Dynamic Accessibility Requirements for Hospital Patients

Dan Morris
Microsoft Research
Redmond, WA, USA
dan@microsoft.com

Amy Karlson
Microsoft Research
Redmond, WA, USA
karlson@microsoft.com

Abstract

Today's hospital is a place of constant information flow, with patients relying on technology more than ever before for records management, for communication with loved ones, for online research, and for the simple distraction of playing games or watching YouTube.

Although a patient may perform all of these computing tasks at home on a regular basis, accessing the same information resources in the hospital presents tremendous usability challenges. A patient's cognitive and emotional states are under constant manipulation by stress, pain, and medication. The patient is situated in a highly constrained physical environment subject to challenges in both ergonomics and sanitation. Transient changes in capabilities leave patients frustrated and uncomfortable even with familiar UIs.

In this position paper, we describe the hospital as an environment in which users have rapidly-changing cognitive and ergonomic capabilities, and argue that the hospital patient should be treated as a situationally-impaired computer user. We highlight unique opportunities to leverage hospital-specific data streams to mitigate this problem, and we discuss the applicability of dynamic adaption and existing assistive technologies.

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.
ACM 978-1-4503-0268-5/11/05.

Keywords

Electronic medical records, dynamic accessibility

ACM Classification Keywords

H.5.2: User Interfaces, J.3: Life and medical sciences.

General Terms

Human factors

Introduction

Jason – an information worker who uses computers every day – arrives in the emergency department (ED), lucid but experiencing severe abdominal pain. He is given a heavy dose of morphine, but before he drifts off to sleep, he uses his phone to keep his family up to date on his hospital visit, and he uses the computer located in his ED room to see the status of tests that his doctor ordered. Both of these tasks get progressive-

ly difficult as the painkiller takes effect, and even reading email becomes challenging. Within an hour Jason loses consciousness, so while Jason rests, his wife (distressed but lucid) takes possession of Jason's phone to continue several ongoing threads of communication which Jason initiated with concerned family members. She also jots down details about Jason's care based on what's visible from the room's patient-facing computer, as well as questions that she wants to ask Jason's doctors. When Jason regains consciousness, he's feeling a little more aware, but is now experiencing severe emotional distress because his care team is considering abdominal surgery. Although Jason's laptop is available and connected to the Internet, he abandons his attempt to do research about his impending surgery because he finds it difficult to concentrate on the task given the stressful circumstances. Moreover, Jason has been put on an IV which restricts his motion, and he isn't comfortable sitting upright for more than a few seconds to use the bedside computer. He would love to play games on his phone as a distraction, but he finds the games he's used to playing every day quite frustrating, since his sensorimotor skills are so restricted, only exacerbating his stress. Furthermore, his wife has gone back to work, so it's up to him to keep up to date on his own electronic medical record. A few hours later, Jason is diagnosed with appendicitis and admitted to the hospital. In his hospital room, the pace of activity slows down a little and he's finally able to calm down and digest all that has occurred over the past several hours. He also has been transitioned to a different painkiller which leaves him a bit more lucid. However, in this room the only display available is the TV: low-resolution and relatively far away, with a bit less privacy than the screen available in his ED room.

Jason's story is typical for patients visiting a hospital for acute care, particularly for ED patients: technology plays an increasingly important role in both comforting patients and keeping patients engaged in their own care, but the hospital presents a profoundly challenging and dynamic usability scenario. Hospital patients experience rapid swings in cognitive ability based on changes in medical conditions and treatments for those conditions, patients experience rapid changes in emotional state (and thus information processing capacity) based on diagnoses and test results [1,9], and patients experience rapid changes in motor capability based on both medical events and the ergonomic constraints of the hospital room. Furthermore, someone other than the patient – who is often experiencing some subset of these impairments – is frequently stepping in to communicate and interact on behalf of the patient, possibly through the same devices used by the patient.

Consequently, we argue that from a design perspective, the hospital patient should be treated as a situationally-impaired user: interfaces designed for hospital use need to account for a wide range of motor and cognitive abilities. Even for general-purpose applications (such as Web browsers) that are not designed specifically for the hospital bed but are of great import to hospital patients, it may be necessary to mediate interaction through assistive technologies that are not typically applied to this space: non-typical input devices, adaptive presentation engines, etc.

Moreover, designing tools for hospital patient use needs to consider the highly *dynamic* nature of these impairments. In the course of a few hours, our fictional but typical "Jason" saw his ability to use a computer fluctuate from "excellent" to "severely impaired".

Our Work in this Area

Work in our group has explored a single point in the adaptation spectrum: transforming the clinician's view of a patient's medical data into a view suitable for the patient, who has restricted health literacy, restricted attention, and restricted interaction relative to clinicians. In [8], we explored the design of simplified, non-interactive information displays through Wizard-of-Oz prototypes, translating data from the electronic medical record (EMR) to a "patient-friendly" view with the help of a patient's physician. This work assumed that the ideal level of detail was static for a given patient, which – for reasons we stated above – is a tenuous assumption. We are thus exploring automatic tailoring of detail and other content manipulation on a per-patient and even per-instant basis. This work also assumed a non-interactive display, due largely to the large form factor we were exploring. We are thus also exploring mobile-device-based interfaces that will enable a richer variety of interactions and deeper personalization.

Through our initial work – and through subsequent focus groups, site visits, and interviews – we have distilled several points that highlight unique accessibility needs identified by patients:

1. Care staff changes rapidly; patients may see many different staff members, any one of whom may not have a sense of the "big picture". The patient may thus be left to piece together the care story on his/her own, a high-level sensemaking task that presents significant challenges to cognitively-impaired patients.
2. Information is generally conveyed to patients verbally. Even if the patient is lucid, this leaves open the possibility of forgetting critical information [3,5]. If the patient is on pain medication, tired, or sedated, processing and/or remembering verbally-conveyed information can be extremely challenging. Patients thus identified a need for computer-based memory support in the hospital, an area of active research for other accessibility scenarios and a design opportunity for in-hospital computing.
3. The hospital is disorienting with respect to its rhythms; the traditional notion of interruptions as a usability problem is exaggerated tremendously in the hospital. A patient may be focusing on a single information task, only to be disrupted by a variety of treatments, room changes, tests, etc., returning to the task in a completely different emotional or physical state. This level of within-task variation during the course of, say, a single Web search is atypical in most computing environments.
4. Patients have limited control over their physical environments [4,6], and are often sharing a room. What space is available to the patient to place a phone, a laptop, or even a keyboard may feel unclean, intimidating, or unsafe. Pockets or simple storage areas may not be available, and physical security of valuables may not be guaranteed. This lack of even basic space ownership challenges some basic assumptions typically made in the design of both desktop and mobile interfaces.

Keeping in mind the challenges outlined in the previous sections, we now briefly discuss possible accessibility and adaptation solutions to some of these problems.

Leveraging the EMR for Adaptation

One of the challenges posed to any system attempting to dynamically adapt to a user's changing needs, context, and situational impairments is *detecting* those changes. A mobile phone interface, for example, might switch from a touch-based interface to a voice-based interface if it can detect that the user is likely driving a car, based on environmental sensing. Impairments as diverse at those occurring in a hospital may be difficult to detect; cognitive impairments in particular may be beyond the scope of current sensing technology, or may require a prohibitive level of user intervention (e.g., completing cognitive assessment surveys).

However, the hospital environment offers a previously-untapped stream of information that may support dynamic adaptation: the electronic medical record (EMR). This unique data stream often contains explicit information about cognitive or motor assessments performed for clinical reasons, and nearly always contains explicit information about treatments and diagnoses with predictable impacts on a user's computing capabilities: medication dosages, physical examination and injury reports, etc. While this data stream may not deterministically map to UI adaptations, it may provide a wealth of information that can be coupled with other data streams – such as those used in other environmental sensing work – to inform dynamic adaptation.

We thus hypothesize that the electronic medical record represents a previously-untapped resource for dynamic accessibility in clinical environments.

The Social Nature of Care: Dynamically "Adapting" UIs by Diverting Responsibility

Due to rapid changes in information processing capacity, hospital patients frequently rely on others to be their "eyes and ears" while the patient is cycling through cognitive and motor lows. This has interesting implications for the design of patient-centered information systems, which may need to support highly permissive sharing models of very sensitive data for short periods of time.

We hypothesize that with adequate detection techniques, transient collaboration may be an appropriate mechanism for addressing situational impairments in clinical environments.

Applying Existing Assistive Technologies to Transient Impairments in the Hospital

Without attempting to address the full breadth of accessibility research here, we highlight that some of the temporary impairments experienced by hospital patients are similar to longer-term or permanent impairments experienced by other computer users. It will be interesting to explore the applicability of research and commercial assistive technologies (ATs) – which are generally *not* dynamic or adaptive – to hospital patients who are experiencing *highly* dynamic (and often short-lived) impairments.

Because such impairments are common in hospitals, the hospital might offer access to ATs that would not normally be sought out by a temporarily-impaired user. However, unique challenges arise here, particularly around the difficulty of learning or accepting an AT in such a short time frame, and it remains to be seen which – if any – ATs are suitable for acute impairments.

For example, motor-impaired users who are unable to rely on keyboards and mice often turn to multimodal input as a primary input stream. Dynamically suggesting, providing, and applying these technologies to hospital patients experiencing transient impairments or ergonomic limitations poses an interesting area of exploration. It also bears mentioning that unique challenges exist around sanitation in the hospital, and multimodal interfaces that don't require physical device contact might be considered cumbersome in many environments, but might be preferable to keyboards and mice in hospital environments.

Further research is also necessary to map well-studied motor and ergonomic impairments – and existing tools to mitigate those impairments – to clinical situations. For example, can we identify sets of parameters in the EMR that suggest a transient impairment which is similar to impairments caused by a disease or injury? And, if so, can we provide established accessibility solutions for that impairment?

Additionally, as outlined above, hospital environments pose numerous threats to patient *memory* and *comprehension* of treatment plans, due both to dynamic changes in patients' mental states over the course of a visit and the unpredictable and interrupt-driven nature of patients' interactions with their care staff. Here we believe valuable lessons can be drawn from prior research tools for memory and planning assistance, such as those for the elderly [7] and children with developmental impairments [2]. *In short, we hypothesize that existing (static) assistive technologies may be (dynamically) employed to support hospital patients, with adequate detection techniques for in-hospital impairments*.

Conclusion

Though hospital patients have not typically been addressed as a user population that can benefit from accessibility research, we argue that the hospital represents a challenging but promising arena for dynamically adaptive accessibility solutions for computer use. The hospital introduces extreme variations in situational motor and cognitive impairments, but offers unique opportunities to leverage both existing and novel adaptive assistive technologies.

References

[1] Byrne, G., Heyman, R. Patient anxiety in the accident & emergency department. *J Clin Nurs*, 6.4 (1997).

[2] Hayes, G.R., Hirano, S., Marcu, G., Monibi, M., Nguyen, D.H., and Yeganyan, M. Interactive Visual Supports for Children with Autism. *Personal and Ubiquitous Computing*, 14.7 (2010), 663-80.

[3] Kessels, R. Patients' memory for medical information. *J Royal Society Med*, 96 (2003), 219-22.

[4] Klasnja, P., Civan-Hartzler, A., Unruh, K., Pratt, W. Blowing in the wind: unanchored patient information work during cancer care. *Proc ACM CHI 2010*.

[5] McGuire, L.C. Remembering what the doctor said: organization and older adults' memory for medical information. *Exp Aging Res*, 22.4 (1996), 403-28.

[6] Unruh, K., Skeels, M., Civan-Hartzler, A., Pratt, W. Transforming clinic environments into information workspaces for patients. *Proc ACM CHI 2010*.

[7] Wherton, J.P., Monk, A.F. Technological opportunities for supporting people with dementia who are living at home. *International Journal of Human-Computer Studies*, 66.8 (2008), 571-86.

[8] Wilcox, L., Morris, D., Tan, D., and Gatewood, J. Designing patient-centric information displays for hospitals. *Proc ACM CHI 2010*.

[9] Yoon, J., Sonneveld, M. Anxiety of patients in the waiting room of the emergency department. *Proc ACM TEI 2010*.