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# Online Health Information Tool Effectiveness for Older Patients: A Systematic Review of the Literature

SIFRA BOLLE<sup>1</sup>, JULIA C. M. VAN WEERT<sup>1</sup>, JOOST G. DAAMS<sup>2</sup>, EUGÈNE F. LOOS<sup>1</sup>, HANNEKE C. J. M. DE HAES<sup>3</sup>, and ELLEN M. A. SMETS<sup>3</sup>

<sup>1</sup>*Amsterdam School of Communication Research, University of Amsterdam, Amsterdam, The Netherlands*

<sup>2</sup>*Academic Medical Center, Medical Library, University of Amsterdam, Amsterdam, The Netherlands*

<sup>3</sup>*Department of Medical Psychology, University of Amsterdam, Amsterdam, The Netherlands*

Online health information tools (OHITs) have been found to be effective in improving health outcomes. However, the effectiveness of these tools for older patients has been far from clear. This systematic literature review therefore provides an overview of online health information tool effectiveness for older patients using a two-dimensional framework of OHIT functions (i.e., providing information, enhancing information exchange, and promoting self-management) and outcomes (i.e., immediate, intermediate, and long-term outcomes). Comprehensive searches of the PubMed, EMBASE, and PsycINFO databases are conducted to identify eligible studies. Articles describing outcomes of patient-directed OHITs in which a mean sample or subgroup of age  $\geq 65$  years was used are included in the literature review. A best evidence synthesis analysis provides evidence that OHITs improve self-efficacy, blood pressure, hemoglobin levels, and cholesterol levels. Limited evidence is found in support of OHIT effects on knowledge, perceived social support, health service utilization, glycemic control, self-care adherence, exercise performance, endurance, and quality of life. OHITs seem promising tools to facilitate immediate, intermediate, and long-term outcomes in older patients by providing information, enhancing information exchange, and promoting self-management. However, future studies should evaluate the effectiveness of OHITs for older patients to achieve stronger levels of evidence.

Information delivery to patients comprises one of the six main functions of medical communication (De Haes & Bensing, 2009). Patients require information on their illness and associated treatments to manage treatments, cope with the illness, and make well-informed decisions. Moreover, appropriate information can improve patient well-being (Finney Rutten, Arora, Bakos, Aziz, & Rowland, 2005). Health information for patients is increasingly being disseminated through online tools (e.g., websites and patient portals; Eysenbach, 2011). Online health information tools (OHITs) present benefits such as widespread access to tailored health information, interactivity, interpersonal communication, social support, and anonymity (Cline & Haynes, 2001). Overall, exposure to OHITs has increased knowledge in patients, made patients feel more socially supported, and has improved patient health-related behavior and clinical outcomes. However, the authors urge that a stronger understanding of OHIT effects on specific patient groups is warranted (Murray, Burns, See Tai, Lai, & Nazareth, 2005). Older patients may benefit from OHIT advantages in particular as they are at risk of poor information access because

of age-related problems such as cognitive decline (Brown & Park, 2003) and sensory impairments (Valentijn et al., 2005).

OHITs present solutions given that a large proportion of the older population has access to the Internet and uses the Internet to search for health information. For example, 85% of the Dutch population between 65 and 75 years of age has access to the Internet. Of this group, 57% uses the Internet to search for health information (Statistics Netherlands, 2014). Nevertheless, older individuals are less experienced computer users than younger individuals, partly because of the aforementioned age-related problems. Therefore, it is essential that OHITs targeted to older individuals are designed according to their needs and abilities. Several web design guidelines have been proposed (Becker, 2004). However, while these guidelines address website layout, they do not discuss website effectiveness.

Only two reviews have focused on OHIT effectiveness for older patients. We consider 65 years of age and older as the older age group because this cutoff point has been used in other studies that have considered diseases in older patients (Benjamin & Matthias, 2001; Silliman, Troyan, Guadagnoli, Kaplan, & Greenfield, 1997) while also being used by individuals themselves to identify older age (Staudinger & Bluck, 2001). The review provided by Marschollek and colleagues (2007), although focused on elderly individuals, did not identify studies on patient populations with a mean age of 65 years and older. While a more recent review by Stelfefon

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Address correspondence to Sifra Bolle, Amsterdam School of Communication Research, University of Amsterdam, P.O. Box 15791, 1001 NG, Amsterdam, The Netherlands. E-mail: [s.bolle@uva.nl](mailto:s.bolle@uva.nl)

and colleagues (2013) included three studies with patient populations of 65 years and older, only Web 2.0 (social media) self-management interventions were examined (Bond et al., 2010; Nguyen et al., 2008; Nguyen et al., 2013). Consequently, few evidence-based guidelines exist for the development of effective OHITs for older patients.

To address this research gap, we continue from the end point of the review by Marschollek and colleagues (2007) while broadening the scope of the review by Stellefson and colleagues (2013). Therefore, the objective of the current systematic review is to assess the effectiveness of OHITs for older patients by (a) providing an overview of OHIT functions and outcomes for older patients and (b) assessing the methodological quality of previous studies.

### *A Framework of OHIT Functions and Outcomes*

To structure the results of this review, we propose a two-dimensional framework. OHIT outcomes depend on the functions for which these tools are developed. Therefore, the first dimension considers OHIT functions. The second relates to older patient outcomes in response to OHITs. Bol, Scholz, and colleagues (2013) distinguish three functions of patient websites: (a) providing information; (b) enhancing information exchange; and (c) promoting self-management. The function of *information provision* connects patients with information on issues such as illnesses and treatments. *Information exchange enhancement* involves sharing information with others or engaging in two-way communication with, for example, other patients or health care providers. *Self-management promotion* helps patients engage with illness or treatment management by, for example, providing information on strategies for coping with side effects. OHITs can consist of multiple functions (Lustria, Cortese, Noar, & Glueckauf, 2009).

The second dimension of our framework, focusing on OHIT outcomes, is based on the framework developed by De Haes and Bensing (2009), who proposed that medical communication function outcomes are partly dependent on the timeframe in which outcomes occur: *immediate endpoints* are outcomes that occur over the course of the medical communication; *intermediate endpoints* occur shortly after the communication is facilitated; and *longer term endpoints* occur at an extended time after the communication is complete. De Haes and Bensing (2009) designed this framework in relation to interpersonal medical communication. Yet, in the *behavior change model for Internet interventions*, a similar distinction is applied. Ritterband, Thorndike, Cox, Kovatchev, and Gonder-Frederick (2009) proposed that website use (immediate endpoint) is determined by the website itself. The authors posit that website use will lead to mechanisms of change (intermediate endpoints), and through these mechanisms individuals will be empowered to change their behaviors or may experience improvements in symptoms (long-term endpoints). We use these frameworks to design a framework for online health communication; immediate outcomes relate to the OHIT usage (e.g., OHIT usage, usability, or satisfaction), intermediate outcomes denote outcomes that occur immediately following

OHIT usage (e.g., information recall, patient participation) or mechanisms that influence long-term outcomes (e.g., self-efficacy). Long-term outcomes denote outcomes that occur an extended period of time after OHIT usage (e.g., clinical outcomes, quality of life, or behavior change). Hence, we distinguish between three functions (i.e., providing information, enhancing information exchange, and promoting self-management) and three types of outcomes (i.e., immediate, intermediate, and long-term outcomes).

## **Method**

### *Search Procedure*

We searched the PubMed, EMBASE, PsycINFO, Inspec, and Communication & Mass Media Complete databases for eligible studies published in peer-reviewed journals from January 1, 2006, to September 4, 2013. This time filter was chosen because the review by Marschollek and colleagues (2007), which searched the same literature until 2006, found no studies concerned with OHIT effectiveness for older ( $\geq 65$  years) patients. The process followed for the PubMed search formed the basis for search strategies applied to the other electronic databases (see the Appendix).

### *Inclusion Criteria*

A study was included if it described a patient-directed OHIT or an OHIT designed to provide information on an illness for general audiences, studied effects on a sample or subgroup with a mean age of 65 years or older, used a quantitative design, was published in English, and was published in a peer-reviewed journal.

### *Study Selection*

The search procedure was developed in collaboration with a clinical librarian (author 3). After the search process was carried out (by the first author), all titles and abstracts were judged by this author and two research assistants who each reviewed half of the titles and abstracts as second reviewers. Articles were excluded if they did not meet the inclusion criteria. Agreement on title and abstract screening across the reviewers was 94.3%. Disagreements were resolved through discussion.

Next, the first author carried out a full-text screening to determine whether the article content met all of the inclusion criteria. The two research assistants each reviewed half of the full-text content as second reviewers. Agreement on the full-text screening across the reviewers was 89.4%. If, after discussion, disagreement persisted, a third reviewer (second author) was consulted.

### *Data Extraction*

The following characteristics were extracted: study design, participants (number of participants, mean sample age, sex and type of patients, i.e., diagnosis), OHIT description, type of outcome measures and time of measurement, and main results (see Table 1).

**Table 1.** Main characteristics of included studies

Author (year)	Study design	Study population	Description of intervention	Outcomes	Main findings
Berman et al. (2011)	Pretest vs. posttest	$N = 12$ patients with abdominal aortic aneurysms; median age = 73 years	Interactive, personalized, computer-based decision support tool	Knowledge and decisional conflict	Patients' knowledge increased after using the tool compared with before using the tool and decisional conflict decreased after using the tool.
Bol, Smets, et al. (2013)	Nonclinical RCT	$N = 169$ lung cancer patients; younger patients (<65 years): $n = 95$ , mean age = 54.2 years; older patients ( $\geq 65$ years): $n = 74$ , mean age = 70.5 years	Website with information on a lung cancer treatment. Three versions were tested: a webpage with text-only information, text with a nonpersonalized video, and text with a personalized video.	Website satisfaction and recall of cancer-related information	Patients were more satisfied with the comprehensibility, attractiveness, and the emotional support from the website when information was presented as text with personalized video compared with text only. Older patients recalled less information correctly than younger patients, except when controlled for Internet use.
Bol, Van Weert, et al. (2013)	Nonclinical RCT	$N = 436$ nonpatients; younger adults (<65 years): $n = 271$ , mean age = 47.5 years; older adults (>65 years): $n = 165$ , mean age = 70.3 years	Website with information on a lung cancer treatment. Three websites were compared: a website with text only, a website with text and cognitive illustrations, and a website with text and affective illustrations.	Website satisfaction, recall of information	Older adults were more satisfied with perceived emotional support from the website than younger adults. Being more emotionally satisfied with the website led to greater recall of information for older adults but not for younger adults.
Bond et al. (2007)	RCT	$N = 62$ patients with diabetes; control group: $n = 31$ , mean age = 68.2 years; intervention group: $n = 31$ , mean age = 66.2 years	Website where patients enter blood glucose readings, exercise programs, weight changes, blood pressure, and medication data. Nurse contacts the patient in case of changes by e-mail or instant messaging/chat. Weekly online educational discussion group using MSN Messenger software.	Hemoglobin and cholesterol levels, blood pressure	Significant reductions in hemoglobin and cholesterol levels, weight, blood pressure in the intervention versus the control group
Bond et al. (2010)	RCT	$N = 62$ patients with diabetes; control group: $n = 31$ , mean age = 68.2 years; intervention group: $n = 31$ , mean age = 66.2 years	Website where patients enter blood glucose readings, exercise programs, weight changes, blood pressure, and medication data. Nurse contacts the patient in case of changes by e-mail or instant messaging/chat. Weekly online educational discussion group using MSN Messenger software.	Depression, quality of life, social support, and self-efficacy	The intervention group showed significant improvement, compared with the control group on measures of depression, quality of life, social support, and self-efficacy.
Finkelstein et al. (2011)	RCT	$N = 84$ frail older people living independently in home community; mean age = 79 years; intervention group:	Web portal allowing videoconferencing and electronic messaging between home care nurses and clients, ordering health-related and home care services, access to health-related information	Perception, satisfaction, and utilization	Intervention group was significantly more positive toward technology compared with baseline and control group. The intervention group indicated that overall the telehealth

(Continued)

Table 1. Continued

Author (year)	Study design	Study population	Description of intervention	Outcomes	Main findings
Hill-Kayser et al. (2011)	Survey	$N = 40$ ; control group: $n = 44$ $N = 26$ older cancer survivors ( $>70$ years)	and general access to the Internet. A web-based tool for the creation of survivorship care plans. It allows users to enter information regarding demographics, diagnosis, and treatment and produces customized care plans.	Satisfaction with the tool	service met their expectations and they would recommend it to others. Intervention subjects made fewer visits in all categories of (home) care utilization. High levels of satisfaction
Homenko et al. (2010)	Survey	$N = 74$ patients with diabetes; mean age = 73.5 years; food-secure patients: $n = 57$ , mean age = 74.1 years; mild food-insecure patients: $n = 17$ , mean age = 71.6 years	IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Ability to purchase and consume appropriate meals; adherence to dietitians' advice; glycemic control	Both groups purchased fresh produce and considered the dietitian's advice when purchasing food. Both groups report similar adherence to dietitians' advice and had similar glycemic control.
Kerr et al. (2010)	Survey	$N = 168$ patients with coronary heart disease, mean age = 66.8 years	The Comprehensive Health Enhancement and Social Support Living with Heart Disease web-based intervention provided interactive information, behavior change support, and peer and expert support components.	Level of intervention use and use of different intervention components	Participants that were older and had experience using the Internet, were more likely to make some or high use of the intervention.
McKinstry et al. (2013)	RCT	Subgroup analysis of hypertension patients $>70$ years; intervention group: $n = 42$ , control group: $n = 43$	Self-measurement and transmission of blood pressure reading to a secure website for review by the attending nurse or doctor and participant, with optional automated patient decision support by text or e-mail for 6 months.	Average daytime ambulatory systolic blood pressure (measured at 6 months)	Intervention was more effective in lowering daytime systolic and diastolic ambulatory blood pressure than was usual care. There were no significant differences between the age group of patients $>70$ years old and patients $<70$ years old.
Mewton et al. (2013)	Pretest vs. posttest	Individuals seeking psychiatric treatment. Subgroup 60+ years: $n = 225$ ; Mean age = 65.4 years (obtained from personal contact with author)	This Way Up: Internet-delivered cognitive behavioral therapy. The course consisted of six fully automated, unassisted online lessons. Content was presented in the form of an illustrated story in which the character gains mastery over their symptoms with the help of a clinician. At the end of each	Adherence to the six lessons course, psychological distress, disability (measured with the same measure for health-related quality of life	Older adults were more likely to complete all six lessons when compared with their younger counterparts. There were significant reductions in psychological distress and quality of life from baseline to postintervention. Results did not differ significantly across age groups.

Nahm et al. (2008)	Survey	<p>lesson, the patient downloaded homework tasks.</p> <p><math>N = 44</math> patients with heart failure; mean age = 72 years</p>	<p>An e-health program that includes telemonitoring and motivational components (i.e., web learning modules, eCommunication). web-based learning module, "What Is Congestive Heart Failure?" Topics included were definitions of heart failure, risk factors, signs, symptoms, diagnoses and treatments, and living with heart failure.</p>	<p>Readiness to use Internet, confidence to learn health information using the web, confidence to use the e-health program, perceived health web site usability, e-health needs</p>	<p>10 participants were users, among 34 nonusers, 17 reported availability of web access, and 15 reported that they would use the Internet if access and training were available. Confidence for using telemonitoring devices and web-based health modules was high. Confidence for learning health information using web modules was lower. The three most highly rated health information needs were research findings, medication, and laboratory tests. Most participants would like to have e-mail communication with their health care providers.</p>
Neafsey et al. (2011)	RCT	<p><math>N = 160</math> patients with hypertension; mean age = 68.6 years; intervention group: <math>n = 87</math> years, mean age = 67.8 years; control group: <math>n = 73</math>, mean age = 69.6 years</p>	<p>Personal education program on a wireless tablet computer. Patients were asked what they took for treating common ailments or conditions and time of medication and dosage was reported. Patients immediately received individually tailored educational content on the tablet. Summaries of a patient's self-reported symptoms, medication use, adverse self-medication behaviors, and corrective strategies were automatically printed for review by the advanced practice registered nurse provider prior to the primary care visit.</p>	<p>Self-medication knowledge and self-efficacy</p>	<p>Compared with patients in the control group, patients receiving the intervention achieved significant increases in both self-medication knowledge and self-efficacy measures, with large effect sizes.</p>
Nguyen et al. (2008)	RCT	<p><math>N = 39</math> patients with COPD; eDSMP group: <math>n = 19</math>, mean age = 68 years; face-to-face DSMP group: <math>n = 20</math>, mean age = 70.9 years</p>	<p>Six-month dyspnea self-management program (eDSMP): the participants submitted real-time information about their symptoms and exercise using a PDA or website. Patients were encouraged to communicate their exercise goals and progress to the nurse by using a web-based goal-setting tool. The nurses reviewed this information to provide individualized feedback and reinforcement to patients regarding their use of dyspnea management strategies and exercise progress by e-mail. Patients accessed web-based</p>	<p>Dyspnea with activities of daily living (primary outcome), stage of motivational readiness for exercise, exercise behavior, exercise performance, health related quality of life, acute COPD exacerbations, knowledge of</p>	<p>Similar improvement of dyspnea with activities of daily living in both groups. A majority of participants in both groups advanced in their stage of readiness of exercise, which was consistent with changes in total duration of endurance exercise per week. Exercise performance declined in the face to face group and increased in the eDSMP group. Health related quality of life improved over time for participants in both groups. Small improvements in knowledge with no differences between groups.</p>

(Continued)



Table 1. Continued

Author (year)	Study design	Study population	Description of intervention	Outcomes	Main findings
Nguyen et al. (2013)	RCT	$N = 125$ patients with COPD; eDSMP group: $n = 43$ , mean age = 68.5 years; fDSMP group: $n = 41$ ; mean age = 68.2 years; control group (receiving general health information): $n = 41$ ; mean age = 69.3 years	education modules on shortness of breath, breathing strategies, exercise, coping and stress, and medications to manage their illness. The content from these modules was reinforced by study nurses during six weekly live chat sessions with patients.	strategies to manage dyspnea, self-efficacy, perception of support, program preference, usage, satisfaction	Improvement of self-efficacy in both groups. Perception of general social support did not change or differ between groups. PDA and peer interaction received lowest satisfaction ratings in eDSMP group. Mean ratings of overall satisfaction were only slightly lower in the eDSMP group compared with the face-to-face group. No differences in dyspnea between groups. Only arm endurance differed between groups. Self-efficacy improved in both intervention groups compared with the control group. Intervention groups perceived high levels of support. Satisfaction rates with the intervention were high, but there were no differences between the online intervention and the face-to-face intervention.
Ruland et al. (2013)	Survey	$N = 47$ prostate cancer patients; mean age = 65 years	Six-month dyspnea self-management program (eDSMP): the participants submitted real-time information about their symptoms and exercise using a PDA or website. Patients were encouraged to communicate their exercise goals and progress to the nurse by using a web-based goal-setting tool. The nurses reviewed this information to provide individualized feedback and reinforcement to patients regarding their use of dyspnea management strategies and exercise progress by e-mail. Patients accessed web-based education modules on shortness of breath, breathing strategies, exercise, coping and stress, and medications to manage their illness. The content from these modules was reinforced by study nurses during six weekly live chat sessions with patients.	Dyspnea with activities, exercise performance, arm endurance, quality of life, self-efficacy, perception of support, satisfaction	Discussion forum was most heavily used component. Patients preferred to submit personal postings to the nurse rather than to the forum.
Shea et al. (2006)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	WebChoice: a self-management tool with symptom monitoring, tailored self-management support, and communication components to communicate with other patients in a forum or through personal postings to a nurse specialist. IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data	OHIT usage Hemoglobin levels, blood pressure, cholesterol levels	Significant improvements in hemoglobin and cholesterol levels and blood pressure after 1 year in the intervention group compared with usual care.

Shea et al. (2009)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	and secure web-based messaging with nurse case managers; and (d) access to education web site. IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Hemoglobin levels, blood pressure, cholesterol levels	Significant improvements hemoglobin and cholesterol levels and blood pressure after 5 years in the intervention group compared with usual care.
Sheeran et al. (2011)	Survey	$N = 48$ geriatric homecare patients; mean age = 76.2 years	A home health monitor that measures weight, blood sugar, heart rate at the patient's home. Through an online interactive screen, these monitors also can ask patients simple questions about their health and healthcare needs and can provide basic education about illness, treatment, health, and wellness.	User satisfaction and acceptability, depression	High levels of acceptability and satisfaction. Preliminary clinical outcomes suggest improvement in depression severity.
Trief et al. (2013)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Glycemic control, self-reported adherence	Over time, self-reported adherence improved for the treatment group compared with usual care. Adherence was a significant mediator of glycemic control. Greater comorbidity and diabetes symptoms predicted poorer adherence.
Trief et al. (2009)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Glycemic control, blood pressure, cholesterol, diabetes self-efficacy (ability to adhere to the diabetes care regimen) over two annual visits	An increase in diabetes self-efficacy over time was related to an improvement in glycemic control, but not in blood pressure and lipid levels. The intervention was significantly related to improved self-efficacy over time, and both directly and indirectly through self-efficacy to improved glycemic control. The mediation effect of self-efficacy was also significant.
Trief et al. (2007)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Self-efficacy, depression, diabetes distress	Intervention group significantly improved diabetes self-efficacy, but not improved depression or diabetes distress.

(Continued)



Table 1. Continued

Author (year)	Study design	Study population	Description of intervention	Outcomes	Main findings
Weinstock et al. (2011)	RCT	$N = 1,665$ patients with diabetes; intervention group: $n = 833$ , mean age = 71 years; usual care group: $n = 821$ , mean age = 71 years	nurse case managers; and (d) access to education web site. IDEATel intervention consisting of four functions: (a) videoconferencing with nurse case managers, (b) remote monitoring of glucose and blood pressure, (c) a web portal providing access to patients' own clinical data and secure web-based messaging with nurse case managers; and (d) access to education web site.	Glycemic control	Highest improvements in glycemic control were found among Hispanics compared with non-Hispanics.
Westlake et al. (2007)	Quasi-experimental, nonequivalent, two-group design	$N = 80$ heart failure patients; intervention group: $n = 40$ , mean age = 66 years; control group: $n = 40$ , mean age = 65.3 years	Web-based patient education regarding heart failure and symptom management and support from fellow patients. Additional features of the website included electronic mail capability to contact nurse specialists and other patients, external links to video content available on the web and electronic submission of clinical information.	Quality of life and perceived control	Significant increase of quality of life and perceived control in intervention group and no significant differences in control group.
Zou et al. (2012)	Pretest vs. posttest	$N = 22$ patients with anxiety; mean age = 66 years	Internet-delivered cognitive-behavior therapy program. A course consisting of five lessons, homework tasks, additional resources, a moderated discussion forum, and weekly telephone support from a Clinical Psychologist.	Anxiety and stress, satisfaction with treatment	Reductions in symptoms of anxiety and stress were found; participants reported high levels of satisfaction with the program

Note. COPD = chronic obstructive pulmonary disease; eDSMP = electronic dyspnea self-management program; fDSMP = face-to-face dyspnea self-management program; IDEATel = Informatics for Diabetes and Education Telemedicine; OHIT = online health information tool; RCT = randomized controlled trial.

### OHIT Functions and Outcomes

For the OHITs in the studies included, the first author determined which (combination) of the three functions (providing information, enhancing information exchange, promoting self-management) each tool focused on. Next, for each outcome that was tested in the studies included, the first author determined whether immediate, intermediate, or long-term outcomes were targeted.

### Assessment of Methodological Quality

To assess the methodological quality of the selected studies, we consulted a rubric created to assess the methodological quality of randomized controlled trials (RCTs) and nonrandomized controlled clinical trials (CCTs; Van Tulder, Furlan, Bombardier, & Bouter, 2003). The rubric consists of eleven criteria for internal validity: three criteria regarding selection bias (a-c), four regarding performance bias (d, e, g, h), and two regarding attrition bias (f, j). All criteria were scored as *yes*, *no*, or *unclear*. All *unclear* scores were later rated as *no*. To be rated of sufficient quality, a study was required to meet six out of 11 criteria. The methodological quality of the CCTs and RCTs, which were in this case all RCTs, were independently assessed by two researchers (first and second authors). Disagreements were resolved by consensus, and if disagreement persisted, a third reviewer (sixth author) was consulted.

### Data Synthesis

The diversity of features among the OHITs and the nature of the methods used to measure different outcomes, made a meta-analysis impossible. Thus, a best evidence synthesis (BES) analysis, using criteria based on Van Tulder and colleagues (2003) and adaptations by Steultjens and colleagues (2003), was conducted for studies using an RCT design. The BES was conducted by attributing various levels of evidence to the effectiveness of the interventions (i.e., evidence, limited evidence, indicative findings, no/insufficient evidence). BES considers study design, methodological quality, and outcomes.

### Sensitivity Analysis

A sensitivity analysis was performed to determine the sensitivity of the BES results to changes in how the procedure was conducted. The BES was repeated following two criteria: (a) low-quality studies were excluded, and (b) studies were rated high quality if at least four (rather than six) criteria of internal validity were met. The results of the altered synthesis were then compared with those of the BES.

## Results

### Study Selection

The search procedure yielded 12,416 references. Double hits ( $n=2,591$ ) were first excluded. After subsequent title and abstract screening ( $n=9,825$ ), 9,461 references were excluded. The full-text content of the remaining 364 references was then screened. Articles were excluded because (a) study (sub)samples did not have a mean age of 65 years or older ( $n=229$ ),

(b) a study did not describe an online tool ( $n=45$ ), (c) the tool described was not designed for patients or did not provide information on an illness ( $n=35$ ), or (d) the study did not follow a quantitative design ( $n=21$ ). Of the 28 remaining publications, another nine were excluded because (a) mean ages were not reported in these articles, and after contact with the authors, the mean age did not meet the inclusion criterion ( $n=4$ ), (b) the author did not respond to the e-mail for clarification on the mean age ( $n=4$ ), or (c) no correspondence information was available ( $n=1$ ). After applying the snowball method for the remaining 19 publications, 6 additional publications were identified. This resulted in the selection of 25 publications in which the results of 18 separate studies were reported and 17 unique OHITs were studied (see Figure 1). Table 2 shows the study designs of the selected articles and the methodological quality of the RCTs. First, we present the characteristics of the included studies, next the assessment of the methodological quality of the included RCTs, and then the results of the data synthesis.

### Study Characteristics

The included studies reported on the effectiveness of OHITs for patients with diabetes (Bond et al., 2007; Bond, Burr, Wolf, & Feldt, 2010; Homenko, Morin, Eimicke, Teresi, & Weinstock, 2010; Shea et al., 2006, 2009; Trief et al., 2013; Trief, Teresi, Eimicke, Shea, & Weinstock, 2009; Trief et al., 2007; Weinstock et al., 2011), heart disease (Kerr et al., 2010; Nahm et al., 2008; Westlake et al., 2007), hypertension (McKinstry et al., 2013; Neafsey et al., 2011), COPD (Nguyen et al., 2008, 2013), abdominal aortic aneurysms (Berman, Curry, Goldberg, Gusberg, & Fraenkel, 2013), psychiatric disorders (Mewton, Sachdev, & Andrews, 2013; Sheeran et al., 2011; Zou et al., 2012), cancer (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013; Hill-Kayser, Vachani, Hampshire, Di Lullo, & Metz, 2011; Ruland et al., 2013), and chronic diseases (Finkelstein, Speedie, Zhou, Potthoff, & Ratner, 2011). Ten articles reported on a sample or subsample with a mean age between 65 and 70 years (Bond et al., 2007, 2010; Kerr et al., 2010; Mewton et al., 2013; Neafsey et al., 2011; Nguyen et al., 2008, 2013; Ruland et al., 2013; Westlake et al., 2007; Zou et al., 2012), 14 articles used a sample or subsample with a mean age between 70 and 75 years (Berman et al., 2013; Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013; Hill-Kayser et al., 2011; Homenko et al., 2010; McKinstry et al., 2013; Nahm et al., 2008; Shea et al., 2006, 2009; Sheeran et al., 2011; Trief et al., 2007, 2009, 2013; Weinstock et al., 2011), and one article used a sample with a mean age of 79 years (Finkelstein et al., 2011). Four articles discussed OHITs based on a single function: three of which were concerned with information provision (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013; Sheeran et al., 2011) and one with self-management promotion (McKinstry et al., 2013). Twelve articles assessed OHITs based on two functions, namely information provision in combination with information exchange enhancement (Finkelstein et al., 2011; Homenko et al., 2010; Shea et al., 2006, 2009; Trief et al., 2007, 2009, 2013; Weinstock et al., 2011), and

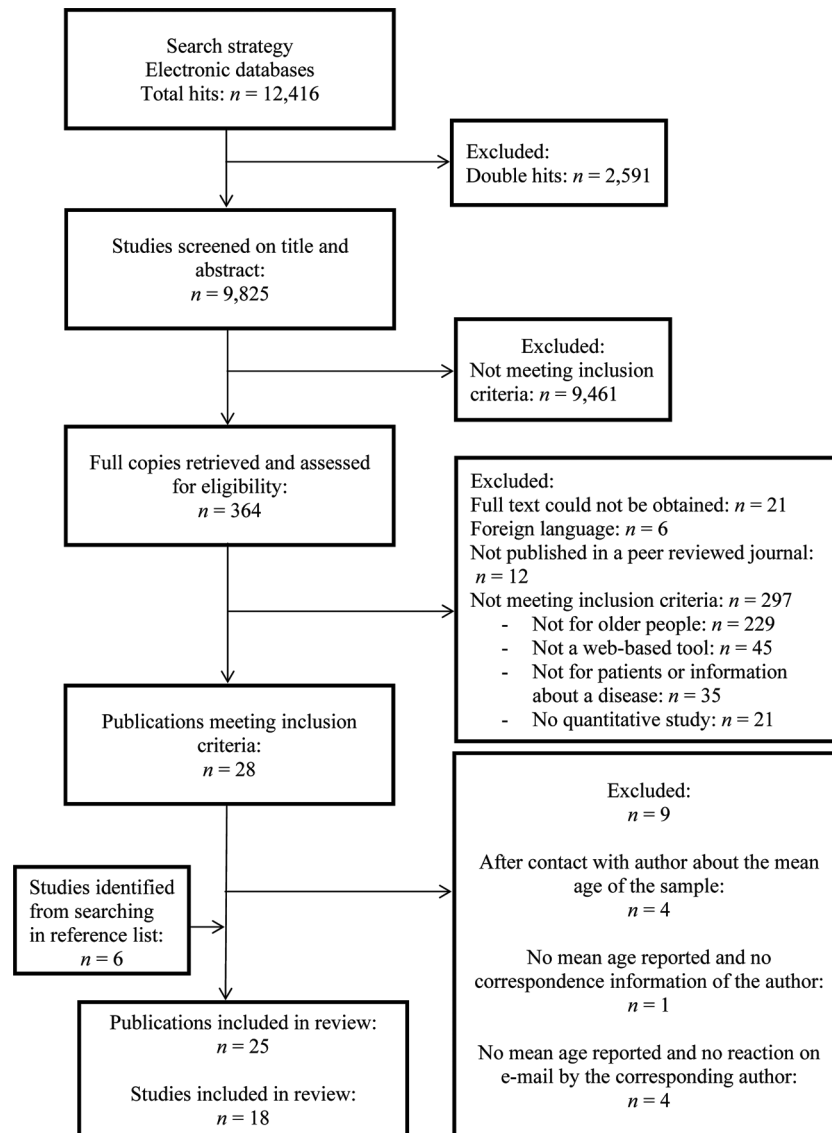


Fig. 1. Study selection process.

information provision in combination with self-management promotion (Hill-Kayser et al., 2011; Mewton et al., 2013; Nahm et al., 2008; Neafsey et al., 2011). Nine articles assessed OHITs based on all three functions (Berman et al., 2013; Bond et al., 2007, 2010; Kerr et al., 2010; Nguyen et al., 2008, 2013; Ruland et al., 2013; Westlake et al., 2007; Zou et al., 2012).

### One Function: Providing Information

Two studies evaluated OHIT effectiveness in providing information on a lung cancer treatment (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013). One study compared a website with textual information combined with a video that was either personalized or nonpersonalized (i.e., information from a patient perspective or from a provider perspective, respectively; Bol, Smets, et al., 2013). The other study compared a website that included textual information combined with

illustrations that were either cognitive (i.e., explaining the text) or affective (Bol, Van Weert, et al., 2013). A third study evaluated the effectiveness of an OHIT in providing information on illness, treatment, health, and wellness for geriatric homecare patients with depression (Sheeran et al., 2011).

### Immediate Outcomes

OHIT satisfaction was measured for all three studies (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013; Sheeran et al., 2011). Patients were more satisfied with an OHIT with personalized video than with an OHIT with nonpersonalized video or those with text only (Bol, Smets, et al., 2013). Adding affective or cognitive images increased satisfaction with website attractiveness for an OHIT providing information on a lung cancer treatment, but not satisfaction with emotional support or comprehensibility. Older patients were more satisfied with the emotional support provided by the OHIT than younger patients (Bol, Van Weert, et al.,

**Table 2.** Included studies and methodological quality of RCTs

Author (year)	Design***	Validity criteria met*/**	Study quality
Berman et al. (2013)	Pretest vs. posttest	N/A	N/A
Bol, Smets, et al. (2013)	Nonclinical RCT	N/A	N/A
Bol, Van Weert, et al. (2013)	Nonclinical RCT	N/A	N/A
Bond et al. (2007)	RCT	a,c,f,i,j,k	High
Bond et al. (2010)	RCT	a,c,f,i,j,k	High
Finkelstein et al. (2011)	RCT	h,i,j	Low
Hill-Kayser et al. (2011)	Survey	N/A	N/A
Homenko et al. (2010)	Survey	N/A	N/A
Kerr et al. (2010)	Survey	N/A	N/A
McKinstry et al. (2013)	RCT	a,b,c,d,f,h,i,j,k	High
Mewton et al. (2013)	Pretest vs. posttest	N/A	N/A
Nahm et al. (2008)	Survey	N/A	N/A
Neafsey et al. (2011)	RCT	a,b,c,g,i,j	High
Nguyen et al. (2008)	RCT	a,b,f,j,k	High
Nguyen et al. (2013)	RCT	c,e,h,i,j,k	High
Ruland et al. (2013)	Survey	N/A	N/A
Shea et al. (2006)	RCT	c,f,h,i,j,k	High
Shea et al. (2009)	RCT	c,f,h,i,j,k	High
Sheeran et al. (2011)	Survey	N/A	N/A
Trief et al. (2007)	RCT	c,e,f,h,i,j,k	High
Trief et al. (2009)	RCT	c,f,i,j,k	High
Trief et al. (2013)	RCT	c,e,i,j,k	High
Weinstock et al. (2011)	RCT	c,f,h,i,j,k	High
Westlake et al. (2007)	Quasi-experiment	N/A	N/A
Zou et al. (2012)	Pretest vs. posttest	N/A	N/A

Note. RCT = randomized controlled trial.

\*Letters correspond to the validity criteria by Van Tulder and colleagues (2003).

\*\*Validity criterion g cannot be decisive in determining low quality of an article. Therefore, some articles that met five criteria were rated as high quality.

\*\*\*Only studies with RCT designs were assessed on methodological quality.

2013). One study found high scores on overall OHIT satisfaction (Sheeran et al., 2011).

#### *Intermediate Outcomes*

Older patients recalled less information than younger patients, except when controlled for Internet use (Bol, Smets, et al., 2013). Older individuals who were more satisfied with the emotional support provided by the OHIT recalled more information than those who were less satisfied. This result was not found for the younger individuals (Bol, Van Weert, et al., 2013).

#### *Long-Term Outcomes*

In one study, a significantly lower level of depression was found at the follow-up condition compared with the baseline condition (Sheeran et al., 2011).

#### **One Function: Promoting Self-Management**

One study evaluated OHIT effectiveness based solely on a self-management function that allowed patients to monitor their own blood pressure and receive automated SMS or e-mail messages with feedback (McKinstry et al., 2013).

#### *Long-Term Outcomes*

Patients in the intervention group showed significantly higher improvements in blood pressure after 6 months compared with the usual care group.

#### **Two Functions: Providing Information and Enhancing Information Exchange**

One article reported on the effectiveness of an OHIT in assisting frail, older individuals who suffered from one or more chronic diseases and who were living independently in their home communities (Finkelstein et al., 2011). The OHIT allowed participants to communicate online with home care nurses for ordering health-related and home-care services and to receive health-related information. Seven articles reported on the effectiveness of the IDEATel intervention (Homenko et al., 2010; Shea et al., 2006, 2009; Trief et al., 2007, 2009, 2013; Weinstock et al., 2011). This OHIT for diabetes patients had several components: web-based communication with nurse case managers, remote monitoring of glucose and blood pressure, a web portal with patient clinical data, and an educational website.

#### *Immediate Outcomes*

After using an OHIT, participants held significantly more positive attitudes towards technology than the baseline and control group. Participants in the intervention group were satisfied with the OHIT. All participants used the OHIT without difficulty. The messaging and health information features were used most frequently (Finkelstein et al., 2011).

### *Intermediate Outcomes*

A significant improvement in self-efficacy was found in the intervention group after one year (Trief et al., 2007), and this effect endured after two years (Trief et al., 2009). No significant improvements in feelings of distress resulting from depression and diabetes were found (Trief et al., 2007). Participants in the OHIT intervention group made use of emergency facilities and home care and transportation services considerably less often (Finkelstein et al., 2011).

### *Long-Term Outcomes*

In three articles, the effects of an OHIT on glycemic control were measured (Homenko et al., 2010, Trief et al., 2009, 2013). One article reported no differences in glycemic control between food-secure patients and patients facing mild food insecurity after OHIT usage (Homenko et al., 2010). A significant improvement in glycemic control was found after 2 years, and this effect was mediated by self-efficacy (Trief et al., 2009). After 5 years, a significant effect on glycemic control was found again, and this effect was mediated by adherence to self care (Trief et al., 2013). Significant improvements in hemoglobin levels, cholesterol levels, and blood pressure were found after one year (Shea et al., 2006) and after 5 years (Shea et al., 2009). The highest improvements in glycemic control were found among Hispanics (compared with non-Hispanic Whites and non-Hispanic Blacks) (Weinstock et al., 2011).

### ***Two Functions: Providing Information and Promoting Self-Management***

One study described an OHIT that serves older cancer survivors, which produces customized care plans providing guidelines for future care (Hill-Kayser et al., 2011). Another study evaluated an online cognitive behavioral therapy program for patients with psychiatric disorders (Mewton et al., 2013). A third study evaluated an OHIT assisting heart failure patients through telemonitoring and online learning components (Nahm et al., 2011). Finally, one study evaluated an OHIT delivering individually tailored educational content for patients with hypertension (Neafsey et al., 2011).

### *Immediate Outcomes*

Participants were willing to use an OHIT and were satisfied with the information that was provided (Hill-Kayser et al., 2011). Older adults were more likely to complete all of the lessons provided than their younger counterparts (Mewton et al., 2013). One study found that 22% of the participants had used an OHIT. Out of the nonusers, 44% of the participants reported that they would use the system if Internet access and training for OHIT usage were available. Levels of confidence with OHIT usage were high. Levels of confidence with learning health-related information using web modules were lower. Most participants would have preferred e-mail communication with their healthcare providers (Nahm et al., 2008).

### *Intermediate Outcomes*

Compared with the control group receiving usual care, patients who had received the intervention achieved

significant increases in both self-medication knowledge and self-efficacy (Neafsey et al., 2011).

### *Long-Term Outcomes*

Significant improvements in psychological distress and quality of life levels were reported from the baseline to the postintervention condition (Mewton et al., 2013).

### ***Three Functions: Providing Information, Enhancing Information Exchange, and Promoting Self-Management***

Two studies evaluated the same OHIT, consisting of a smartphone and web diary, reinforcement e-mails, interactive patient education, and live chat sessions with access to chat-based transcripts for patients with chronic obstructive pulmonary disease (COPD; Nguyen et al., 2008, 2013). This OHIT was compared with an intervention that consisted of face-to-face consultations, paper diaries, reinforcement telephone calls, printed educational modules and face-to-face group sessions. A third article described an OHIT that provided interactive information, behavior change support, and both peer and expert support components for heart disease patients (Kerr et al., 2010). The fourth study evaluated an OHIT that consisted of a symptom-monitoring component, a tailored self-management component, an information component, and a communication component for corresponding with other patients and nurses (Ruland et al., 2013). The fifth study tested the effects of an OHIT for diabetes patients, which allowed patients to enter their medical information, contact their nurse, and participate in online educational discussion groups (Bond et al., 2007; Bond et al., 2010). The sixth study evaluated the effectiveness of a web-based, heart failure self-management OHIT (Westlake et al., 2007). Last, one OHIT provided online cognitive behavior therapy to patients with anxiety disorders (Zou et al., 2012).

### *Immediate Outcomes*

High levels of satisfaction with OHITs were identified (Nguyen et al., 2008, 2013; Zou et al., 2012). In two studies, satisfaction with OHITs was equal to that of face-to-face interventions (Nguyen et al., 2008, 2013). Older patients who were more experienced with using the Internet were more likely to become either moderate or heavy OHIT users (Kerr et al., 2010). Because of technological issues, one study found OHIT usage to be sub-optimal (Nguyen et al., 2008). The discussion forum was the most heavily used component of the OHIT. However, patients preferred to submit personal postings to the nurse (the second most heavily used component) rather than to the forum. Most patients contended that nurses should have contributed more to the discussion forum (Ruland et al., 2013).

### *Intermediate Outcomes*

Patients with abdominal aortic aneurysms showed a significant increase in knowledge and significant decrease in decisional conflict after OHIT usage (Berman et al., 2013). Significantly higher levels of social support and self-efficacy were found in the intervention group than in the control group receiving usual care (Bond et al., 2010). One study measured patient knowledge of strategies for managing



dyspnea, self-efficacy, and support perception (Nguyen et al., 2008). Equal improvements were found for all of the variables in the online and face-to-face group. The same intervention was tested again at a later date and was adapted to include a control group that received general health education only (Nguyen et al., 2013). For both intervention groups (online and face to face), self-efficacy levels were marginally significantly ( $p = .06$ ) higher than that of the control group that received general health information. One study found a significant increase in perceived control in the OHIT intervention group, whereas this increase was not found in the control group that was given usual care (Westlake et al., 2007). One study reported significantly lower anxiety and stress levels in participants after OHIT usage than before its use (Zou et al., 2012).

#### *Long-Term Outcomes*

Significant quality-of-life improvements and reductions in depression, blood pressure, hemoglobin, and cholesterol levels were found in the intervention group that received an OHIT in addition to usual care compared with the control group, that received usual care only (Bond et al., 2007, 2010). Another study found significant improvements to patient quality of life through OHIT usage (Westlake et al., 2007). Yet, another study found improvements in quality of life through OHIT usage that were equal between the online and face-to-face intervention group. The same result was found for patients with dyspnea. Exercise performance significantly declined among patients in the face-to-face intervention group and significantly increased for those in the OHIT group (Nguyen et al., 2008). The repeated study did not find any differences in quality of life and dyspnea levels between the online intervention group, face-to-face intervention group and control group. After 12 months, significantly greater improvements were found on arm endurance (the number of times a participant can lift an object) for the online intervention group than for the face-to-face intervention group and control group (Nguyen et al., 2013).

#### *Methodological Quality*

We included 13 RCTs. The remaining 12 studies were quasi-experimental (Westlake et al., 2007), randomized nonclinical controlled trials (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013), pretest versus posttest surveys (Berman et al., 2013; Mewton et al., 2013; Zou et al., 2012) and surveys (Hill-Kayser et al., 2011; Homenko et al., 2010; Kerr et al., 2010; Nahm et al., 2008; Ruland et al., 2013; Sheeran et al., 2011). For the methodological quality assessment, only RCTs were reviewed. Eleven publications that used an RCT design rated high-quality studies. One RCT was rated as a low-quality study (Finkelstein et al., 2011). Table 2 lists the quality ratings assigned to each RCT.

#### *Data Synthesis*

The BES demonstrates that there is evidence (consistent findings in two or more high-quality RCTs) that OHITs are effective with respect to four outcomes. Three high-quality RCTs found positive intermediate self-efficacy

outcomes (Bond et al., 2010; Neafsey et al., 2011; Trief et al., 2007, 2009). Another three high-quality RCTs found that OHIT usage significantly improves long-term blood pressure outcomes (Bond et al., 2007; McKinstry et al., 2013; Shea et al., 2006, 2009). Two high-quality RCTs found significant improvements in long-term hemoglobin and cholesterol level outcomes through OHIT usage (Bond et al., 2007; Shea et al., 2006, 2009).

Limited evidence (significant findings in at least one high-quality RCT) was found in support of OHIT effects on nine outcomes. One high-quality RCT found a significant positive effect of OHIT usage on intermediate knowledge outcomes (Neafsey et al., 2011), while another found a significant effect on intermediate perceived social support and long-term quality of life outcomes (Bond et al., 2010). One high-quality RCT found significant improvements in long-term glycemic control outcomes through OHIT usage (Trief et al., 2009, 2013) and Trief and colleagues (2013) also found significant improvements in long-term self-care adherence outcomes. One high-quality RCT found a significant positive effect of OHIT usage on long-term exercise performance outcomes (Nguyen et al., 2008). Using the same intervention but under a different high-quality RCT design, a significant effect on long-term arm endurance outcomes through OHIT usage was found (Nguyen et al., 2013). Indicative findings were identified for two outcomes. One low-quality RCT found a significant positive effect of OHIT usage on immediate technology perception outcomes and a significant decline in intermediate service utilization outcomes (Finkelstein et al., 2011).

No/insufficient evidence was found for outcomes that were not significant or for inconsistent findings. One study that employed an RCT design did not find significant improvements in distress levels (Trief et al., 2007). Mixed findings were found for long-term depression outcomes. One high-quality RCT found significant improvements in depression (Bond et al., 2010), while another did not find significant improvements for this outcome (Trief et al., 2007). Hence, we found no/insufficient evidence for OHIT effects on distress and depression.

No level of evidence could be recognized for outcomes of studies that employed study designs other than RCT models or for RCT outcomes that were not compared with a control group. OHIT usage was measured in studies that did not use an RCT design (Kerr et al., 2010; Mewton et al., 2013; Nahm et al., 2008; Ruland et al., 2013) and in studies that employed an RCT design but which did not compare intervention group outcomes to a control group (Finkelstein et al., 2011; Nguyen et al., 2013). This was also the case for immediate OHIT outcomes satisfaction (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013; Finkelstein et al., 2011; Hill-Kayser et al., 2011; Nguyen et al., 2008, 2013; Sheeran et al., 2011; Zou et al., 2012) and usability outcomes (Nahm et al., 2008) and intermediate information recall (Bol, Smets, et al., 2013; Bol, Van Weert, et al., 2013), perceived control (Westlake et al., 2007), decisional conflict (Berman et al., 2013), anxiety, and stress outcomes (Zou et al., 2012). Table 3 shows the outcomes of the selected studies and the BES results in our two-dimensional framework.

**Table 3.** BES outcomes integrated in the two-dimensional framework of functions and outcomes of patient-directed OHITs

Function	Immediate endpoints	Intermediate endpoints	Long-term endpoints
Providing information	<ul style="list-style-type: none"> <li>• Satisfaction with the OHIT<sup>a</sup></li> <li>• Use<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Recall<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Emotional long-term outcomes</li> <li>• Depression<sup>4</sup></li> </ul>
Promoting self-management			<ul style="list-style-type: none"> <li>• Clinical outcomes</li> <li>• Blood pressure<sup>1</sup></li> </ul>
Providing information and enhancing information exchange	<ul style="list-style-type: none"> <li>• Satisfaction with the OHIT<sup>a</sup></li> <li>• Use<sup>a</sup></li> <li>• Perception of technology<sup>3</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Emotional intermediate outcomes</li> <li>• Anxiety<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Clinical outcomes</li> <li>• Blood pressure<sup>1</sup></li> <li>• Hemoglobin levels<sup>1</sup></li> <li>• Cholesterol levels<sup>1</sup></li> <li>• Glycemic control<sup>2</sup></li> <li>• Emotional long-term outcomes</li> <li>• Depression<sup>4</sup></li> <li>• Self-care adherence<sup>2</sup></li> <li>• Quality of life<sup>2</sup></li> </ul>
Providing information and promoting self-management	<ul style="list-style-type: none"> <li>• Satisfaction with the OHIT<sup>a</sup></li> <li>• Usability<sup>a</sup></li> <li>• Use<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge<sup>2</sup></li> <li>• Self-efficacy<sup>1</sup></li> </ul>	
Providing information, enhancing information exchange, promoting self-management	<ul style="list-style-type: none"> <li>• Satisfaction with the OHIT<sup>a</sup></li> <li>• Use<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge<sup>2</sup></li> <li>• Self-efficacy<sup>1</sup></li> <li>• Emotional intermediate outcomes</li> <li>• Anxiety<sup>a</sup></li> <li>• Decisional conflict<sup>a</sup></li> <li>• Perceived (social) support<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Clinical outcomes</li> <li>• Blood pressure<sup>1</sup></li> <li>• Hemoglobin levels<sup>1</sup></li> <li>• Cholesterol levels<sup>1</sup></li> <li>• Arm endurance<sup>2</sup></li> <li>• Emotional long-term outcomes</li> <li>• Depression<sup>4</sup></li> <li>• Quality of life<sup>2</sup></li> <li>• Exercise performance<sup>2</sup></li> </ul>

OHIT = online health information tool.

<sup>1</sup>Evidence.

<sup>2</sup>Limited evidence.

<sup>3</sup>Indicative findings.

<sup>4</sup>No/insufficient evidence.

<sup>a</sup>Significant findings in non-randomized controlled trial studies. Hence, no level of evidence could be assigned.

### Sensitivity Analysis

To conduct the sensitivity analysis, the BES was first repeated using 12 high-quality RCTs (thus disregarding the low quality RCT). No differences were found for the outcomes for which we found evidence or no evidence. Only those outcomes for which we found indicative findings changed to no/insufficient evidence (i.e., technology perception and service utilization). In repeating the BES under the principal that studies were required to meet four rather than six internal validity criteria, the results remained the same. This demonstrates that the BES results are robust.

### Discussion

We aimed to assess the effectiveness of OHITs for older patients by systematically providing an overview of OHIT functions and outcomes for older patients and assessing the methodological quality of previous studies. To this end, we related OHIT functions to OHIT outcomes on the basis of the included 25 articles. Of these articles, 13 reported

on seven RCTs, and these were assessed on methodological quality to attribute levels of evidence to the effectiveness of the interventions. A BES provides evidence for OHIT effectiveness in improving intermediate self-efficacy and long-term clinical outcomes with respect to blood pressure, hemoglobin, and cholesterol levels.

Significant improvements in patient self-efficacy were found in studies that reported on OHITs with multiple functions, leading us to conclude that OHITs with self-management and information provision functions can improve self-efficacy. This finding is consistent with evidence that self-management interventions can improve self-efficacy (Warsi et al., 2004), while providing information alone appears insufficient in accomplishing this goal (Coates & Boore, 1996). Self-management interventions address self-efficacy by providing patients with the skills needed to manage disease symptoms, and this is a prerequisite for the attainment of longer-term outcomes. Illustrating this fact, OHIT usage effects on glycemic control (likely caused by health-behavior change) were mediated by self-efficacy (Trief et al., 2009).



Significant improvements in long-term blood pressure, hemoglobin and cholesterol level outcomes were mainly found when patients engaged with OHITs with two or three functions. Only one OHIT that offered one function (promoting self-management) improved blood pressure outcomes. Because determining whether specific function combinations are more effective than others is not possible using the results of this review, we recommend comparing OHITs on varying levels of sophistication in future studies.

No levels of evidence could be assigned to outcomes that were not measured using an RCT design. However, the results of these studies still agree with previous studies and theoretical explanations. For example, three studies found OHIT effects on cognitive outcomes such as recall and knowledge. These findings can be explained by information processing theories such as the elaboration likelihood model, which states that personally relevant information is processed on a deeper level (through the central route) and is therefore more likely to improve information comprehension and recall (see Rimer & Kreuter, 2006). OHIT characteristics such as interactivity, the capacity to tailor and facilitate interpersonal communication and social support may increase the personal relevance of information provided.

Immediate outcomes such as OHIT usage and satisfaction cannot be compared with a control group. These variables were thus not included in the BES, and we consequently could not make any judgments on OHIT effectiveness with respect to these outcomes. However, most studies that assessed satisfaction with an OHIT found high scores for this outcome, and with the exception of the self-management function, for which satisfaction was not measured, this outcome was found for OHITs across all (combinations of) functions.

As of 2006, no articles to our knowledge exist that have published results on OHIT effectiveness for older patients. The results of our review provide an agenda for future research. First, limited accumulated knowledge exists on specific effects. To determine whether outcomes supported by limited or no/insufficient evidence could be proven in the future, more research is required on outcomes that have either not been studied in high-quality RCTs or which have only been studied through one high-quality RCT. Second, none of the evaluated studies discussed OHITs with respect to interpersonal, patient-provider communication (e.g., patient participation). OHITs are expected to increase patient participation by providing (previsit) information, which consequently enables the patient to become a more capable conversation partner (Dedding, Van Doorn, Winkler, & Reis, 2011). This point is especially relevant given that previous research has shown that older cancer patients are typically less proactive and tend to ask fewer and less in-depth questions than younger patients (Sparks & Turner, 2008).

This review is methodologically limited in that not all studies may have been included in the analysis. We attempted to minimize this possibility by carrying out a systematic literature search in consultation with a medical librarian and following the snowball method. In addition, the screening of abstracts and full papers was repeated by a second

reviewer. Still, there is a possibility that we may have missed studies.

We conclude that the body of literature on OHIT effectiveness for older patients, while still in its infancy, is growing rapidly. This review provides a starting point for the systematic development and evaluation of evidence-based OHITs for older patients. The results of this review are promising in that we found evidence for clinical outcomes and for an important determinant of long-term outcomes, namely self-efficacy. The outcomes for which we found limited evidence or indicative findings suggest that OHITs may lead to improvements in several outcomes. This finding is encouraging given that technology evolves at a rapid pace, and thus the use of OHITs will likely increase. At present, it is important for professionals and scholars to recognize that OHITs targeted to older patients can facilitate several outcomes—even clinical outcomes—and that these programs are also effective at providing information, enhancing information exchange, and promoting self-management among older patients.

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## Appendix: Search Strategy

(“Consumer Health Information”[Mesh] OR “Internet”[Mesh] OR internet[tw] OR “Telemedicine”[Mesh] OR telemedicine[tw] OR telemedical[tw] OR “e health”[tw] OR ehealth[tw] OR telehealth[tw] OR mobile health[tw] OR “m health”[tw] OR mhealth[tw] OR website[tw] OR web based[tw] OR webbased[tw] OR web site\*[tw] OR website\*[tw] OR web portal\*[tw] OR online support group\*[tw]) AND (elderly[tw] OR elder[tw] OR elders[tw] OR aged[tw] OR “Aged”[Mesh] OR older person\*[tw] OR older adult\*[tw] OR older patient\*[tw] OR “old people”[tw] OR aging[tw] OR ageing[tw] OR senior[tw] OR community-dwelling[tw] OR geriatric[tw] OR Psychogeriatrics[tw] OR “postmenopausal women”[tw] OR “Homes for the Aged”[Mesh]) AND (satisfaction[tw] OR client attitude\*[tw] OR “Patient Satisfaction”[Mesh] OR “usability”[tw] OR “usefulness”[Text Word] OR “Quality of Life”[Mesh] OR qol[tw] OR “behavior\* change”[tw] OR ((lifestyle[tw] OR life style[tw]) AND (change[tw] OR changing[tw])) OR “Health Behavior”[Mesh] OR health behavior[tw] OR self efficacy[tw] OR “Self Efficacy”[Mesh] OR self management[tw] OR self care[tw] OR “Self Care”[Mesh] OR “Independent Living”[Mesh] OR independent living[tw] OR living independent\*[tw] OR self administration[tw] OR self medication[tw] OR (treatment[tw] AND (compliance[tw] OR non compliance[tw] OR noncompliance[tw] OR adherence[tw] OR nonadherence[tw])) OR (medication[tw] AND (compliance[tw] OR noncompliance[tw] OR adherence[tw] OR non adherence[tw] OR nonadherence[tw])) OR “Medication Adherence”[Mesh] OR anxiety[tw] OR “Anxiety”[Mesh] OR “Stress, Psychological”[Mesh] OR (stress[tw] AND (emotional[tw] OR psychological[tw])) OR recall[tw] OR knowledge[tw] OR “Knowledge”[Mesh] OR “Comprehension”[Mesh] OR comprehension[tw] OR understanding[tw] OR patient participation[tw] OR “Patient Participation”[Mesh] OR patient empowerment[tw] OR decision making[tw] OR “Decision Making”[Mesh] OR “Patient-Centered Care”[Mesh] OR patient centered[tw])