.66	16.85	22.90	21.90
6 M	17.82	18.16	25.26	24.51
Support Services				
6 W		66.55	62.11	68.13
3 M		98.35	102.59	115.37
6 M		121.56	133.32	148.93
Coaching Services				
6 W			4.23	3.52
3 M			6.37	4.83
6 M			7.80	6.18

Note. 6 W = 6 weeks; 3 M = 3 months; 6 M = 6 months. Means are covariate-adjusted for age, education, minority status, days since diagnosis, and Internet/computer experience. Values with different superscripts differ at $p < .05$.

Table 3. Pattern of usage over time in each condition

Condition and pattern	CHESS Info only (N = 118)	CHESS Info + Support (N = 109)	Full CHESS (N = 111)	Full CHESS + Mentor (N = 105)
All CHESS				
Linear	3.60#	1.47	4.06*	.63
Quadratic	.71	1.24	.23	.60
Information Services				
Linear	3.60#	4.77*	2.99#	1.70
Quadratic	.71	3.40#	.01	1.34

Note: Entries are F value for tests of within-subjects contrasts. Controlling for age, education, minority, days since diagnosis, Internet/computer experience. #p < . 10. *p < .05.

Table 4. Partial correlations between usage and cancer information competence

Condition and time	CHESS Info only (N = 118)	CHESS Info + Support (N = 109)	Full CHESS (N = 111)	Full CHESS + Mentor (N = 105)
All CHESS				
6 W	.09	.12	.05	–.01
3 M	.17	.26*	.09	.19
6 M	.21#	.06	.12	.10
Information Services				
6 W	.09	.09	.09	–.03
3 M	.17	.24*	.14	.08
6 M	.21#	.09	.10	.12
Support Services				
6 W		.12	.02	.01
3 M		.26*	.06	.20#
6 M		.06	.11	.09
Coaching Services				
6 W			.26*	.06
3 M			.30**	.14
6 M			.10	–.02

Note: Controlling for age, education, minority, days since diagnosis, Internet and computer experience, and pretest score of the cancer information competence. 6 W = 6 weeks; 3 M = 3 months; 6 M = 6 months. For cancer information competence, we asked, on a five-point scale ranging from 0 = *not at all* to 4 = *very much*, whether they agreed or disagreed with statements such as "I can figure out how and where to get the information I need.", #p < .10. *p < .05. ** p < .01.

Information service usage over time. However, the results suggest that the decrease in Information service use in the CHESS Information + Support condition was statistically significant (F = 4.77, p < .05), while overall use in the same condition did not conform to this trend (F = 1.47, n.s.). Further, the decrease in overall use in the Full CHESS was statistically significant (F = 4.06, p < .05), although its component of Information service was not (F = 2.99, n.s.). In addition, overall and Information service use in Full CHESS + Mentor were not significantly decreased, thus remained sustained over time.

Correlations Between Usage and Outcome Measures

RQ3 asked about how cancer patients' engagement with overall and particular ICCS service types related to her perceived health benefit of cancer information competence. The results show that increases in cancer information competence were significantly related to pages requested in CHESS Overall (r = .26, p < .05), Information (r = .24, p < .05), and Support services (r = .26, p < .05) at 3-month follow-up, all in the CHESS Information + Support condition (Table 4). In the Full CHESS condition, CHESS Coaching services play an important role as indicated by significant correlations at both 6 weeks (r = .26, p < .05) and 3 months (r = .30, p < .01). Across the four conditions, change in competence scores showed significant correlations with usage primarily at 3-month follow-up interval.

Discussion

The primary aim of this study was to quantitatively investigate the mechanism of how cancer patients engage with different ICCS tools and obtain benefits from them. These are a part of an ongoing in-depth analysis of how patients use an ICCS and improve in health outcomes after having access to the system. The results from the current study have been enough for allowing us some insights into how patients use the varied eHealth tools and systems and get benefits from it.

Overall, the data are consistent with the notion that the more services that are available to patients, the more patients will spend time with an ICCS, with their usage being distributed over the newly added tools (see Table 2). For example, providing CHESS Support services in addition to Information services not only increased overall use at each time point but also didn't significantly decrease use of Information services per se. Likewise, providing additional CHESS Coaching services didn't significantly reduce use of either Information or Support services, although the overall increase was not statistically significant. The addition of the Mentor herself didn't significantly reduce any of particular service use. Thus, these findings suggest that patients' access to more complex tools can potentially drive the use of all services provided but the point here is that use patterns are not competitive, highlighting that multiple components enhance the usage of an ICCS for cancer patients, with different system components potentially meeting complex needs along the disease continuum (Han et al., 2010).

Consistent with the literature (Eysenbach, 2005), the data also suggest an overall trend that the greatest intensity of use tends to occur in the first 6-week period while usage after that tends to drop over time across all conditions (see Table 2). However, as shown in Table 3, the repeated measures analyses show that the decline is not statistically significant in the Full CHESS condition that is accompanied by a Mentor. This is interesting because usage in the Full CHESS condition seems to follow the overall trend of a decrease over time. These results lead us to elaborate on the role of the Mentor in the intervention. During each month of intervention, the Mentor contacted each patient with a summary of the woman's recent system usage and any worries reported to CHESS, and could refer women to specific resources within CHESS, based on her knowledge gained from ongoing monitoring of what parts of

CHESS have been used or not (Hawkins et al., 2011). Thus, the Mentor appears to have been effective in driving sustained and higher rates of CHESS use. Moreover, although a significant linear drop in usage of Information services was found for the Information + Support condition, the same condition produced a sustained overall CHESS use over time. This in turn suggests that the decline seems less severe in the other service—Support services, which is confirmed from additional analysis not reported here. Taken together, these findings imply that peer-to-peer (such as online discussion group) and peer-to-expert (such as the Mentor) interactions may drive long-term engagement with the system.

But it is unclear why overall use from Full CHESS condition tends to decrease over time. We suspect that it may be linked to the use of Coaching services but our research design does not allow us to assess it because Coaching services are offered together with Support services (Baker et al., 2011). Overall, these results suggest the importance of an interactive communication function in the design of eHealth systems for sharing information, support, and understanding during the intervention.

With regard to the relation of CHESS effects on cancer information competence, there is modest evidence that overall CHESS use drives competence increases over time in the Information only condition. For the Information + Support condition, however, both overall and specific service uses significantly produce the health benefit at the 3-month follow-up period. It is important to note that, in the original evaluation research by 'intent-to-treat' approach (Baker et al., 2011; Hawkins et al., 2011), the benefits of CHESS were produced largely by the Information + Support condition and our finding confirms it, at least in terms of perceived cancer information competence. But the results also suggest that the benefit of the otherwise beneficial services tends to be reduced when the Coaching services were added alone (Full CHESS) or together with the Mentor (Full CHESS + Mentor) as none of Information or Support service usage significantly predicted the outcome measure in both conditions. It may be that the effectiveness of the Information and Support services was attenuated in more complex versions of Full CHESS or Full CHESS + Mentor because (1) the complexity of the combined service and the availability of many options and services at a time may have overwhelmed user or discourage them from engaging more with the beneficial services (as shown in Table 2, adding Coaching service or Coaching + Mentor did not significant increase Information or Support service use). In fact, other research has found that more complicated eHealth interventions can yield diminished effects (Strecher, 2007); or (2) it may be that the tailoring effort may have limited patients' information/support search activities too early in the intervention, thus reducing the breadth of information and services to which they could otherwise have been exposed (Baker et al., 2011).

However, it is important to note that competence increases are more tightly linked with the use of the Coaching services in the Full CHESS condition. Thus, while Coaching services, and the attempt to tailor content to the patient's treatment status and concerns, are only lightly used, their use is most highly associated with the benefit primarily in the Full CHESS condition. As noted before, Full CHESS tended not to produce overall better outcomes than the less complex and intensive services such as the Information + Support condition (Baker et al., 2011). The current findings indicate that a complex set of services such as Full CHESS will not help patients in general, but the patients who are attracted to the interactive Coaching services that are available are the ones who will be helped most over time. This should increase our attention on strategies to gradually refine or tailor a patient's ICCS use experience depending on their prior patterns of service use.

These findings suggest that blanket judgments about eHealth resources are not reasonable; rather, different services and resources should be assessed within context encompassing information about competing demands, services/resources available, patient need, patterns of usage, and so on (Baker et al., 2011). Nevertheless, the findings clearly suggest that the strongest relationship between use and cancer information competence appears relatively late in the follow-up period, suggesting that the sustained engagement with an ICCS may be responsible for the benefit (Han et al., 2009). It may permit sufficient time for cancer patients to access and learn from the system.

There are some caveats in this study. First of all, it is clear from Table 1 that the majority of study participants is Caucasian and also highly educated. While this is a worthy population to examine how patients use and benefit from ICCSs, the degree of generalization to other populations remains to be tested. The results are also generalizable only to the extent that CHESS and its services are representative of the types of ICCSs they are intended to model (Baker et al., 2011). Additionally, the analyses used do not constitute formal mediation analyses. Such analyses would permit stronger causal inferences.

Although our analysis tried to rule out as many covariates as possible, there are several important factors that future study should assess in order to reduce confounding effects. For example, this study did not collect measures of other communication resources that cancer patients may have used outside of ones that the current intervention provided. In addition, individual-level factors such as perceived usefulness and perceived ease of use should be considered as they have been widely applied to understand adoption of new technologies (Davis, Bagozzi, & Warshaw, 1989). Even though substantial training in computer operations, and both general Internet and CHESS system use, was provided by staff members, aiming to remove the gap in basic access/experience in the use of technology (McDowell, Kim, Shaw, Han, & Gumieny, 2010), such measures should be adopted to gauge whether training actually improves patient's perceived usefulness and ease of use when engaging with eHealth resources.

It is also worth noting that this study quantified use of Support services by the number of pages requested but uses and effects from such services may be more properly represented by measuring the type of support or information patients talk about (Han et al., 2011; Han et al., 2012; Kim et al., 2012). On a related note, we adopted the number of pages requested as a single measure of engagement with the eHealth system. Therefore, future research needs to develop additional measures capturing various levels of engagement with eHealth resources and tools.

In conclusion, this study provides a new knowledge on how an eHealth system works, and underscores the importance of continuity of care and patient engagement. In fact, the findings from this research are in line with the more general idea that knowledge and support derived from electronic medical communication systems is only potential, and benefits depend upon a patient's active engagement and commitment over time. The next generation of eHealth systems should develop and refine health applications acknowledging patient's complex and changing needs, and encourage users to engage with them in meaningful directions.

Acknowledgments

We thank the women who agreed to participate in our study. Additionally, we thank Haile Berhe and Gina Landucci for technical contributions.

Funding

The work was supported by the National Cancer Institute at the National Institutes of Health (P50 CA095817-05).

References

Badr, H., Carmack, C. L., & Diefenbach, M. A. (2015). Psychosocial interventions for patients and caregivers in the age of new communication technologies: Opportunities and challenges in cancer care. *Journal of Health Communication*, *20*(3), 328–342. doi:10.1080/10810730.2014.965369

Baker, T. B., Gustafson, D. H., & Shah, D. (2014). How can research keep up with eHealth? Ten strategies for increasing the timeliness and usefulness of eHealth research. *Journal of Medical Internet Research*, *16*(2), e36. doi:10.2196/jmir.2925

Baker, T. B., Hawkins, R. P., Pingree, S., Roberts, L., McDowell, H., Shaw, B., … Gustafson, D. H. (2011). Optimizing eHealth breast cancer interventions: Which types of ehealth services are effective? *Translational Behavioral Medicine*, *1*(1), 134–145. doi:10.1007/s13142-010-0004-0

Blumler, J. G. (1979). The role of theory in uses and gratifications studies. *Communication Research*, *6*, 9–36. doi:10.1177/009365027900600102

Davis, D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*, 982–1003. doi:10.1287/mnsc.35.8.982

Eysenbach, G. (2005). The law of attrition. *Journal of Medical Internet Research*, e11. Retrieved from http://www.jmir.org/2005/1/e11/

Gustafson, D. H., Hawkins, R. P., McTavish, F., Pingree, S., Chen, W. C., Volrathongchai, K., … Serlin, R. C. (2008). Internet-based interactive support for cancer patients: Are integrated systems better?. *Journal of Communication*, *58*, 238–257. doi:10.1111/j.1460-2466.2008.00383.x

Gustafson, D. H., Hawkins, R. P., Pingree, S., McTavish, F., Arora, N., Mendenhall, J., … Salner, A. (2001). Effects of computer support on younger women with breast cancer. *Journal of General Internal Medicine*, *16*(7), 435–445. doi:10.1046/j.1525-1497.2001.016007435.x

Han, J. Y. (2011). Transaction logfile analysis in health communication research: Challenges and opportunities. *Patient Education and Counseling*, *82*(3), 307–312.

Han, J. Y. (2012). A longitudinal study of use of an interactive health communication system. *Health Communication*, *27*(4), 319–330.

Han, J. Y., Hawkins, R. P., Shaw, B., Pingree, S., McTavish, F., & Gustafson, D. (2009). Unraveling uses and effects of an interactive health communication system. *Journal of Broadcasting & Electronic Media*, *53*(1), 112–133.

Han, J. Y., Kim, J-H., Yoon, H. J., Shim, M., McTavish, F., & Gustafson, D. (2012). Social and psychological determinants of levels of engagement with an online breast cancer support group: Posters, lurkers, and nonusers. *Journal of Health Communication*, *17*(3), 356–371.

Han, J. Y., Shah, D. V., Kim, E., Namkoong, K., Lee, S. Y., Moon, T.J., … Gustafson, D. H. (2011). Empathic exchanges in online cancer support groups: Distinguishing message expression and reception effects. *Health Communication*, *26*(2), 185–197.

Han, J. Y., Wise, M., Kim, E., Pingree, R., Hawkins, R., Pingree, S., McTavish, F., & Gustafson, D. (2010). Factors associated with use of interactive cancer communication system: An application of the comprehensive model of information seeking (CMIS). *Journal of Computer-Mediated Communication*, *15*, 367–388.

Hawkins, R. P., Han, J. Y., Pingree, S., Shaw, B., Baker, T., & Roberts, L. (2010). Interactivity and presence of three eHealth interventions. *Computers in Human Behavior*, *26*(5), 1081–1088. doi:10.1016/j.chb.2010.03.011

Hawkins, R. P., Pingree, S., Baker, T. B., Roberts, L. J., Shaw, B. R., McDowell, H. E., … Gustafson, D. H. (2011). Integrating eHealth with human services for breast cancer patients. *Translational Behavioral Medicine*, *1*(1), 146–154. doi:10.1007/s13142-011-0027-1

Hawkins, R. P., Pingree, S., Shaw, B., Serlin, R., Swoboda, C., Han, J. Y., … Salner, A. (2010). Mediating processes and effects of two communication interventions for breast cancer patients. *Patient Education and Counseling*, *81*, S48–53. doi:10.1016/j.pec.2010.10.021

Johnson, D. J. (1997). *Cancer-related information seeking*. Cresskill, NJ: Hampton Press.

Jones, J. B., Weiner, J. P., Shah, N. R., & Stewart, W. F. (2015). The wired patient: Patterns of electronic patient portal use among patients with cardiac disease or diabetes. *Journal of Medical Internet Research*, *17*(2), e42. doi:10.2196/jmir.3157

Kim, E., Han, J. Y., Moon, T. J., Shaw, B., Shah, D. V., McTavish, F., & Gustafson, D. H. (2012). The process and effect of supportive message expression and reception in online cancer support groups. *Psycho-Oncology*, *21*, 531–540. doi:10.1002/pon.1942

McDowell, H., Kim, E., Shaw, B., Han, J. Y., & Gumieny, L. (2010). Predictors and effects of training on an online health education and support system for women with breast cancer. *Journal of Computer-Mediated Communication*, *15*, 412–426. doi:10.1111/(ISSN)1083-6101

Rubin, A. M. (1983). Television uses and gratifications: The interactions of viewing patterns and motivations. *Journal of Broadcasting*, *27*, 37–51. doi:10.1080/08838158309386471

Ruland, C. M., Maffei, R. M., Børøsund, E., Krahn, A., Andersen, T., & Grimsbø, G. H. (2013). Evaluation of different features of an eHealth application for personalized illness management support: Cancer patients' use and appraisal of usefulness. *International Journal of Medical Informatics*, *82*(7), 593–603. doi:10.1016/j.ijmedinf.2013.02.007

Sieverink, F., Kelders, S. M., Braakman-Jansen, L. M. A., & van Gemert-Pijnen, J. E. W. C. (2014). The added value of log file analyses of the use of a personal health record for patients with type 2 diabetes mellitus: Preliminary results. *Journal of Diabetes Science and Technology*, *8*(2), 245–255. doi:10.1177/1932296814525696

Strecher, V. (2007). Internet methods for delivering behavioral and health-related interventions (eHealth). *Annual Review of Clinical Psychology*, *3*, 53–76. doi:10.1146/annurev.clinpsy.3.022806.091428

Turk-Charles, S., Meyerowitz, B. E., & Gatz, M. (1997). Age differences in information-seeking among cancer patients. *International Journal of Aging and Human Development*, *5*(2), 85–98. doi:10.2190/7CBT-12K3-GA8H-F68R

U.S. Department of Health & Human Services Web site. (2012). *HHS announces next steps to promote use of electronic health records and health information exchange*. Retrived November 30, 2012, from http://www.hhs.gov/news/press/2012pres/08/20120823b.html.

van den Berg, S. W., Peters, E. J., Kraaijeveld, J. F., Gielissen, M. F., & Prins, J. B. (2013). Usage of a generic web-based self-management intervention for breast cancer survivors: Substudy analysis of the breath trial. *Journal of Medical Internet Research*, *5*(8), e170. doi:10.2196/jmir.2566

van Gemert-Pijnen, J. E. W. C., Kelders, S. M., & Bohlmeijer, E. T. (2014). Understanding the usag content in a mental health intervention for depression: An analysis of log data. *Journal of Medical Internet Research*, *16*(1), e27. doi:10.2196/jmir.2991

Ventura, F., Öhlén, J., & Koinberg, I. (2013). An integrative review on supportive e-health programs in cancer care. *European Journal of Oncology Nursing*, *17*, 498–507. doi:10.1016/j.ejon.2012.10.007