

Usability and Accessibility in Consumer Health Informatics

Current Trends and Future Challenges

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Abstract: It is a truism that, for innovative eHealth systems to have true value and impact, they must first and foremost be usable and accessible by clinicians, consumers, and other stakeholders. In this paper, current trends and future challenges in the usability and accessibility of consumer health informatics will be described. Consumer expectations of their healthcare providers and healthcare records in this new era of consumer-directed care will be explored, and innovative visualizations, assistive technologies, and other ways that healthcare information is currently being provided and/or shared will be described. Challenges for ensuring the usability of current and future systems will also be discussed. An innovative model for conducting systematic, timely, user-centered research on consumer-facing websites at the National Cancer Institute (NCI) and the ongoing efforts at the National Institute of Standards and Technology (NIST) to promote health information technology (HIT) usability standards and evaluation criteria will also be presented.

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Introduction

Health information technology (HIT) is a multidisciplinary field that must often coordinate and work across many different silos. However, to have true value and impact, HIT must, first and foremost, be usable and accessible by clinicians, consumers, and other stakeholders. This paper addresses the major issues related to consumer health informatics (i.e., eHealth). Section 1 addresses the consumer expectations for eHealth. Section 2 discusses innovative visualizations and assistive technologies in consumer informatics. Section 3 discusses accessible eHealth information. Section 4 discusses usable eHealth information. Section 5 discusses the necessity of usability and accessibility in the certification process of HIT applications. Section 6 extracts conclusions from the research-based discussion in the prior

sections essential for the success of consumer health informatics.

Consumer Expectations for eHealth

The Pew Internet & American Life Project (<http://www.pewinternet.org>) has tracked online activities since early in 2000, including a focus on consumer use of online health information. Their 10-year data chart rising use of the Internet by all age groups (Figure 1). The use of the Internet for health information is also on the rise, although adults with chronic diseases are less likely to go online than healthy adults.¹ These statistics are mirrored in the experience of researchers at the NCI's User-Centered Informatics Lab in qualitative research. Early on, for example, few people claimed to know about or use social media tools. More recently, answers at these interviews have shifted: the web has gone from something that is unusual or used only at work to something that is normal and used everyday, on both computers and mobile devices. The question now is not whether the public is ready for eHealth information, but whether eHealth information is ready to meet the public's expectations. eHealth is joining commerce, banking, travel, and other industries, already online.²

The challenge for HIT is to design systems that are powerful enough not only to handle the volume of information and the complexity of medical data, but also to

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support both patients and professionals in doing their work. This means paying attention to usability from the beginning of a project. Usability is a quality of the product, but it is defined in the terms of the people. The widely cited International Organization for Standardization (ISO) standard for usability says that a product is usable if the people who are intended to use it can do so in a way that is effective for them, efficient in their terms, and satisfying for them in terms of their own goals.³ Another ISO standard simply defines accessibility as usability for a broader group of people—those with the widest range of capabilities.⁴ In other words, all users have an equivalent experience no matter what assistive technology they may use, or whether they are on a computer or mobile device.

This result is not achieved by attempting to “add usability” to a system after it is designed. Both usability and accessibility must be considered from the very beginning of a project. In the field of human-computer interaction, this process is often called user-centered design (UCD) and comes with its own research tradition⁵⁻⁷ and international standards.⁸ This process begins with an understanding of the context of use and incorporates evaluation of design solutions as a way to modify the design until it meets the needs of users (Figure 2).

As important as standards are, they often do not address the usability and accessibility needs of

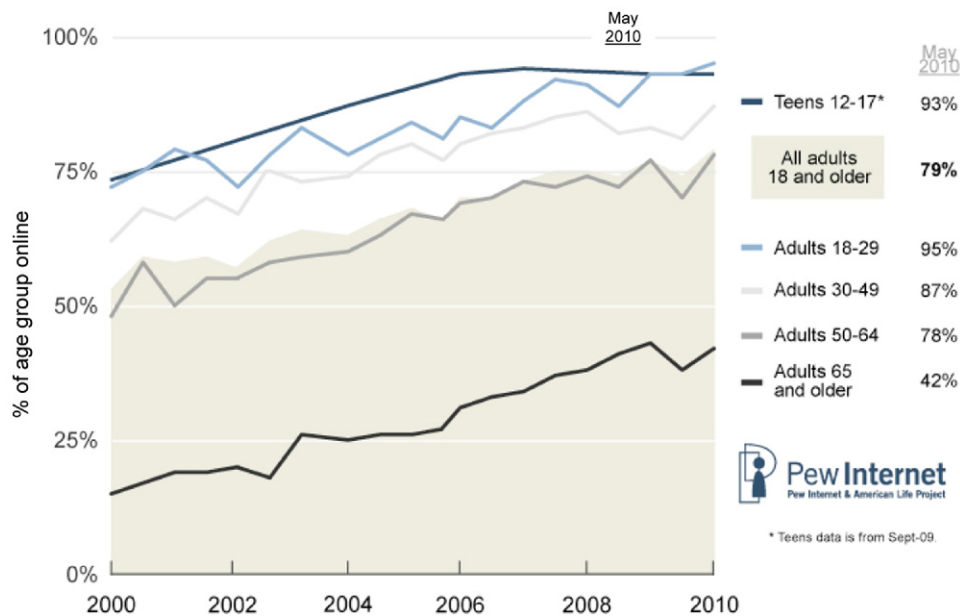


Figure 1. The Pew Internet & American Life Project shows the dramatic rise in the use of the Internet by all age groups. As of May 2010, 79% of all adults aged ≥18 years were online. The lowest use is by the cohort of adults aged ≥65 years, at only 42%, rising to 95% for those aged 18–29 years (www.pewinternet.org/Infographics/2010/Internet-access-by-age-group-over-time-Update.aspx, 1/20/11). Printed with permission

the real people who have to use them because they are not written around broad goals for usability and accessibility. One of the key tenets of user-centered design is that the people who use the system for information must be seen as individuals in a context of use, not just as a collection of demographics. To better understand consumer needs, a

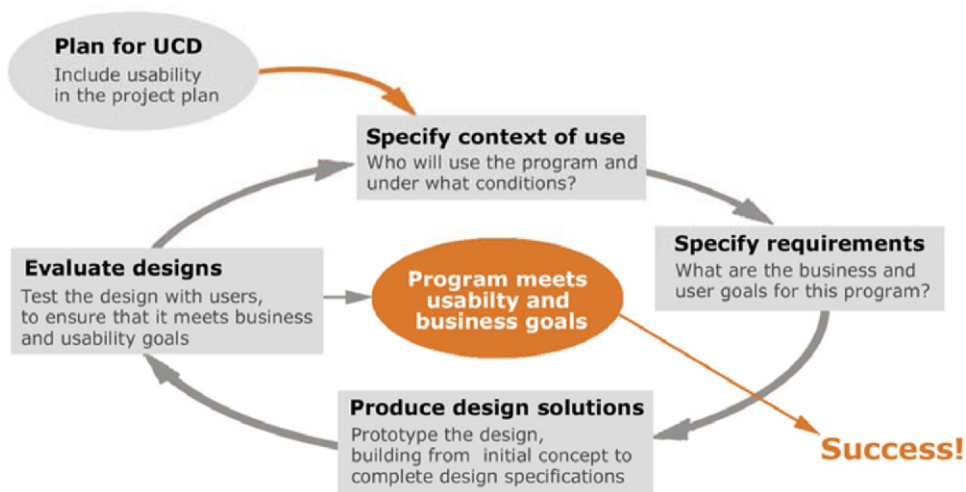


Figure 2. The UCD process in ISO 9241-210 is an iterative cycle that generates requirements from an understanding of the context of use, uses those requirements to produce design solutions, and then evaluates them. The results of that evaluation are used to update the design until the product meets both usability and business goals. UCD, user-centered design

Patients, Friends, Family on a Cancer Journey Personas for Cancer.gov

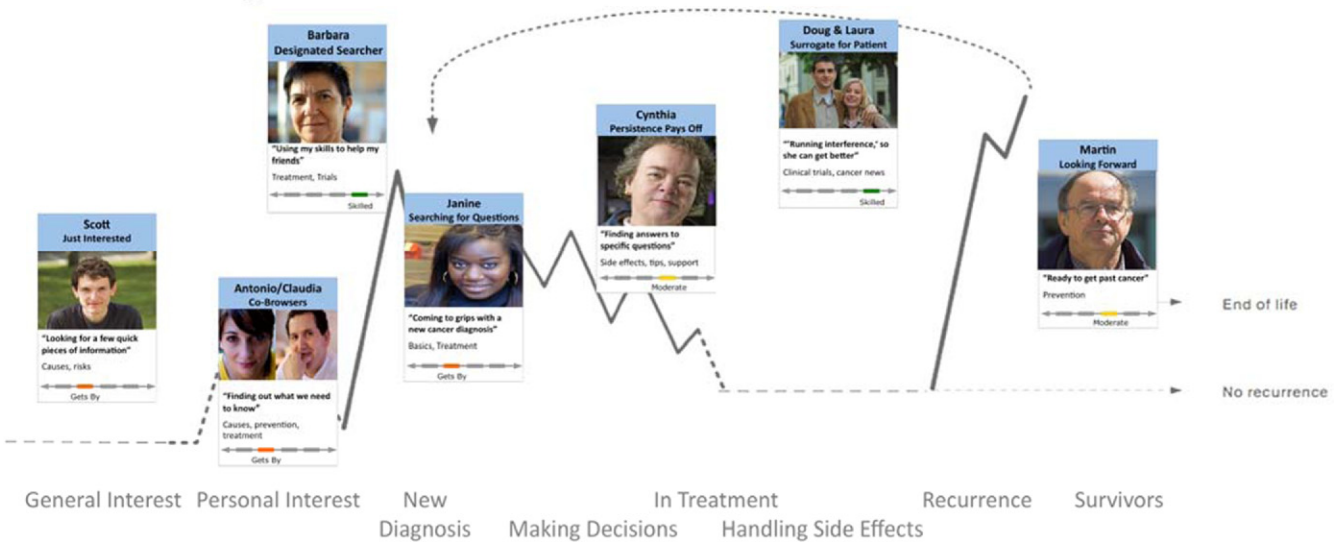


Figure 3. For the National Cancer Institute's www.cancer.gov, the map of consumer personas considers both technology and health literacy, but also differing needs at various places along the cancer journey.

case study is explored, involving the development of detailed "patient personas" to guide the design of a National Cancer Institute consumer-facing website. Personas help picture the audience for any system in a way that can drive the design process from the user perspective.⁹ Personas package demographic data, qualitative data, attitudes, and typical scenarios into a portrait of a type of user (Figure 3).

Personas help address a challenge for most technology projects: health information specialists, designers, and other health professionals, although present, there is rarely a patient actively working on a project. This is not just a challenge in health care; in many information technology projects, developers work in environments that make it difficult to have any real connection to the context in which their work will be used. Designing without user and task analysis often produces products that ignore accessibility requirements,¹⁰ fail to address the variations in roles, and do not provide the right balance of usability requirements.¹¹ For example, a health provider who works with the same program all the time, may want it to work quickly and efficiently and to give a lot of information at once. But a patient might want the information delivered in a more gentle way and to be sure that it helps them understand the implications. Both might want a system that is error tolerant, supporting them by both preventing errors and helping them undo mistakes.

As work proceeds toward usability standards for certification, those standards must address the full range of human experience and health contexts. It is a mistake, for example, to think that "consumers engaging with health

information" happens in only a single type of interaction. In addition to the wide variety of systems, technologies, and devices in use, health information from people—healthcare providers, friends, and family—is still important.¹ This means thinking about HIT in the context of the larger social ecosystem, providing links between online systems and human support. Participants in a usability study were recently asked what hours they wanted the NCI's Cancer Information Service to be available for phone, e-mail, and online chat. Many answered that even though it is not necessarily practical, they would prefer to have 24-hour support. They understood the realities, but still wanted to have access to information any time that they need it. If usability and accessibility in the consumer context are not taken into account, then there is no way that the final products will meet usability and accessibility goals for the broadest range of people with the widest range of capabilities.

Framework for Design

The Reader-to-Leader Framework (Figure 4) is designed to help researchers, designers, and managers understand human motivation to participate in social media. This framework enables them to improve user-interface design and social support for projects run by their companies, government agencies, and nongovernmental organizations. These improvements could reduce the number of failed projects, while accelerating the applications of social media in health care, disaster response, community safety, and more.^{12,13}

The culture of the Internet is about much more than information transfers—it has become increasingly social and communal. While individuals' needs and characteristics initially shape interface designs, social requirements determine the nature of technology-mediated communication.¹⁴ Researchers, designers, and managers want to learn from successful applications and to apply this knowledge in the design and management of applications that they care about.¹⁵

The successive levels of social participation can roughly be categorized as reading, contributing, collaborating, and leading. These are not complete descriptions, and users don't always progress from one to another, but this simple framework is a useful basis to describe what many users do. Raising awareness of social media can be done by creating interesting, attractive, and relevant content.¹⁶ Rogers¹⁷ points out, for example, that innovation is more likely to be accepted if the value of the material is clear to potential users. Good user-interface design produces accessible and universally usable applications that enable solitary reading or social interactions that meet the needs of diverse user populations.^{15,18}

Reader, Contributor, Collaborator, and Leader

The most understandable motivation for people to read user-generated content is that they personally benefit from doing so. A critical mass of new content¹⁸ and user interaction that engages but does not overwhelm^{19,20} helps to entice people to return regularly. A contribution is an individual act that adds to a larger communal effort. Individual contributions can bring substantial benefits to all participants, even though there is no direct communication between individuals.

Collaboration involves two or more contributors working together to create something or share information.²¹ An essential element in this process is the development of a common ground—that is, mutual understanding, shared beliefs, and assumptions.²² Trust and empathy play a large role in encouraging people to work and play together online just as they do offline.^{23,24} People who trust each other often do so because they see similarities between themselves and the other people,²⁵

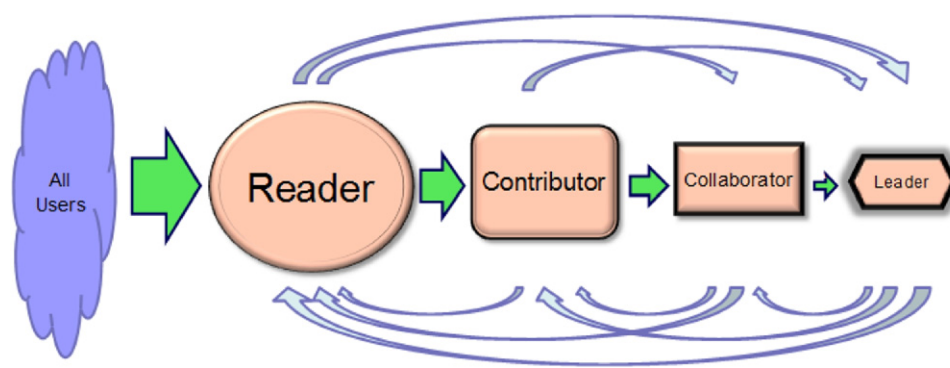


Figure 4. The Reader-to-Leader Framework suggests that the typical path for social media participation has four stages: (1) reading, followed by (2) modest contributions and then more frequent contributions. Eventually some contributors become (3) collaborators who participate in discussions of future directions and take on longer-term efforts. A small number of participants become (4) leaders who set policy, deal with problems, mentor newcomers, and inspire all forms of participation (aisel.aisnet.org/thci/vol1/iss1/5/).

so they encourage each other to participate.²⁶ Designers of the patient support community PatientsLikeMe have explicitly used this knowledge in their site design. They make it easy for patients to find others like them in terms of gender, age, medical problems, and so forth. Everyone can find a picture on the homepage that helps them to find similar others, which can lead to collaborations on stories and exchanges of helpful tips for dealing with a health problem.^{15,27}

While individual contributions and group collaborations are the most visible aspects of social media participation, every social system must have some way of establishing community norms and explicit policies if it is to survive.^{28,29} Leaders tend to synthesize discussions and arguments that they then articulate for others.³⁰ Leadership is a higher calling to which only a small fraction of readers, contributors, and collaborators aspire.¹⁵

A Research Agenda

The Reader-to-Leader Framework, characterizing the evolution from reader, to contributor, to collaborator, and finally, to leader, is a simplified but helpful model of reality. Synthesizing and analyzing this large body of research helps justify the claim for the Reader-to-Leader Framework, but it still needs empirical testing in a variety of contexts. Other frameworks, such as Li and Bernoff's³¹ social technographic profiling and Porter's³² funnel offer alternative models that deserve attention. They strive to identify rudimentary metrics that are essential for studying the success of design and social interventions for encouraging participation. An important component of scientific research is the development of appropriate metrics in order to gauge progress, identify problems, and predict future performance. While some social scientists

engage in small-scale controlled experimentation with dozens of users or groups, the capacity to perform large-scale interventions with thousands of users opens up new opportunities for research. These intervention methods were developed by web companies to study the impact of page layouts, product presentation graphics, or special offers on customer purchasing patterns, but they can be easily applied to technology-mediated social participation projects.³³

Planned and natural interventions are forms of social science case studies that, with replication, can accumulate evidence in support of predictive hypotheses.^{34,35} Progress in providing personal health information to patients can be accelerated by innovative social-networking strategies, more effective search capabilities, and improved user-interface design.¹⁵

Innovative Visualizations

Computerized PHRs pose tremendous problems to system developers. As infrastructure and privacy issues are dealt more realistically, patients will become increasingly comfortable in using web-based services. Poorly designed user interfaces that require horizontal scrolling, clumsy searches, endless menus, and chaotic layouts will eventually be replaced by compact designs with clear layouts. Guidelines documents and usability testing can promote consistent and comprehensive systems that provide good service to consumers, their professional healthcare providers, and clinical researchers who may discover important patterns with these large data sets. Techniques are being developed to summarize, filter, and present voluminous information, enabling consumers and professionals to make important discoveries.³⁶

Personal health records (PHRs) contain a wealth of information, but can be challenging to analyze because categoric event data, such as complaints, diagnoses, and treatments, are outside the scope of standard statistical tools. However, current research efforts are moving beyond numeric data and single-record visualization techniques, thus enabling users to discover patterns of categoric events across multiple records.³⁷

In a past project for the Maryland Department of Juvenile Services, the University of Maryland's Human-Computer Interaction Lab developed a new technique called LifeLines (www.cs.umd.edu/hcil/lifelines) to visualize personal history records that will also enable advanced searching and filtering capabilities. A one-screen overview of the record using timelines provides direct access to the data. LifeLines can reduce the chances of missing information, facilitate the spotting of anomalies and trends, streamline the access to details, and still

remain simple and able to be tailored to various applications.³⁶

Lifelines2^{38,39} is an interactive tool (www.cs.umd.edu/hcil/lifelines2) for visualizing temporal categoric data across multiple records (Figure 5). The goal of the project is to enable discovery and exploration of patterns across these records to support hypothesis generation, and finding cause-and-effect relationships in a population—tasks first motivated by electronic health records. Lifelines2 provides a simple set of operators to allow users to manipulate multiple records simultaneously to understand chronologic relationships across records. The alignment operator forces every record to be aligned by a certain feature (e.g., 3rd Heart Attack) so the events that occur prior to and after the feature can be compared easily. The rank operator sorts patient records according to a feature such as the number of heart attacks, and the filter removes irrelevant patient records, such as those who never experienced angina. In addition, analysts can use temporal summaries to view distribution of multiple event types over time. Temporal summaries enable users to see the average time between pairs of events and allow multiple groups of records to be compared.³⁷

Accessible eHealth Information

Health care is being restructured to take advantage of technology's promise to improve quality of care, deliver cost efficiencies, speed information exchange, and build consumer health literacy. However, missing from the national efforts toward pervasive availability of HIT for patients, families, doctors, and healthcare facilities is a programmatic and policy-based effort to ensure that people with disabilities are able to participate equally in all the opportunities that new Health 2.0 networks and tools have to offer and be able to independently access and manage their personal healthcare information, or use the emerging tools as healthcare workers with disabilities.

The needs of people with disabilities—as patients, caregivers, and professionals—must be addressed in the development of HIT requirements for information design, exchange, and display within both public and private products and services, and the standards governing HIT. Although existing accessibility requirements require federal agencies to purchase or deploy electronic and information technologies that can be used by people with disabilities, there are numerous documented cases of lack of compliance, oversight, and enforcement of the section 508 rules.⁴⁰ Efforts to address the existing gaps are underway at the White House and at the CIO Council, whose members are the chief information officers of federal executive agencies and departments.⁴¹ In the meantime, numerous HIT standards and certifications are be-

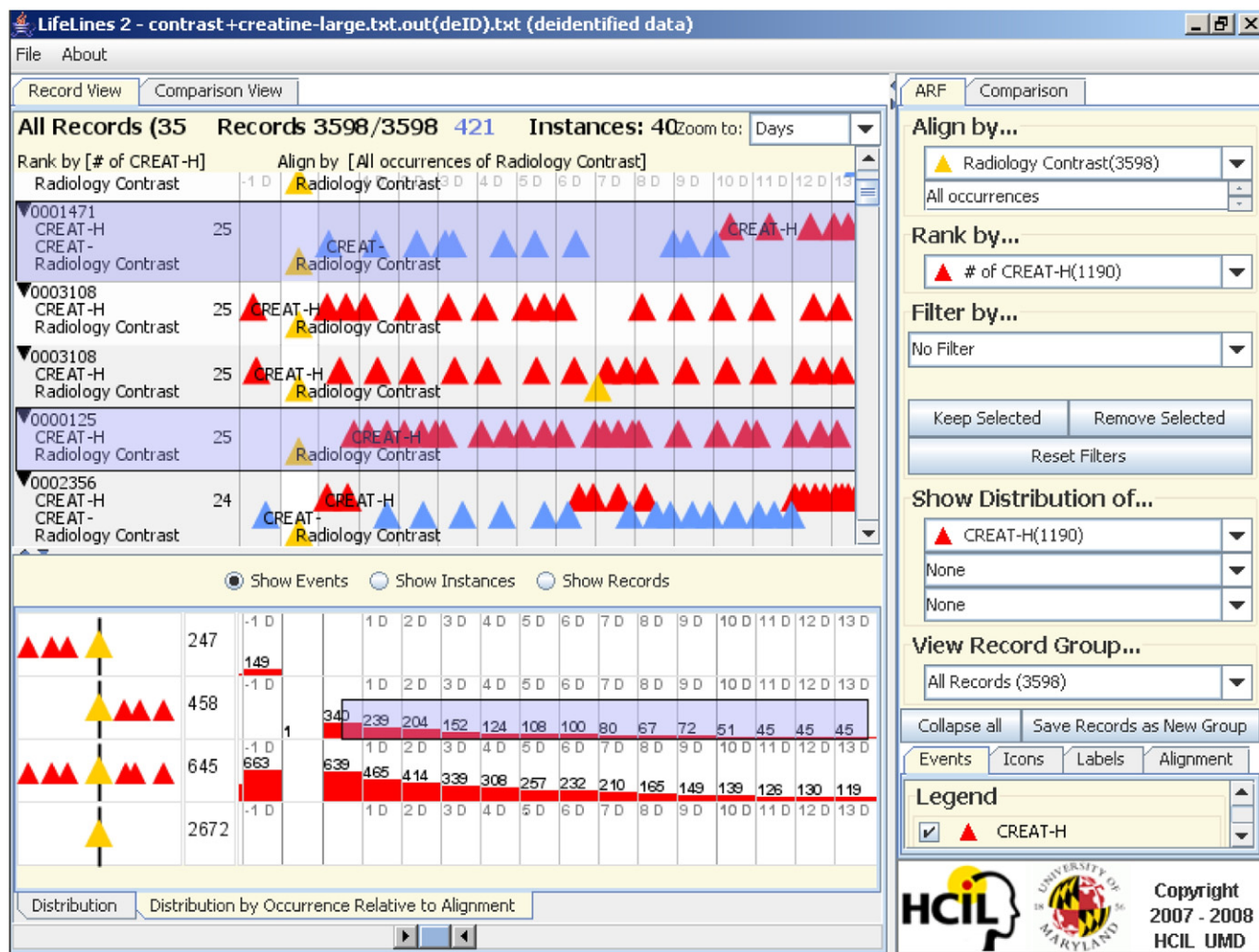


Figure 5. LifeLines2 shows each person’s history as a set of time-stamped events, in this case, results of creatinine blood tests and radiology contrast injections. A researcher is studying the pattern of creatinine-high results within 14 days after the injection of radiology contrast (www.cs.umd.edu/hcil/lifelines2).

ing approved and deployed and new HIT products and services are being used by major healthcare providers and employers—but do not include reference to usability and accessibility requirements of people with disabilities.

Organizations^{42,43} that research and develop technologies, tools, and policies to advance technology equity for people with disabilities are actively seeking to promote attention to these challenges, secure resources to address them, and influence implementation of accessible products and services by public and private technology vendors. The goal is to encourage development and adoption of interoperable standards, specifications, systems, and services that can identify, filter, and present content in ways that are meaningful to people with a wide variety of specific needs.

In order to achieve these goals, public- and private-sector partners and collaborators need to apply their resources to help make advancements in accessible and assistive technol-

ogies in the HIT sector. Specific needs and requirements include design and development of public and private health-related websites according to W3C Web Content Accessibility Guidelines,⁴⁴ design and development of public and private health-related software according to section 508 guidelines,⁴⁵ and, for online media, addition of equivalents to audio for deaf and hard-of-hearing people (e.g., closed captioning or synchronized text) and equivalents to visuals for blind and visually impaired people (e.g., narrated descriptions).^{46,47}

The Food and Drug Administration⁴⁸ and the CDC⁴⁹ are two of many healthcare-related federal agencies that have already made great strides in ensuring that their electronic media are fully inclusive. The initial steps among a few key federal agencies toward full HIT inclusion for people with disabilities need to be matched by similar efforts across the board, starting with an explicit set of policies, standards, and tools that can be guided by

the Office of the National Coordinator for HIT within the DHHS.⁵⁰ Accessibility requirements must be included in the certification process for electronic health records (EHRs) and PHRs. In this way, as the use of HIT becomes more widely adopted and as government funding affects adoption, accessibility will become a prerequisite as well as an assumed aspect of the design, development, and implementation of this- and next-generation HIT.

Usable eHealth Information

The NCI is the U.S. federal government's principal agency for cancer research and training and is responsible for the incorporation of state-of-the-art cancer treatments into clinical practice.⁵¹ The NCI has invested substantially in new applications and technologies to support and achieve its goals. However, as cautioned by the IOM, creating health technology tools and support systems will be valuable only to the extent that they are engineered to be useful and usable to the researchers, providers, and consumers expected to use them.^{52,53} The costs of making mistakes and not "getting it right" can be prohibitive. Inadequate software development projects cost the U.S. economy about \$30 billion per year, and once a system is in development, correcting a problem costs ten times as much as fixing it in design. The cost in missed opportunity for scientific discovery, or to individuals' lives from malfunctioning HIT, is incalculable.⁵⁴

Evidence-based decision making is integral to minimizing mistakes and pushing out poorly executed technologies that fail to be adopted. During his White House Forum on Health Reform on March 5, 2009, President Obama said, "I think it is so important that all of us make decisions . . . based on evidence and data and what works But that requires us to actually look at the evidence." Dr. Harold Varmus, the newly appointed Director of NCI, reiterated this point at his first NCI town hall meeting on July 12, 2010, by saying, "There is a unifying principle, one I will adhere to extremely stringently: Everything that we do, and everything that we say, will be based on evidence."

The NCI has given great credence to this principle for evidence-based decision making by creating and funding an internal office that is dedicated to providing in-house communication and informatics research expertise to its offices and divisions in order to best understand its audiences' needs and avoid costly development mistakes. This office, the Office of Market Research and Evaluation (OMRE), provides a unique model within the federal government that relies on methods and theories derived from psychology, human factors, communication, and informatics engineering. OMRE aims to eliminate the problems and inefficiencies described above by providing

ongoing evidence on audiences' needs, their reactions to dissemination efforts, and their ability to use the technologies developed to assist them in treating cancer.

Specifically, OMRE works with others at NCI to conduct the following types of research: (1) formative or consumer research to ensure an understanding of the information and other resource needs of people and organizations that can benefit from the NCI information resources, and how best to deliver those resources; (2) marketplace research, also commonly referred to as competitive analysis, to identify gaps in information and other resources that NCI should fill; (3) information design research to ensure that the NCI's information products and services have maximum value to their intended target audience; (4) user-centered informatics research with regard to interactive and online information products, to ensure that the information products being developed are effective in conveying their intended content; (5) process-tracking research to document the success, or lack therefore, of efforts to disseminate information resources, including web-analytics; and (6) evaluation research to assess the impact of NCI's dissemination activities.

The OMRE serves a model within the U.S. federal government system. One example that successfully applies the multiple methodologies within OMRE to ensure the development of useful and usable technologies is its contribution to the development of caMATCH, or BreastCancerTrials.org, an online mechanism that matches the patients' actual medical history record to inclusion and exclusion criteria in clinical trials. The project started with a needs assessment of women with breast cancer in how to access clinical trial information online, leading to the development of a testable web-based tool to assist women with this task,⁵⁵ and then ultimately an evaluation of two versions of the tool to identify the impact of the tool on women with breast cancer while using it.⁵⁶

Ensuring Usability and Accessibility

At the end of the day, no one can be satisfied with a system in which the system itself is a contributing factor to an error in patient treatment. Therefore the only two things that should matter are how these EHR systems promote the ability of medical practitioners to perform their routine tasks and deliver high-quality medical services to their patients and ensuring that the user-interface designs of these systems do not lead to critical errors. To achieve these objectives, systems must first be usable and accessible by practitioners, patients, and other stakeholders. The most critical component of an evaluation criterion is a test of actual user performance that measures successful

task completion, accuracy, and an acceptably low frequency of critical errors. The way to ensure a truly meaningful adoption and use of HIT is to define objective usability standards and adhere to them through established test methods.

To promote adoption and usage of HIT, the DHHS will soon be offering incentives for doctors and hospitals to use information technology and integrate it in a meaningful way into their healthcare delivery processes. Usability is a key factor in the meaningful use of these systems, because functionality is for naught if not used effectively, efficiently, and safely by its human users. The ultimate goal of this work is the detailed specification of an objective, valid, and repeatable procedure for measuring and evaluating the usability of HIT systems.

Designing a Health Information Technology Usability Certification Process

Methods of evaluation based principally on how much a medical practitioner likes using a system are irrelevant to performance-based certification. In the world where high technology systems meet the time-honored medical profession, there is no room for user-interface designs and evaluation methods that operate on the margin of the problems we face today. Therefore the hope is to achieve systems that will be certified for a medical purpose that allow medical practitioners to deliver the right treatment to the right patient at the right time and support the health or recovery of that patient; usability supporting the medical practitioner in meeting the goal listed above; accessibility of user interfaces supporting those who might be “star” medical practitioners, were it not for the lack of a technology supporting a disability for which they are challenged; and finally, resolution of HIT-related disparities for the lower sociodemographics, people with disabilities, those with English as their second language, and those who are simply in stress and cannot perform adequately. Against these goals, the only thing that matters is that there are standards for certification and established test methods against the standards.

There is a well-established user-centered design⁵⁷ process defined that can make HIT systems more usable today. For the usability test during this process, the focus is exclusively on the validity and methodology of the test and not on the test results. Using design guidelines, researchers generally focus on what is happening, not how. Design guidelines tend to be component-specific and do not deal with how the components combine to support workflow. There are many ways to measure human performance based on the different usability tests. Performance benchmarks are created as a goal for the users being tested. These tests are done by specifying tasks to be

completed and testing protocols. The systems will either pass or fail based on the benchmark criteria.

Stages for Certification Development and Design

Extensive human factors research needs to be conducted to establish pass/fail criteria and standards for usability certification. This research will result in the development of test methods that include specific protocols. The next step is to test the methods and protocols for validity and repeatability. Once it has been established that the protocols are valid and repeatable after the first experiment within a single test environment, the protocols need to be applied in other test environments (using different testers, different labs, and different test participants representing end users) to ensure that they as well produce repeatable results across all test environments. After this work has been completed, it is established that the strict pass/fail criteria for certification using these test protocols are valid for use by accredited test entities.

Timing (or task completion time) can be an important criterion for efficiency; however, timing might not be an appropriate criterion for a pass/fail performance benchmark (unless failing to complete a task within a specific time period is considered an error). Usability testing takes place in a lab setting where users who test the system may behave artificially because they know that they are not performing tasks in the real world. Consequently, they may take extra time for exploratory activities in performing their tasks. Essentially, the most critical component of a pass/fail criterion is one that tests actual user performance and measures accuracy, successful task completion, and freedom from critical errors.

As findings accumulate from research efforts, a usability component will gradually be incorporated into the meaningful-use criteria in stages. In the short-term view of the testing, the focus is on the process. This stage requires manufacturers to submit a report of a summative usability test using a standard industry format, customized for the healthcare context, to show evidence of product usability and the presence of usability engineering processes. Manufacturers must also submit a list of user requirements as defined by the Theofanos report⁵⁸ in which usability requirements consist of three parts: context of use, measures and metrics, and the testing procedure. In the medium term, focus is on design features and the process. This stage provides voluntary usability design guidelines that manufacturers can use for self-evaluation of their systems, in addition to requiring submission of the usability report and user requirements. In the long term, design features, the process, and performance are the main focus. In this stage, specific and measurable usability objectives are adopted for HIT. A

formal testing procedure is instituted that involves the application of performance-based pass/fail usability criteria.

One should start out by specifying the type of technology being studied, the users that are testing, and the tasks that will be completed in the study. Human performance measures and their related benchmarks must be clearly defined in relation to the tasks being studied. Usability measurement is conditioned by the tasks carried out, the users involved, and the settings in which the product will be used. Since these factors will be different for each product, customization is of utmost importance in the usability testing.

Conclusion

Consumer health informatics discussed, as above, gives us various ideas for approach to its success. These viewpoints are considered in this section to summarize the whole review. The personas are considered to help address the challenge for most technology projects. Personas are one tool to help picture the audience for any system in a way that can drive the design process from the user perspective.⁹ Inference can be drawn from the Reader-to-Leader Framework to understand human motivation to participate in social media. This framework enables them to improve user-interface design and social support for projects. These improvements could reduce the number of failed projects while accelerating the applications of social media in health care, disaster response, community safety, and more users. Good user-interface design produces accessible and universally usable applications that enable solitary reading or social interactions that meet the needs of diverse user populations.^{15,18}

Progress in providing personal health information to patients can be accelerated by innovative social networking strategies, more effective search capabilities, and improved user-interface design.¹⁵ LifeLines, the University of Maryland's Human-Computer Interaction Lab technique developed to visualize personal history records is an example to be studied in depth. The most critical component of an evaluation criterion is a test of actual user performance that measures successful task completion, accuracy, and an absence of critical errors. The way to ensure the truly meaningful adoption and use of HIT is to define objective usability standards and adhere to them through established test methods. Designing without user and task analysis often produces products that ignore accessibility requirements,¹⁰ fail to address the variations in roles, and do not provide the right balance of usability requirements.¹¹ This means thinking about HIT in the context of the larger social ecosystem, providing links between online systems and human support. If us-

ability and accessibility in the consumer context are not taken into account, then there is no way that the final products will meet usability and accessibility goals for the broadest range of people with the widest range of capabilities.

Accessibility requirements must be included in the certification process for EHRs and PHRs. Evidence-based decision making is integral to minimizing mistakes and pushing out poorly executed technologies that fail to be adopted. A unique model that relies on methods and theories derived from psychology, human factors, communication, and informatics engineering aims to eliminate the problems and inefficiencies described above by providing ongoing evidence on audiences' needs. The OMRE research approach is noteworthy and a pattern to be followed for efficacy of the results. The way to ensure the truly meaningful adoption and the use of HIT is to define objective usability standards and adhere to them through established test methods. Design guidelines tend to be component-specific and do not deal with how the components combine to support workflow. Usability requirements consist of three parts: context of use, measures and metrics, and the testing procedure. A formal testing procedure needs to be instituted that involves the application of performance-based pass/fail usability criteria. Human performance measures and their related benchmarks must be clearly defined in relation to the tasks being studied. All these would lead to a successful consumer health informatics scenario.

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