Design and Usability Testing of Anonymous Touch-Screen Electronic Queuing System: Towards Improving Patient Satisfaction

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***Abstract* — Patients' experiences of hospital waiting rooms are often negative. Academic literature reports patients' describing fear, anger, uncertainty, and rage (sometimes directed at staff). Electronic white boards are being used to give staff overviews of ward activity, but information systems aimed at patients are often concerned with using time spend in the waiting room for patient education, rather than clarifying the queuing process. Patient confidentiality is a key concern within health care. This paper describes the design and initial usability testing for an anonymous electronic waiting room system. The results regarding participants' perception of the software's usability, learnability, and usefulness were encouraging, and the interaction success rate was high.**

Keywords-component; Waiting Room, Usability, Touch-Screen

I. Introduction

A. The Experience of Waiting

Fear has been described as a common aspect of the hospital waiting experience [1] [2]. Obviously, in many cases the waiting experience is benign. However, the degree of emotion varies according to circumstances (largely the severity of the condition affecting a patient). Waiting rooms may trigger a sense of distress and vulnerability in patients (especially those with potentially life threatening illnesses, such as cancer). Occasionally strong emotions may even lead to those who are waiting becoming aggressive toward hospital staff. There are suggestions that such behaviour is increasing (in the UK) [3]. Patients sometimes become frustrated when they wait longer than anticipated. It can be difficult for staff to quickly provide accurate estimates of waiting times.

Reference [1] describes the differing views of, and interactions between (an undetermined number of) patients and five receptionists within three specialist medical clinics (in the USA). It includes instances of patients swearing at receptionists as a result of waiting room issues (such as late arrival), where the patient's main concern was being denied access to health care. It provides evidence that responding to waiting room queries consumes a significant amount of staff time. However, it argues that 'patient health care begins in the waiting room' [p. 230], as responding to patient queries plays such an important role in the treatment process.

Reference [2] describes the experiences of 12 participants who were family members or friends of a patient in a Canadian adult critical care unit. Data collection was done via dialogical engagement (a form of interviewing where a single open-ended question is asked, and then the interviewer contributes as little as possible, except to encourage the participant to continue). It argues that the experience of waiting may be characterised by:

- vigilant attentiveness – where participants are persistently watchful of what is happening, and engaged in anticipating (often unpleasant) alternative possibilities (termed creative imagining)
- ambiguous turbulent lull – where participants describe feelings of time standing still and are unsure / uncertain when the wait will end
- uplifting engagements – where participants experience calming or comforting contact with other people.

Although the study probably encountered the more severe examples (as the data were collected in a critical care unit), it seems likely that these characteristics apply across other departments to both patients and visitors. The experience is one of external physical inactivity with internal mental chaos (to varying degrees).

For the general public (internationally), the process of waiting lists and queuing within hospitals is contentious, and has attracted the regular attention of the media [4] [5] [6] [7]. Much of this focuses on waiting to get a hospital appointment, which may influence patients' thoughts and behaviour in the waiting room.

There is considerable literature regarding the process and experience of waiting. However, much of it focuses on emergency departments (ED) or critically ill patients. There seems to be less available regarding the patient's experience in other departments. None of the work identified specifically dealt with patients in an Ear Nose and Throat (ENT) department.

B. Electonic Whiteboards and Patient Records

Recently, technological improvements and reductions in cost have encouraged interest in healthcare information systems. Applications that were previously technically impractical or too costly (such as electronic patient records) are now being developed and entering routine clinical use [8], [9], [10].

There is also a growing interest in the design, introduction, and evaluation of electronic white boards within healthcare [11]. This has largely focused on

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supporting a clinical overview for staff in emergency departments, which are arrival (rather than appointment) based. The nature of the working practices and thus the software requirements may differ in other departments. Much of the work looking at presenting information to patients has focused on using waiting rooms for patient education.

C. *Patient Confidentiality*

Patient confidentiality is a core concept within healthcare. There is concern that the increase in technology brings an increased risk of breaches, and staff are encouraged to be wary of information being discussed or displayed in public parts of hospitals (such as waiting rooms) [12] [13].

D. *Anonymous Electronic Queuing System*

An audit (conducted in a UK hospital) suggested that an electronic waiting-room system may help improve patient satisfaction. The hospital contacted the University. Waiting-room information software has been developed in collaboration with a local hospital's Ear-Nose-and-Throat (ENT) department. This shows current queues operating within the clinic and anonymous ticket numbers of the patients in each queue (on a large screen). It is hoped that this will make it easier for staff to inform patients of estimated waiting times.

This work focuses on the support of the patient rather than providing a staff overview. However, in order to support patients the system requires effort by staff. The work considers how the staff will perceive this effort when the obvious benefits may be for the patient. A potential benefit to the staff could be in fewer patient queries and / or greater ease in dealing with patient queries.

II. METHOD

There are three aspects to the present study:

- the development of an understanding of the ENT waiting room,
- the development of software to support the queuing process, and
- the evaluation of the usability of this software (in preparation for a clinical audit).

Although these aspects are described separately, there was a degree of overlap in the process.

A. *Analysis of Waiting Room Human-Activity System*

A pseudo-ethnographic approach was taken. Initially, several unstructured interviews were conducted with the lead clinician. This gave an overview of the department and the requirements. Then three observations were conducted in the natural setting during normal clinic operating hours (one in the reception area, and two in the consulting room corridor). This was done to provide a more detailed understanding of the queuing process within the clinics, and therefore the requirements for a queuing system. Each observation lasted approximately 3 hours, during which time field notes were taken. Audio and video recordings were avoided for reasons of patient confidentiality, and interference with the natural setting. An understanding of the waiting room human-activity-system (HAS) was developed from these interview and field notes. Key and recurrent themes were identified emergently (no pre-determined coding scheme was used).

B. *Initial Software Development*

The initial software was developed based on the understanding of the HAS. There was a focus on graphical interface (usability, learnability, and usefulness). Although it is unlikely that software failure would lead to patient morbidity, it could cause serious disruption to the working process and therefore indirectly interfere with patient care.

C. *Software Usability Study*

The intention was to identify and correct usability problems, prior to live trials, routine use, and staff and patient audit (evaluation of effectiveness, where usability issues may act as a confounding factor). The study was designed to answer questions regarding issues identified during the previous evaluations with clinicians (such as to allow the investigation of alternative designs, to determine which was the most effective).

Exhaustive testing with clinical staff was impractical. Therefore, university students and staff from the computing department were recruited (although these surrogate users were not members of the target user population, they were readily available and avoided the risk of biasing the actual staff).

A standard protocol was followed for all participants. The study sought to simulate the process of keeping the queue display up to date. Participants were asked to play the role of a nurse / doctor who was allocating patient ticket numbers to queues. Changes to patient ticket number positions were read to participants, and the participants were asked to use the software to reflect those changes on the queue display.

Participants were instructed to imagine that they were stood by the trolley in the consulting area (described in section 3A), with a touch screen in front of them. The usability tests simulated the process of keeping the queue display up to date (as patient notes arrive, as patients leave, as patients are moved between queues, as patients are re-ordered with a queue).

A sequence of thirty four tasks were read by the researcher to the participant. Fig 1. shows an excerpt from the task list. The same task list was used for all participants, and the tasks were presented in the same order.

101 to Audiology
105 to Nurse
No, that should have been 106 [instead]
108, 109 to Barker
105 to Jones
104 to Smith
100 Seen

Figure 1. Excerct from the task list, showing seven tasks that were read to the participants.

The sessions were audio recorded to capture comments, and video recorded to pick up the state of the screen, and participants hand gestures. Participants were encouraged to describe their thoughts during the activity (thinking aloud protocol [14]). It was stated that the study sought to evaluate the software (to see how easy it is to use), not the participants. Participants were told that the data collected would only be used by members of the research project for the stated aims. Individual data would not be distributed to other parties, nor would it be used for other purposes (only anonymous aggregate data would be presented in publications).

A Viewsonic Viewpad was used with the first three participants. However, it stopped responding just before use with the fourth participant. It was replaced by a Dell Inspiron Duo Tablet PC (which was used with the final five participants).

III. RESULTS

A. Waiting Room Human-Activity System

The ENT department operates two clinics per day, with about fifty patients attending each clinic. Fig. 2 shows the department's reception, with the main waiting room seating area to the left (out of view).

Figure 2. Photograph of reception.

As patients arrive they report to reception. The receptionist checks their name and address against the electronic patient records system (which includes details of their appointment). The receptionist then moves the patient's notes from a large shelf to the reception desk. The patient then takes a seat in the waiting room.

At regular intervals, staff (usually nurses and health care assistants) move the notes to a small trolley in the consulting area. Sometimes it is not immediately clear who a patient will see when their notes arrive on the trolley. Fig. 3 shows a doctor (Consultant) reviewing patient notes on a trolley that is used as a co-ordination point, prior to calling the patient into the consulting room.

Figure 3. Consulting area corridor, tolley, and view into consulting room.

Within the ENT department is an Audiology unit, which conducts hearing tests. Patients may be sent there as they arrive, or after seeing a doctor. They may then be seen again by that doctor to review the results of the hearing test (thereby jumping the queue). Urgent cases from other hospital departments (such as ED) may also jump to the top of a queue.

Once a week, there is a specialist oncology clinic, which brings in expertise from other disciplines (Maxillo-Facial, and Plastic Surgery) to join the ENT team.

B. Waiting Room Software

At reception each patient will be allocated a cloak room ticket (e.g. 106), which come in identical pairs. One ticket will be given to the patient, the other attached to their notes.

The Electronic Queuing System has two components:

- Patient View – This (shown in Figure 4) displays queues of anonymous electronic patient tickets. An individual patient can see which queue they are in and how many other patients are in front of them (by locating the electronic ticket that matches the physical ticket they were given on arrival). This is shown on a large screen monitor (42") located prominently in the waiting room (permanently wall mounted in the waiting room). Interaction with this screen is limited to viewing only.

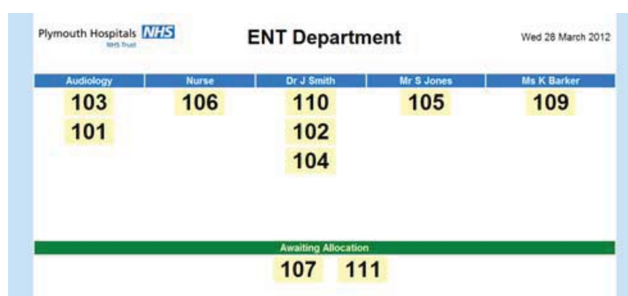

Figure 4. Patient View sceen shot.

- Staff View – This (shown in Fig. 5) displays the same queues of anonymous patient tickets, as well as tickets that have not been used yet, and tickets that have been seen. This is shown on a touch-sensitive screen (10” for this study, but 22” for the live system) – wall mounted above the trolley (in the consulting area). It allows clinicians to allocate patient tickets to queues (as they become aware of changes), and thereby keep the Patient View up to date. Specifically, Fig. 5 shows the display just after ticket number 110 has been selected. Buttons are displayed that allow the selected ticket to be moved to another queue, up and down the current queue, and to the seen area. The ‘Awaiting Allocation’ queue allows patients to be shown and then allocated to a specific queue later.

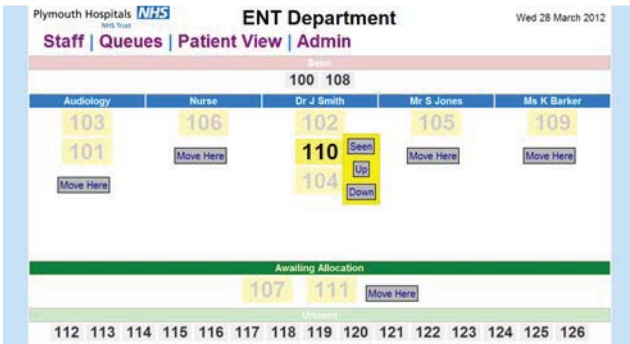

Figure 5. Staff View screen shot.

C. *Usability Tests*

Eight participants were recruited (four students and four staff, all male). Table 1 shows key background information for the participants. Seven participants were either studying or teaching computing. Three participants used the Viewsonic Viewpad, and the remaining seven used the Dell Duo.

TABLE I. BACKGROUND DATA OF PARTICIPANTS (A TO H)

	A	B	C	D	E	F	G	H
Tablet[a]	V	D	D	D	D	V	D	V
Discipline[b]	C	C	N	C	C	C	C	C

a. V – Viewsonic ViewPad, D – Dell Duo

b. C – Computing, N – Non-computing

Table 2 shows the main issues that emerged during the usability testing. Two participants did not attempt to drag and drop tickets. Five participants tried drag and drop. One participant considered drag and drop, but decided to try the simpler separate click approach.

TABLE II. MAIN ISSUES IDENTIFIED DURING USABILITY TESTING FOR EACH PARTICIPANT (A TO H)

	A	B	C	D	E	F	G	H
Drag and Drop	y/n[a]	y	n	y	n	y	y	y
Multiple Select	y	y	y	y	y	y	n	y
Seen button	n	n	y	n	n	n	y	n
Remembered	n	n	n	y	n	n	y	y

a. Participant considered drag and drop first, but tried separate click first.

All participants were able to complete all activities. The following issues were identified:

- Drag and Drop – Most (5) participants instinctively tried to drag and drop tickets
- Click accuracy – All participants had difficulty clicking on tickets and buttons (if they missed then it was only by a few pixels).
- Position of Seen button – one participant looked for the seen button in the seen section, and it took quite a while for them to locate it in the ticket context menu.
- Colour Coding – One participant raised the issue of people with colour blindness not being able to distinguish the sections of the screen if staff used the colours to describe the sections (such as green for the awaiting allocation area).
- Moving Back – When a mistake was simulated, and the participant wanted to reverse an action, participants had difficulty remembering where the ticket had come from.

Table 3 summarises the success rate of participants’ actions in attempting to complete the tasks.

TABLE III. SUMMARY OF SUCCESS AND FAILURE OF ACTIONS DURING USABILITY TESTING FOR EACH PARTICIPANT (A TO H)

	A	B	C	D	E	F	G	H
Total Actions	92	92	92	92	92	92	92	62
Success	84	86	83	90	89	85	89	57
Misses	8	6	9	2	3	7	3	5
Success rate (%)	91.3	93.5	90.2	97.8	96.7	92.4	96.7	91.9

Tables IV, V, VI, and VII show participants’ perceptions of software learnability, usability, interference with staff, and impact upon patients.

TABLE IV. CLASSIFICATION OF SOFTWARE LEARNABILITY (NUMBER OF PARTICIPANTS)

Very Easy	Easy	Neutral	Difficult	Very Difficult	Total
6	2	0	0	0	8

TABLE V. CLASSIFICATION OF SOFTWARE USABILITY (NUMBER OF PARTICIPANTS)

Very Easy	Easy	Neutral	Difficult	Very Difficult	Total
6	2	0	0	0	8

TABLE VI. CLASSIFICATION OF SOFTWARE INTERFERENCE WITH STAFF WORK (NUMBER OF PARTICIPANTS)

Very Unlikely	Easy	Neutral	Likely	Very Likely	Total
4	2.5	1	0.5	0	8

TABLE VII. CLASSIFICATION OF SOFTWARE IMPACT ON PATIENTS (NUMBER OF PARTICIPANTS)

Very Helpful	Helpful	Neutral	Problematic	Very Problematic	Total
4	4	0	0	0	8

IV. DISCUSSION

The results regarding participants' perception of the software's usability, learnability, and usefulness were encouraging (describing it as easy to learn and use, and likely to help patients without hindering staff).

The average success rate amongst participants was 93.8% (the lowest 90.2%, and highest 97.8%). Whilst these figures are encouraging, some of the comments made by participants during the studies indicated significant levels of frustration (especially initially). One participant indicated that they were having to concentrate quite intensely to ensure accuracy. This suggests that (without modification) acceptability during routine use may be lower.

It is clear that mouse interaction gives a greater degree of precision and control, and that the touch-screen buttons need to be larger. However, due to the nature of this application there is a balance to be struck between large buttons and fitting all of the tickets on the screen at the same time. It seems that the actual hardware makes a difference (the Dell unit seemed more accurate than the Viewsonic – its use gave fewer errors).

This study used a relatively small sample size (eight) of non-target users. There seemed to be differences between the (surrogate) test users and target user population. However, given difficulties in gaining repeat access to the target population, the study was still very useful (as long as analysis took user-gap into consideration).

More work is required to investigate the optimum button size, and interaction mode (separate clicks vs. drag and drop), with a larger number of participants.

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