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MSc in Human Centred Systems

Project Report

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Patient Vital Signs Software on a Tablet PC - Specification, Development and Evaluation

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Declaration

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Gerard Isdell

Abstract

The focus of this research is in the area of mobile healthcare technology. This dissertation explores the recording and visualisation of patient vital signs using a web-based application running on a touch screen tablet PC. Although nurses routinely record a patient's vital sign on a paper form, new technologies present an opportunity to convert this process to an application running on a mobile device. This dissertation develops a detailed set of requirements for such a system, in the context of nurses' working at the children's ambulance transport service (CATS). To fulfil these requirements, a database-backed web application is developed and evaluated. The research methods consisted of a wide review of relevant literature on mobile healthcare technologies, specification and development of the application using human-centred design methodologies, and evaluation of the application. The results of this research provide a detailed set of requirements for the application and a fully functional implementation of these requirements, called 'CATS Mobile'. This is a web-based application, running on a tablet PC, that records and visualises patient vital signs. The findings from the evaluation of CATS Mobile provide evidence that user-satisfaction with such a system is high and that nurses can work efficiently on this mobile device when using an on-screen keyboard is to input data

Keywords; vital signs, mobile healthcare application, tablet PC, on-screen keyboard.

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1 Introduction & Objectives

1.1 Description of Problem

Delivery of healthcare to patients throughout the UK is undergoing profound change due to the introduction of information technology. The NHS Connecting for health programme has seen over 1 million summary care records created on the spine, over 80% of GP practices and pharmacies using the first phase of the electronic prescription service, and 22 million bookings made using Choose and Book (Connecting For Health 2010). Two of its key aims are to enable better, safer care for patients and to enable clinicians to increase efficiency and effectiveness. And throughout the NHS, other services are using information technology to meet these aims. The Queen Alexandra Hospital in Portsmouth is using a system called VitalPac to provide early warning signs of deteriorating patients and to reduce the patients' length of stay (Connecting For Health 2010).

Based at the Centre for Human Computer Interaction Design at City University, Ghandi (Generic Handover Investigation) was a three year project that investigated handover and interaction technologies to support clinical handover in healthcare settings. One outcome of the project was the deployment of 'PaperChain' (School Of Informatics, City University n.d.), a novel ICT system to support handover, at the Children's Acute Transport Service (CATS) at Great Ormond Street Hospital(Children's' Acute Transport Service n.d). The system use a digital pen and paper to transfers notes written on a digital referral form that CATS doctors use when retrieving patients from other hospitals by ambulance. The information is transferred to a web server where it can be accessed by members of the team who are at other locations.

During the patient retrieval process, nurses complete the 'CATS Retrieval Nursing Form', part of which records patient vital signs (see Appendix A). These observations and other information including medical interventions, ventilator settings and drug infusions, are generally taken by CATS nursing staff every 15-20 minutes during transport of the patient from a referring hospital to a paediatric intensive care unit (PICU). Whilst this paper-based system is a something with which nurses are extremely familiar and find easy to use, they have expressed an interest in replacing the paper-form with some sort of electronic means of collecting vital sign data. At present, historical records in the form of paper documentation from transferred patients are stored in lever arch files and take up a considerable amount of space. Medical notes that are written by hand can also be difficult to read. And finally, the data on these paper forms becomes highly inaccessible once the form has been archived. Staff members at CATS have said they would be able to extract valuable information about transport times, patient demographics, and the course of treatment if the data was stored in an electronic format which could be queried.

This project will undertake a full analysis of requirements of nurses at CATS for a mobile, web-based system to record patient data that is currently recorded by paper. A fully functional prototype will be developed and deployed on the Panasonic CF-H1 Mobile Clinical Assistant (MCA). (The MCA is a tablet PC, specifically aimed at the healthcare market). The prototype will be evaluated to examine usability issues.

1.2 Project Beneficiaries and Research Value

The main project beneficiary will be nursing staff at CATS, the Children's Ambulance Transport Service. This study will provide research into the requirements of an application they plan to use as a replacement to the current paper nursing form.

The project will add to the understanding of functionality that applications which record patient vital signs and other observations should have. This will be of benefit to nurses working in patient retrieval services and nurses taking bed-side observations. Furthermore, this study will help inform clinical practitioners about the suitability of tablet PCs as an option for mobile healthcare solutions. Tablet PCs are a new type of technology and research into their potential use in healthcare settings has been limited.

Finally, the project will add to knowledge on the specific area of data input and visualisation on tablet PCs. Recording patient vital signs and other observations is a critical part of the nurses' responsibilities. The usability tests which will be undertaken as part of this project, will help inform the choice of data entry method used on tablet PCs, and will also examine the usability issues surrounding the visualisation of this data as presented on the tablet PC.

1.3 Project Objectives and tests

This project will produce a working, prototype web-application to run on the Panasonic CF-H1 Mobile Clinical Assistant, a tablet PC. The application will allow CATS nursing staff to input and visualise patient vital sign data. The three main objectives are listed below:

1.3.1 Objective 1

To understand the CATS work environment and the requirements that nurses have when recording and visualising patient vital signs during transport. [The test of this objective will be a comprehensive set of functional requirements of the application's data-entry and visualisation screens and the non-functional requirements of the application itself]

1.3.2 Objective 2

To build a fully functional prototype web-based application to run on the mobile clinical assistant that allows nurses to input patient vital sign software and visualise this data. The purpose of the software will be to provide an alternative to the paper form that nurses currently use to record vital sign data. [The test of this objective will be the production of a web application with fully operational data input and visualisation modules]

1.3.3 Objective 3

To evaluate the usability issues that arise when using the mobile clinical assistant to input and visualise vital sign data. [The test of this objective will be a test-script for user-testing of the data entry and visualisation screens, and the results from the user-tests]

1.4 Scope and Definition

The project will be restricted to the specification, development and evaluation of a prototype web application that replicates the 'observations/patient vital signs' section of the nursing form. The application will include both data entry and data visualisation modules.

1.5 Research Context

The project is being undertaken in order to examine the usability and feasibility of a web-based interface to input and visualise patient vital sign data, running on a touch-screen tablet device. Nurses on the CATS team have expressed an interest in using this type of device as part of their work practice. The system aims to benefit nurses by making a data entry interface which is efficient to use, and by providing a means of visualising the data which they have entered, in order that trends in the data can be observed.

Abbot et al (2007) used an observational ethnography study to examine the usability of a mobile clinical assistant by nurses in a simulated clinical environment. Their results suggest a

positive level of usability. Constantinescu et al (2009) have looked at how rich internet applications can be used on mobile devices to impact mobile clinical practice. The prototype that they developed was successful in allowing communication between a handheld device and hospital information systems. In the UK Khawar Hameed has looked at how mobile computing and technology can benefit the UK health service (Hameed 2002). Sookyung et al (2000) developed a prototype for a mobile nursing information system.

Chen (2000) has examined various techniques for evaluating information visualisation techniques. Zuk et al (2006) have examined how heuristics can be used to evaluate the usability of information visualisation.

1.6 Methods

This section describes the methods used in this dissertation.

1.6.1 Literature Survey

Comprehensive review of published work in the areas of nursing working practices, especially patient vital-sign collection and applications on mobile devices.

1.6.2 Requirements Gathering

In order to gain an understanding of the nurses' working environment and how they interact with the paper form an interview will be conducted with one or more nurses from the CATS team. The aim of the interview is to understand how they use the paper form in their current working practice, and their functional and non-functional requirements of the web-based data entry screens with particular emphasis on usability issues of a touch-screen interface. The interview will determine the most appropriate type of data visualisation for patient vital sign history. Conduct additional interviews with nursing staff from outside the CATS organisation to gain understanding of nurses' views on adopting new information technology in the workplace. At the end of the requirements gathering phase a functional and a non-functional requirements document will be produced.

System Design and Prototype

Develop system architecture, layout and information architecture for application and produce paper prototypes.

Evaluation of Prototypes

Conduct user-testing of prototypes with CATS staff. Use results of user testing to update functional requirements / non-functional requirements.

System Development and deployment

The next stage will be the development of the web-based application which will be deployed on the Panasonic CF-H1 mobile clinical assistant. Development will use PHP (a web application server and MySQL, a database server)

Evaluation

The evaluation of the application will be conducted using user-testing, interviews and questionnaires.

1.7 Report outline

This section outlines the structure of this dissertation.

Following this introduction chapter, a survey of literature will be undertaken in chapter 2. This will cover existing research into mobile healthcare solutions, examining adoption barriers and

success factors of mobile healthcare applications. In the methods chapter (chapter 3), an account is given of the process used to gather requirements for the vital signs application using a user-centred design methodology, the design and development process and the evaluation of the application. In chapter 4, the results of these processes are and these results are discussed and analysed in chapter 5. Finally, chapter 6 discusses the conclusions that can be drawn from this study.

2 Literature Survey

2.1 Introduction

This literature review will examine the key issues surrounding the use of information technologies in healthcare, focusing in particular on the use of mobile technologies to record patient vital signs, systems for use in patient retrieval and usability issues surrounding data entry and visualisation on these systems. This review focuses on the objectives outlined in section 1.3 of the introduction chapter

1) To understand the CATS work environment and the requirements nurses have when recording and visualising patient vital signs during retrieval and transport

2) To build a web-based prototype to run on the mobile clinical assistant that allows nurses to input patient vital sign software and visualise this data. The purpose of the software will be to provide an alternative to the paper form that nurses currently use to record vital sign data.

3) To evaluate usability issues that arise when using the mobile clinical assistant to input and visualise vital sign data.

The review is intended to form a basis for a critical understanding of current research in mobile healthcare applications and their adoption, usability issues that clinical practitioners encounter when using such applications and methods uses to evaluate these IT applications in healthcare.

Key to fulfilling objective 1 is an understanding of how information technology is being adopted within healthcare. Consequently the first section of the literature survey looks at the success factors and adoption barriers within HIT (Healthcare Information Technology).

In order to fulfil objective 2 and 3 this survey explores some of the current technologies used for recording data in healthcare settings, the usability problems that these entail and the methods use to evaluate usability.

At the end of this chapter a critical understanding of these key areas of focus should have been demonstrated and the relevance of the areas of review to this project's objectives explained.

2.2 Success factors and Adoption barriers in IT Healthcare

The first objective of this project is to clearly define the requirements for the patient vital signs monitoring system. This first part of this literature survey looks at the success factors and adoption barriers that previous studies have reported regarding IT adoption in healthcare.

2.2.1 Success factors

Adoption of information technology in hospitals can potentially solve some of the problems which clinical staff encounter in hospital wards. Ammenworth et al (2000) summarise the problems as lack of access to patients' records during rounds, and the need for new diagnoses or drug orders determined during rounds having to be entered on a workstation at a later time. Whilst the technology in the study is dated by today's standards (an Apple Newton PDA), the results of their study indicated that clinical staff would be willing to use the PDA if it was "stable, fast and user-friendly"

The work of DeLone and McLean (1992) identify six key factors in the success of information system. These are system quality, information quality, use, user satisfaction, individual impacts and organizational impacts. They updated their model (2003) to take account of advances in technology adding 'Service Quality' to the list of qualities and combining the "impacts" into "net benefits", a measure of the use of the system from the point of view of stakeholders.

Chaterjee et al (2009) have conducted a study into the success factors of mobile work in healthcare. Based upon a study of key factors suggested in the literature "that influence the success of mobile work within the healthcare context", they extend DeLone and McLean's work, adopting his proposal that system qualities depend on the context in which the information system is deployed. The study's context being mobile work in healthcare, they extended the set of crtieria for success, proposing the following constructs in their model:

System Quality	
Extent of data processing	The amount of data processing capability (in terms of computational power, presence of s/w application for decision support) possessed by the mobile device.
Extent of information access	The amount of information that can be accessed by the mobile device (e.g. the extent to which the device allows access to centralized medical records).
Portability	The extent to which the mobile device supports the "nomadicity" of today's life, and may be carried by the healthcare workers easily from one location to another.
Content Quality	
Task structure	The extent to which the task being performed by the healthcare workers is routine, predictable, with well defined solutions (i.e., high structure) or unbounded and unpredictable with no clearly defined procedures (i.e., low structure).
Urgency	The extent of time pressure under which the healthcare workers perform a task, and the extent to which the task requires immediate response from stakeholders involved.
Extent of mobility (spatial/temporal/contextual)	The extent to which the healthcare workers have (or require) "independency from geographical constraints." *Spatial mobility* refers to the extent of "geographical movement" of the healthcare workers from one location to another, and can involve wandering, travelling, or visiting. *Temporal mobility* refers to the order, sequence, duration, and recurrence of the activities being performed by the healthcare workers. *Contextual mobility* refers to the extent to which the healthcare workers need to "continuously reframe their interactions" while performing their daily activities.
Information complexity	The extent to which the information being dealt with by the healthcare workers (and

	being handled by the mobile device) consists of audio, video, and image components, in addition to textual data.
Service Quality	
System reliability	The extent to which the system can be depended upon to complete a task without problems and breakdowns
System support	The extent to which there is commercial software and hardware support available for the mobile device.
Outcome variables	
Use	The extent to which the mobile device is actually used by the healthcare workers in their day-to-day task performance.
User satisfaction	The extent to which the health care workers are satisfied with the use of the mobile device (i.e., with their experience of mobile technology-mediated work).
Net benefits	The extent to which there is a reduction in the delay of healthcare service provided to patients, increase in the accuracy and efficiency of healthcare service, reduction in errors in medical records, improved security of medical records, increase in the ability to continuously monitor critical patients, etc

Table 1 - System Qualities as defined by Chaterjee

In their proposed model, the attributes of system, content and service quality positively affected use and user satisfaction which in turn positively affected net benefits. They reviewed the literature to determine whether the proposals in their model could be confirmed or disconfirmed. The system qualities which their research supported as positively affecting system use were determined to be portability, task structure, system reliability and system support. The other system qualities in their model were determined not to have a positive outcome in relation to use. Importantly for this project in which portability cannot be altered because the device has already been selected, tasks with a high structure should be most suitable for use in a mobile clinical context.

Wu et al (2007) have examined the various factors affecting the acceptance of mobile healthcare systems (MHS) in the healthcare industry. They used the technology acceptance model (TAM) extended by Venkatesk and Davis (2000) (to become TAM2), which proposed behavioural intention to use as being determined by perceived usefulness (PU) and perceived ease of use (PEOU). Their study integrated the technology model with three additional variables, compatibility ("The degree to which the use of MHS is perceived to be consistent with healthcare professionals' existing values, prior experiences and needs"), self-efficacy ("The healthcare professional's perceptions of his or her ability to use MHS in the accomplishment of healthcare task") and technical support and training ("The technical support and the amount of training provided by individuals or groups with the MHS knowledge"). Compatibility was determined to be the most significant determinant of MHS success indicating the users' demands and needs must be analyzed carefully in order to increase the acceptance of such applications in clinical settings.

2.2.2 Adoption Barriers

Lu et al (2005) have undertaken a review of the literature to examine the adoption of handheld computers in healthcare. They note that mobile computing has particular advantages for use in healthcare:

> *"Mobile computing adds value to clinical practice in a number of ways, such as by giving clinicians access to clinical information where and when the information is needed, by improving the exchange of information (thus, reducing medical errors resulting from inadequate access to clinical data), and by providing clinical decision support to give clinicians feedback at the point of care"*

Their study focuses on personal digital assistants (PDAs), defining them to be "lightweight, compact handheld computers that literally fit into one's palm or pocket". Naturally this excludes the Panasonic CF-H1, which this project is studying; nevertheless the study does provide useful information on a particular type of mobile healthcare technology. The authors categorised the types of PDAs in use in healthcare according to operating system type, device type (Pocket PC, Palm OS, Smart Phone, Blackberry) and supported applications. Their review describes the following usability issues with handheld PC's:

> *"Data entry mechanism with graffiti was unintuitive and not easy to use...*
> *...limited battery power, limited memory, perceived fragility...*
> *...Size, weight, and small screen: most users think that PDAs should be smaller and lighter but have the largest screen possible screen size"*

2.3 Information Technology and Vital signs

In order to help fulfil the second objective of the project the literature survey reviewed previous studies into information systems used to monitor patient vital signs, which had been adopted in clinical settings. The aim is to increase understanding of information technology used in healthcare and develop and understanding of the types of technologies and mobile applications which have been deployed. This section also examines specific usability problems with each of these technology types and the types of evaluation that are used to assess these usability problems.

2.3.1 Pen and Paper

Pen and paper has been the traditional method by which clinical staff recorded patient vital signs. This has included nurses who are taking bed-side observations, as well as those who are taking observations of patients in transport to or between hospitals, in which has the recordings are made in an ambulance or similar patient transport vehicle.

Evans et al (2001) in their study into determine the best available evidence on vital sign measurement indicate a need for significant research into this area:

> *"While there is a wealth of research on specific aspects of blood pressure and temperature measurement, the more important questions on the role, the nature and the optimal practice of vital sign measurement have not been asked. On this basis, there is an urgent need for rigorous evaluation of most aspects of vital sign measurement as used for hospital patients"*

Moreover, Sahlstedt et al (1997) have identified nursing documentation as a key element in provision of high quality nursing care.

In the following sections three main technologies used to record patient data are explored. These are digital pen and paper, medical sensor and hand-held device. The technology in each

area is summarised and along with relevant usability issues and methods used to evaluate these.

2.3.2 Digital Pen and Paper

Yen and Gorman (2005) undertook usability testing of a digital pen and paper system in nursing documentation. The digital pen and paper aims to overcome some of the problems alternative technologies have when recording patient data:

> *"Tablet PCs, and Personal Digital Assistants (PDAs... do not support free text to allow rich clinical data...*
> *... Speech recognition systems... are much less suitable in noisy public spaces...*
> *...Tablet PCs are limited by their weight and fragility, which reduce their acceptability to nurses"*

The digital pen contains a camera and when writing on special digital paper, records the writing pattern, which can then be uploaded to a central server. This technology is close to the traditional pen and paper which clinical staff are used and as a result can potentially provide a lower barrier to adoption by staff. Their study examines the usability of the digital pen and paper based upon Stagger's model (1994) which includes tasks, users, tools and the task environment. To conduct the study they used questionnaires consisting of seven point Likert scale items to compare usability of the digital pen with the traditional pen, and interviews/observations to obtain qualitative data around nurses' use of the digital pen. Whilst nurses were initially positive about the adoption of the digital pen/paper system, they did eventually reject it due to usability considerations, finding it bulky, not always to hand and prone to falling from their pockets as they lent forward or stooped down. The authors conclude that devices used for nursing documentation must be "compatible with the work environment, tasks, and goals of clinical practice". Their work highlights the importance of evaluation taking place within in the workplace.

In a study conducted across two hospitals in Boston, Dykes et al (2006) examined the feasibility of using the digital pen to capture patient vital signs. Whilst many aspects of the electronic patient record had become computerised at these hospitals, recording of patient vital signs in the in-patient departments was still being conducted using traditional pen and paper. The digital pen and paper system was proposed as a solution to electronically "capture vital sign data typically recorded on bedside flow sheets". The digital pen system was implemented at the two sites and evaluated over a period of six weeks. The study looked at two aspects, reliability of data acquisition and user-satisfaction. To measure data reliability, a research team examined the data collected by the digital pen system and classified it into accurate, data missing, and data incomplete categories. Overall data acquisition was determined to be 91% accurate, the 8% error being mainly due to inaccurate handwriting recognition. User-satisfaction was measured using a web-based survey which included 20 Likert scale questions – this was run pre digital pen implementation to obtain a baseline satisfaction level and post-implementation to assess the satisfaction with the digital pen. The study saw satisfaction rise in several key areas, especially vital sign data access. However, because of the high-level of errors in handwriting recognition, it was determined that data would have to be verified before being transferred to the patient record. This was viewed as an unacceptable break in workflow practice at hospitals. Again, as in the case of the previous study, usability issues came to the fore demonstrating that any facet of the technology that will interfere with clinical workflow or patient safety can only have a negative affect on user's acceptance of the new technology.

2.3.3 Medical sensors

Gao et al have looked at participatory user-cantered design techniques for a large scale ad-hoc health information system called AID-N. The system being designed was a patient monitoring system that had to record patient vital signs at a disaster site. The vital signs data for each patient was recorded using medical sensors which connected to a wireless network and then transmitted to a central server which could be accessed by attending triage staff. They used a user-centred and iterative design process, interviewing paramedics, observing fire and police dispatchers and using a questionnaire. This allowed the creation of a user-task flow chart and a list of user-needs. Users were asked to rank each need using a survey. Prototypes were built and demonstrated at round-table discussions using cognitive walkthroughs, prompting more user needs. The feedback was integrated into the next version of the prototype and this cycle of user-feedback sessions and prototype development was repeated four times. During the iterative design process a set of design principles were discovered and recorded;

Principle	Application to system
Learnability	Provide guidance for tasks: Display descriptive text when cursor hovers over a button. Provide visual feedback to users' actions: Use a marker to indicated when a patient's electronic tag is turned off
Familiarity	Use familiar workflow terms: label users with common terms such as "triage officer", "staging area" Use common conventions for symbols, abbreviations, and text: Label with roman numerals commonly printed on paper triage tags.
Failsoft	Plan for failures: Continuously save state of the system. If the computer crashes, users can restart from previously saved states. Plan for unreliable networks: Incorporate ad-hoc wireless mesh networking capabilities.

Table 2 - Gao's design principles

The user interface of AID-N displays summary panels for each patient and a graph of patient vital signs data when the panel is clicked. When an anomaly is detected in the vital sign data (determined using published detection algorithms) an alert appears on the interface. During the iterations the concerns of the stakeholders and users were recorded and addressed;

Training	Users may forget how to use the system because disasters occur infrequently: Solution: The system was integrated in the hospitals regular system allowing users to experience using it more frequently
Maintenance	The system may be idle for long periods of time and should not require continual maintenance Solution: Because its a web solution, most of the software is maintained at the server and updates are transparent to the user
Reliability	The system must function even if the existing telecoms infrastructure is damaged Solution: The system has redundancy with multiple communication paths through an ad-hoc network.
Vital sign statistics	Differences in vital statistics between patients. Solution: Customizable alerts that adjust thresholds based on patient age, height, and pre-existing patient records

Table 3 - Stakeholder concerns

In another study from the same group, the AID-N application was observed being used in a real-world setting as the authors rode-along with nursing staff in an ambulance (Ashar et al 2005). They noted a number of issues. These included form fields which were completed automatically by the application being filled in incorrectly and had to be manually adjusted wasting valuable time. A large amount of time was spent filling out separate set of redundant paperwork forms. These issues suggested that the software needed to be improved, allowing data to be entered once and then copied to all the necessary forms. The medics in the ambulance felt it would be helpful to have a steady keyboard. And it was noted that the connection to the network was important to allow data to be transmitted to/from the central server.

Shen et al (2007) have proposed a mobile physiological monitoring system for patient transport. Recognising the increase that has taken in place in intra or inter-hospital patient transports to provide specialised care, and the increased availability of wireless networks, their system provides continuous monitoring of patient vital sign data. They state that the success of all critical care transport is dependent on continuous monitoring of vital signs and that knowing the physiological changes of patients while they are being transported supports a preventive and early treatment strategy that makes transport safe and smooth. Their system utilised medical sensors to acquire patient vital signs (heart rate, temperature, respiration rate, blood pressure and pulse oximetry) which were linked to a control node via Bluetooth. This control node used the mobile telephone network to pass the data to a database which could be queried by clinicians using application called the 'management application'. The use of medical sensors meant that transport nurses did not have to enter the patient vital signs manually into a PDA or tablet device. The management application has a windows application or a web-based interface and displays heart rate, pulse oximetry, and ECG values. There is an alarm settings window which enables the medical staff to set up the alarm threshold of pulse oximetry and heart rate individually according to the physiological status of the patient. In order to evaluate the acceptance of the system in a medical organisation, Shen et al proposed a new research model (based on the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB)) which modelled "mobility", "usability", "performance of the overall system on transport", "attitude" and "intention to Use" in this context. A test scenario was set-up which transported patients from one building to another, while allowing medical staff to monitor the patients' data. A survey, conducted to elicit operator's opinions on the system found staff were positive about the system's performance and usability.

Kulkarni et al (2007) have comprehensively documented the requirements and design spaces of a mobile medical care system. They envisage a complex system that could be considered ubiquitous or pervasive in that the patient would wear a sensor that would wirelessly feed patient data to a central server which could be queried by clinical staff. The sensor would continuously monitor the patient and recording real-time data allowing for deviations from baselines or trends to trigger alarms. Data on the central server would be accessible to a variety of stakeholders including hospitals, paramedics, and the patient's doctor.

2.3.4 PDAs

Choi et al (2004) have implemented a system called MobileNurse, a mobile point-of-care system to handle patient information and nursing recording. The application runs on PDAs, which nurses use to access clinical information from the hospital information system. The requirements for the system, based on interviews with nurses and studies of the literature, were determined to be:

"Retrieving patient information: Patient information is transmitted electronically to nurses using PDAs, which eliminates any delay in searching for patient information on the central database and then calling the nurse for notification.
Checking medical orders: Medical orders and test results are delivered to portable PDAs in real-time. This system is a vast improvement over the current lab results delivery system, which is done by fax/courier/remote printers.
Nursing recording: Nurses can record the results of their practices at the bedside and send the records to the central database in HIS to reflect the new information.
Nursing care plan: It is helpful for retrieving the nursing care plans for all patients, such as patients' discharge, consultation and transfer."

The architecture of the system consisted of PDAs which synchronise with the Hospital Information System (HIS) via an intermediary Mobile Support System. MobileNurse was tested at Seoul National University Hospital by six nurses in the care of four simulated patients over the course of one day. After the trial, the nurses were asked to complete a survey about the usability of the interface and PDAs. The nurses indicated that found the screen size to small, inputting data (especially text) too time consuming, and they felt that the application should be able to replace their paper forms completely, as opposed to just a section of the form. Whilst the authors only devote a small part of their paper to the details of their clinical trial and survey, and do not present a detailed explanation or interpretation of the survey's results, the authors conclude that in order for such a system to be adopted in clinical setting, the user interface would have to be effortless for nurses to use.

In a study of nurses' attitudes to adopting a PDA into their work environment, questionnaires and interviews were used to determine the information categories and functionality that nurses wanted. The interviews highlighted usability concerns that nurses had with PDAs; these included worries about the small screen size, older people's concerns about using IT, ease of navigation through any system and ability to recover from mistakes. Whilst this study reveals important demands and concerns of nurses about adoption of PDA technology, it does so in isolation of any specific information system solution. A more complete understanding of usability issues nurses encounter when using PDAs could only be determined with a proper usability evaluation of a prototype system or completed system.

2.3.5 Tablet PC's

Karhoca et al (2010) undertook a usability analysis of two software prototypes of an information system designed for a hospital emergency department. Both prototypes were designed for use on tablet PCs but differed in that one was driven by a more visual interface which used icons and the other used purely text-based navigation and menus. As well as a heuristic evaluation and cognitive walkthrough they conducted a user-test of both prototypes and a user satisfaction survey.

The user test was based on a scenario which drew from the most commonly performed clinical tasks, including entering patient identification information, case notes history, and recording patient vital signs. The same scenario was used when testing both prototypes, with the authors stating that that the six week delay between the two tests should remove any learning curve bias introduced by test subjects. To be sure of removing this bias, it would have been better if the authors had alternated which of the two prototypes was tested first. Efficiency and effectiveness of the prototypes was measured based on task completion times and percentage of successfully completed tasks respectively. They also measured the learnability of the system using task completion times which were measured twice within a 12 hour period and compared. Finally, to measure user-satisfaction, users were asked to complete a questionnaire containing eight questions which used seven point Likert scales.

Their results indicated that users preferred simplified forms with fewer elements and lower complexity. The virtual on-screen keyboard gave rise to usability issue because of the small size of the keys. User satisfaction, effectiveness and learnability were all higher in the icon driven GUI.

2.3.6 Comparative studies

Cole et al (2006) has undertaken a comparative study of digital pens, PDAs and tablet PCs for data collection during clinical trials. The study aimed to compare "speed, accuracy, ease of use, and user satisfaction" of the various technologies using standard pen and paper as a control. Using a standard research form used in recording of mammography interpretation information, an electronic format, suitable for display on each of the different technologies was prepared. Each technology was used to record data for 20 mammograms. For each mammogram, the recording time and number of help requests and data accuracy was recorded in order to measure, speed, ease of use and accuracy respectively. A survey consisting of 4 questions with five point Likert scales was used to measure user-satisfaction with each technology.

The study found that the tablet PC and digital pen were equally fast and easy to use and compared favourably to the PDA. The results for user-satisfaction also favoured the Tablet PC and digital pen over the PDA. The validity of the results in this survey is inherently tied to the application itself and the design of the specific form. These results cannot be generalised to other applications. To assess the most suitable technology for use with other applications that require data entry, for example patient vital signs, these comparisons and test would have to be undertaken with a prototype of completed application.

2.3.7 On-screen keyboards

Because tablet PC's do not have their own physical keyboards, users are restricted to entering data using on-screen keyboards. Recognising the importance that the type of on-screen keyboards have in terms of usability, Tullis et al (2007) have compared usability and user-satisfaction with 7 different configurations of on-screen keyboard when used to enter login information. They found that none of the on-screen keyboards came close to the level of performance of a normal keyboard, and that of the on-screen keyboards that were tested, the QWERTY style keyboards were the fastest and received highest user satisfaction scores. A comparison of different on-screen input keyboards was undertaken also undertaken by Yatani and Truong (2007). They compared four different types of on-screen keyboard on a PDA. Their study found that users were able to complete tasks more quickly using the QWERTY keyboard compared with the character recognition method.

2.3.8 Conclusion

Studies by Chaterjee et al (2009) and Jen and Chao (2008) have used DeLone and McLean's (2003) model to show that success factors for adoption of healthcare IT include system reliability, task structure, and user satisfaction. Wu et al (2007) found compatibility to be another important factor, indicating that any proposed system should fully take account of users' needs and should be consistent with their current workflows.

Studies into a wide variety of technological solutions have been undertaken, including digital pen and paper medical sensors, PDAs and Tablet PCs.

Across these studies a wide range of usability metrics were studied including user-satisfaction, effectiveness, learnability. Methods used included user-testing, questionnaires and surveys. These studies can only be considered valid for the particular device and application which the study has considered. System requirements and usability findings from these studies can

certainly inform requirements and usability concerns for the vital sign application proposed in this study, but the requirements will certainly have to be specified with user involvement as part of a user-centred design process, and usability issues will have to be evaluated based on the working prototype.

To arrive at a complete understanding of the requirements for vital signs application, this study will use a full user-centred design methodology. These requirements will be used to develop a fully functional prototype application. The usability of this application will then be evaluated using user tests.

The next section of the report outlines the methods involved in gathering requirements, the development process used to build the software, and the methods used to analyse the system's usability.

3 Methods

3.1 Introduction

This section outlines the methods used during this project. The project has aimed to follow a human-centred design methodology consisting of five main steps;

1. Plan human-centred design process
2. Specify stakeholder and organisational requirements
3. Understand and specify the context of use
4. Develop design solutions
5. Evaluation

Table 4 Stages in Human-Centred design methodology

This methodology is based on ISO TR 18529 - Human-centred system development (International Organisation for Standardisation 2000).

The human-centred design process elevates the user-perspective in the development of software solutions. User involvement and feedback is considered important at all stages of the development cycle, from requirements gathering through to evaluation and deployment.

The process is iterative, with the output from one phase feeding back into another. For example, on the first iteration, the 'develop design solution' phase produced a prototype which was then evaluated. The results of the evaluation were used to refine the requirements and context of use. On the second iteration, the design solution was a fully functional prototype, called CATS Mobile, which was then evaluated using user-testing.

This chapter describes the methods used to conduct this study. It gives a detailed description of all project work undertaken, how these relate to the project objectives, and the output that these methods product.

3.2 Plan human-centred design process

The first stage in the project was to plan the human-centred design process. This was done in order to determine how user-involvement could be incorporated into the development cycle. The aim was to ensure that project stakeholders had as much input into the vital-signs application as possible, by including them in the all stages of the project.

Project Stage	User involvement	Human centred methods used	Output
Specify Stakeholder and Organisational Requirements	CATS Nursing Staff CATS Consultant Non CATS nursing staff	Interviews	Functional Requirement Non functional Requirements
Understand and specify the context of use	CATS Nursing Staff CATS Consultant Non CATS nursing	Interviews	User tasks User attributes Organisational environment

	staff		Physical environment Technical environment
Produce Design Solutions			*Iteration 1* Paper Prototype *Iteration 2* Fully functional working prototype
Evaluation	CATS Nursing staff Non CATS nursing staff Non-nurse users	User-testing	Refined Requirements Refined Context of use

Table 5 User involvement and human centred methods employed in this study

3.3 Specify Stakeholder and Organisational Requirements

Gaining as complete an understanding as possible of the requirements that the nurses at CATS had when recording patient data is obviously key to fulfilling objective 1, as defined in section 1.3.

CATS, the Children's Ambulance Transport Service, is based at Great Ormond Street Hospital. It is a patient retrieval service, transporting patients between hospitals and intensive care units. During patient transport, one of the nurse's duties is to observe the patient and record his/her vital signs. At present this information is recorded on a paper form know to staff as the retrieval nursing form (see Appendix C).

3.3.1 Interview with nursing staff at CATS

An initial meeting with nursing staff from CATS took place at the CATS office in central London on September 15th 2010. Present at the meeting were two advanced nurse practitioners from the CATS service. The aim of this meeting was to get detailed information on current nursing practice during patient retrieval and transport. The meeting was used to conduct a semi-structured interview with two advanced nurse practitioners. Both nurses were interviewed at the same time. The session was audio recorded and transcribed afterwards. The interview questions were planned in advanced and focused on current working practice, future needs and problems with the paper nursing form. The interview questions and transcript are available in Appendix B. This session lasted an hour and a quarter and covered the patient transfer process, use of the current paper nursing form that is used to collect patient data, and the requirements of the proposed electronic system. The staff supplied me with examples of completed paper nursing forms that had been anonymised by removing patient identifiers. These forms were copies of original forms which had been used in the transfer of patients and contained real-world data. The forms provided valuable examples of the allowed data values for the various fields in the form. These completed examples of the form are available in Appendix C.

3.3.2 Interview with healthcare IT specialists

A second interview was conducted with two IT specialists, currently working in healthcare IT. One was a former nurse with specific knowledge of IT in high acuity wards, the other was and IT specialist in this same area. A set of interview questions was prepared (see Appendix B) and a semi-structured interview took place with both participants at the same time. The session was audio recorded and transcribed afterwards (Appendix B). The session lasted 35 minutes and covered usability issues that nurses experienced when using information technology and the IT adoption in hospitals.

3.3.3 Producing Requirements Documents

Having conducted the interviews with CATS and other nurses, the next step was to analyze and document the requirements of the project stakeholders.

The requirements were categorised into separate groups, as defined by the Volere Requirements Specification Template, known as the Volere Shell (Atlantic Systems Guild 2010). Requirements of a system belong to two distinct groups, functional and non-functional. Functional requirements describe the behaviour of the system i.e. the output a system should provide in response to some input, and drive the application architecture. Non-functional requirements describe constraints imposed on the system, help specify the overall characteristics of the system, and drive its technical design. The system's non-functional requirements were further categorised into data, performance, security, display and usability.

Requirement Type		Description
Functional		Describes the behaviour of the system
Non-functional	Data	Describes the information the system stores
	Performance	Describes the speed at which the application runs
	Security	Describes the speed at which the systems responds and how it performs under load
	Usability	Describes the ease with which the system is used, it's learnability, effectiveness
	Display	A subcategory or usability, describes the way in which the information is arranged on the page and how it looks

Table 6 System Requirements

The first stage in determining the requirements was to analyse the transcript of the interview with the CATS Nurses (See Appendix B). The interview transcript was analysed in details, looking for any phrase which described the way in which CATS nurses currently record patient data on the nursing form, or the way in which the proposed new system should function or behave and the properties it should have. This phrase was then expressed as a requirements, in the form, "The system shall..."

Each requirement was assigned a unique number and listed with a description, the rationale for the requirement and the source e.g. CATS interview, paper nursing form.

Stakeholders that were mentioned during the interview identified, and the way in which they would be impacted by the vital-signs application was noted.

This analysis allowed the requirements document to be produced which described in detail the project stakeholders, functional and non-functional requirements.

Another source of requirements was the paper nursing form. The form defined the patient data that was currently recorded being recorded. It was analysed to determine the data requirements for the project.

The stakeholder descriptions and requirements which were gathered during this part of the project are described in section 4.1.

3.4 Understand and specify the context of use

Understanding and specifying the context of use is an important part of the human-centred design methodology. Context of use is defined as the "goals of the user community, and the main user, task and environmental characteristics of the situation in which it will be operated" (Maguire 2001).

The purpose of understanding and specifying the context of use is to identify, clarify and record the characteristics of the stakeholders, their tasks and the technical, organisational and physical environment in which the system will operate. As a result of successful implementation of this process the following will be defined; the characteristics of the system users, the tasks the users are to perform, and the technical and physical environment in which the system is used.

3.4.1 Characteristics of System Users

Using the transcripts of the interview with nursing staff from CATS and the healthcare IT specialists (for transcript Appendix B), the characteristics of potential users of the system was produced. This was done by analysing the transcripts and extracting phrases that described the potential users of the new system. For each type of user, their general work duties are recorded, as well as the types of interaction they would have with the vital signs application, their use of the existing paper system, and their level of information technology literacy. Some assumptions were made when constructing these user profiles. For example, the IT literacy level of different user groups was not revealed in the interview transcripts, however it was assumed that they had were IT literate and used information systems on a daily basis. The characteristics of systems users are described in section 4.2.1

3.4.2 Users' tasks

The next stage in constructing the context of use is to determine the tasks that users of the system will undertake, and to assign each of these tasks to the appropriate user group. The list of tasks was determined by examining the functional requirements produced in the previous section. Each functional requirement that was associated with an input by a user was expressed as a task and associated user/user. The result was a list of user tasks for the proposed vital signs system. This list is shown in section 4.2.2.

3.4.3 Technical and physical environment

Finally in this section, the technical and physical environment was described in the context of use document. The technical environment was proscribed, to some extent, because the choice of technology had been prescribed for this project i.e. the application type (web-based) and device (Panasonic CF-H1) had been chosen before the project started.

A key part of the physical environment is the paper form currently used by nurses to record patient data during the retrieval process. This was analysed as part of the examination of the context of use.

This information was included in the context of use document, as well as information about the physical environment in which the stakeholders work, based on the interview transcripts. The description of the technical and physical environment is shown in section 4.2.3.

3.5 Develop Design Solutions (Iteration 1 – Paper Prototypes)

The next phase of the project was the development of the design solutions, based on the requirements and context of use documents developed above. The first step was to consider the system architecture and how the tablet PC could be used to fulfill the nurses' requirements. One of the constraints on this project was the choice of technology. The system had to be web-based and use the Mobile Clinical Assistant (MCA) tablet PC. Bearing this in mind, an architecture was proposed that was based on the tablet PC. A diagram was created to illustrate the architecture of the proposed system. Details on the system architecture can be seen in section 4.3.1.

Next, the design of the screen interfaces was considered. The design criteria were based on the requirements of the nurses, gathered during the interviews, and was also heavily influenced by the paper nursing form which provided a detailed specification of the patient data that had to be recorded. To come up with the design I Two alternative layouts for data entry screens were developed in order to present a choice to CATS nursing staff. The first presented information in a 'tabbed' layout, the second used and 'accordion' style layout.

Following this, paper prototypes for all screens in the application were created. This was done using Balsamiq, a prototyping application. The prototypes were created to cover all the tasks that were defined as being required, including login screen, adding a new patient, listing patients, data entry/visualisation screens.

3.6 Evaluation (Iteration 1 – Paper Prototypes)

This stage of the process was a key stage at which user feedback could be used to refine the application's requirements and design.

The evaluation method chosen was user testing with the think-aloud protocol. The think aloud protocol is a technique used in the user-test where the test subject is asked to speak their thoughts as they are carrying out a task. The aim is to discover which tasks or parts of the task that the user has managed to perform easily, and information about which parts they have found difficult. For the test, a series of scenarios and tasks were defined that covered the main user tasks.

The user-test was conducted at the CATS team in their offices in central London at 10:00am on October 22nd 2010. One nurse took part in the test. At the start of the test, the nurse was shown an project information sheet and given a consent form to sign (see Appendix G). The test was audio-recorded and a transcript is available in Appendix H.

The scenarios and tasks are from the user-test are shown below:

Scenario 1

"You are here at CATS and a new call has come in to transfer a patient from hospital 1 to hospital 2, at 18:00. The patients name is patient Tom, his CATS Id is 744"

Task 1

"Create a new record for this patient"

Scenario 2

"So you set off on your journey and you have arrived at the hospital. You've got your eyes on the patient and you're about to take a set of readings"

Task 1

"Record a NiO2ppm value of 1.25ml/hr"

Scenario 3

"Half an hour has passed; you are still monitoring the patient"

Task 1

"Enter a Nio2ppm value of 1.50ml/hr"

Following the user-tests, an informal walk through of the remaining screens was presented to the nurse using the paper prototypes. The two alternative methods to layout the data entry screen were discussed as well as a proposed method of visualising patient vital signs.

As mentioned above, the entire session was recorded. The transcripts were analysed to obtain additional requirements. These are described in section 4.4

3.7 Develop design solutions (Iteration 2 – Working prototype 'CATS Mobile')

This phase of the project was essentially a second iteration in the human-centred design methodology. Having completed the first iteration, as described above, the new requirements from the testing of the paper-prototypes were used to design and build a fully functional working prototype called CATS Mobile, to record and visualise patient vital signs.

3.7.1 Technical Specification

This section describes the technical environment in which the development took place.

The application was developed as a web-based application, and was designed to run in any browser operating on the Panasonic CF-H1 Mobile Clinical Assistant (MCA) running Microsoft Windows XP.

It was decided to focus development effort on the CATS Mobile application only and to not undertake any development work on the CATS Central application.

The application is an n-tier application, utilising a database, application server, web server and web browser as client. The technical details of the application are given below:

Web Server: Apache 2.2

Database Server :MySQL 5.1

Application Server :PHP 5.3.3

Client: Any web browser running HTML 4 or greater.

3.7.2 Development Environment

The application was developed using Zend Studio 7 and MySQL Workbench 5.2

3.7.3 Development Process

The requirements of this project have identified two distinct applications, CATS Mobile and CATS Central, as described in section 4.3.1. Because of time constraints, the remainder of this project will be focused on CATS mobile, the part of the system which will operate on the tablet PC, and be used by nurses to record vital signs.

The development process was time consuming and technically difficult. A considerable amount of time was spent in constructing the database, making the layout as efficient as possible and minimising the amount of user interaction that was necessary to complete a task.

The first stage was the construction of the database. Using the data requirements in section 3.3, a database was constructed to store information on patients and their vital signs observations. Next, the web pages were built using cascading style sheets (CSS) and HTML. The modules for inputting and visualising data were constructed. It was important from the user's perspective that the data entry/visualisation screen was responsive, uncluttered and easy to use and so a lot of effort was put into producing a system was efficient to use and required the least amount of user interaction.

A description of files created, and screen shots showing the functionality of the application are shown in section 4.5.

3.8 Evaluation (Iteration 2 – Working Prototype)

The evaluation of the working prototype was comprised of three parts. Firstly an analysis of three different ways of inputting data into the tablet pc, secondly a comparison of the tablet pc with traditional pen and paper, and finally user-testing of the tablet PC to discover usability issues and measure user satisfaction.

3.8.1 Comparison of three data entry methods

The first aspect of the evaluation of the working prototype was to examine in the detail the usability of data input methods on the tablet PC. As described in the technical environment in section 4.2.3, the tablet PC provides the user with a variety of on-screen keyboards which can be used to input data. In addition, as part of the development process, I created a custom numeric keypad style keyboard as part of the vital signs application. This section of the study compares the usability of two native on-screen keyboards, which are supplied with the tablet PC, and the custom on-screen keyboard which was developed as part of this project.

Using user-testing, four aspects of usability of these keyboards were measured, namely efficiency, error rates, learnability and user satisfaction. A test scenario, described below, was created that was based on nurses clinical experiences.

> *'You are working as an advanced nursing practitioner on the Children's ambulance transport team. You have arrived at St. Bartholemew's Hospital, London, to transport Amy, an 11 year old girl with severe asthma. Her vital signs are displayed on the patient monitor and need to be recorded using the CATS Mobile application'*

Four tasks were created, each of which involved inputting a set of patient vital signs into the CATS application.

Task 1

Please enter the following set of observations into the CATS application.

Observation	Value

Time	2.27
Temperature	34.2
Heart Rate	118
Blood Pressure	69/49
Respiratory Rate	11
Mean Arterial Blood Pressure	65
Cap Refill Time	2

Task 2
Please enter the following set of observations into the CATS application.

Observation	Value
Time	4.01
Temperature	34.4
Heart Rate	122
Blood Pressure	75/45
Respiratory Rate	21
Mean Arterial Blood Pressure	68
Cap Refill Time	3

Task 3
Please enter the following set of observations into the CATS application.

Observation	Value
Time	5.05
Temperature	34.8
Heart Rate	118
Blood Pressure	65/42
Respiratory Rate	8
Mean Arterial Blood Pressure	61
Cap Refill Time	2

Task 4
Please enter the following set of observations into the CATS application.

Observation	Value
Time	5.25
Temperature	35.0
Heart Rate	114
Blood Pressure	71/45
Respiratory Rate	16
Mean Arterial Blood Pressure	64
Cap Refill Time	3

The four tasks were completed in this order using one keyboard and then repeated on the second keyboard and then on the third keyboard. This gave a total of 12 tasks.

A pilot test was conducted with one participant on November 25th 2010. The duration of this pilot test was found to be one hour and fifteen minutes. As a result of this, test subjects were given the option of taking part in this evaluation on its own, or taking part in the comparison of pen and paper evaluation as well.

After the pilot test, twelve users took part in this user-test, but following suggestions from my project supervisor, a further eight users were included in the study, giving a total of twenty test subjects. These tests were conducted between November 25th, 2010 and January 2nd, 2011.

At the start of the test session, each user was asked to read a project description document (see Appendix G) which outlined the purpose of the study.

Next, I gave a brief introduction to the mobile clinical assistant, demonstrating how the pen was used, and showing the three types of keyboard that were going to be evaluated. The test scenario was read to the test subject and he/she was asked to complete the four tasks on each of the three keyboards in turn, giving a total of 12 tasks. The order in which the keyboards were tested was changed between each user-test, in order to remove any bias that could come from repeating the same task on the three keyboards.

For each task, the completion time, number of errors encountered, and whether the task was completed successfully or not was recorded. A task was regarded as being successfully completed if the user successfully entered the correct value in the appropriate form field in the application. During the test a note was taken of the types of errors that users encountered.

After all tests were completed, users were asked to complete a usability questionnaire for each of the three data entry methods. The questionnaire (see Appendix G) was based on the USE Questionnaire (Lund 1998). This aims to measure the application's usefulness, ease of use and user satisfaction, using a set of questions with seven-point Likert scale responses. Users were also asked to answer two additional questions to elicit their views on the advantages and disadvantages of each keyboard type.

3.8.2 Comparison of pen and paper with Tablet PC

Another user-test was undertaken in order to compare time taken to enter data using a traditional pen and paper with the time taken to enter data using the tablet PC. This task involved entering a full set of patient data (interventions, infusions, observations, ventilation, blood gases and neurological) using both methods. In order to use as realistic data as possible, the test data was taken from an anonymised paper retrieval nursing form which had been used on an actual retrieval. The patient data was extracted from this form and used as the basis of the test script (See Appendix H).

As described in the previous section, users who agreed to take part in the comparison of data entry methods were asked if they had time to take part in this evaluation. Of the initial batch of 12 test subjects, 8 agreed.

Test subjects were asked to complete two tasks

1) Entering the patient data using the traditional pen and paper,

2) Entering the data using the CATS Mobile application on the tablet PC.

The order in which each test subject was asked to do the two tasks was changed for each new subject in order to remove any bias that might occur due to learning the task.

For each task the subjects were read out a scenario from the test script and then given a piece of paper on which a full set of patient observations had been written (see Appendix G). This method was chosen in order to replicate clinical settings where the nurse would have to read an observation from a piece of equipment and then write it on the nursing form. The aim was to replicate the way in which the users' attention alternates between the device and the paper form. The time to

complete each section of the form was noted and the total calculated to give a value for entering a full set of patient data.

For the pen and paper task, the test subjects were given a blank nursing retrieval form and asked to enter the full set of patient data from the task sheet. The time taken to complete this task was recorded. For the tablet PC task, the users were asked to enter the same set of tasks using the tablet PC. For this task users were asked to use the QWERTY keyboard for the interventions section, and the custom built JavaScript keyboard for all other sections of the form (infusions, observations, blood gases, ventilation and neurological). This was done because, based on the results from the previous tests, these were the fastest ways to enter text and numbers respectively. Again, the time taken time to complete each section of the form was recorded and totalled to give a value for the entire set of patient data.

3.8.3 Usability issues

The final stage of the evaluation process was a user-test with nursing staff. Two nurses from CATS took part in the test, took part as well as another test subject who had been a nurse in a high acuity ward.

3.8.3.1 **User Test**

The test subjects were read out a scenario (see Appendix G) and asked to carry out a task which involved entering a set of observations using the CATS Mobile. The think aloud protocol was used, as in the paper prototype evaluation. Tests were audio recorded and transcribed. Using the transcript the usability issues that users encountered were catalogued.

3.8.3.2 **Post task questionnaire**

Following the completion of the task, each user was asked to complete a post-task questionnaire (see Appendix G). Again, the questionnaire was based on the USE questionnaire, but modifications were made to focus the questions on particular issues. The modified questions that were used in this version of the questionnaire are shown below.

> It is found the stylus and touch screen easy to use.
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA
>
> I found it easy to use the on screen numeric keypad
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA
>
> I feel it would be quicker to use than the paper nursing form.
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA
>
> I can easily read the patient's vital signs by looking at the graph.
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA
>
> It is easy to see all the information I want to see on the screen at the same time
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA
>
> I found it quick to enter a set of vital sign observations
> Strongly Disagree 1---2---3---4---5---6---7 Strongly Agree NA

3.8.3.3 **Post test interview**

Finally an informal interview was conducted with each of the three test participants to uncover additional requirements and usability problems. Using the transcript from this interview additional requirements and usability problems (that had not been discovered using the think aloud protocol in the user-test) were catalogued.

4 Results

This section presents the results that were obtained using the methods described in Chapter 3.

4.1 Requirements document

The contents of this section are based on the requirements specification stage of the project outlined in section 3.3 and additional requirements established following evaluations of the paper prototype and web application.

4.1.1 Purpose of Product

The system being developed is a working prototype of a web application to record and display patient vital sign data. The application is being developed for nurses who work at the Children's ambulance transport service (CATS) at Great Ormond Street Hospital, London. At present, nurses record the vital signs of patients being transported on a paper form. To cater for this demanding environment, nurses will use a Panasonic Mobile Clinical Assistant (MCA) which will provide a web-based interface to record and view patient vital sign data.

4.1.2 Stakeholders

There are four main stakeholders in this system. This section briefly describes their role and the impact the introduction of the system will have.

4.1.2.1 **Nursing staff at CATS**

Nursing staff at CATS will be the stakeholders most affected by this system. Their role is to provide clinical care for patients that are being transported by ambulance from the referring hospital to the receiving hospital. At present, they record patients' vital signs and any medical interventions they make on a paper form. The system will replace this form, resulting in a significant impact to the way in which they work. They will move from using a pen and paper to enter data to using a touchscreen interface on a tablet PC. Because the data is stored in a database, they will have access to improved visualisations of the patient data.

4.1.2.2 **Clinical staff CATS**

Clinical staff at CATS includes the doctors and consultants (excluding nurses). This system will provide them with a way of accessing the patient data using an online application, which hasn't been available to them before. This will allow them to monitor the progress of a transfer from the CATS base station and also to view the data of patients that have been transferred in the past.

4.1.2.3 **Clinical staff at receiving hospital**

Clinical staff at the receiving hospital will use the system to monitor the progress of patient's in transit to that hospital. The system will reduce the need to contact staff at CATS to check the progress of a transfer.

4.1.2.4 **Administrative staff at CATS**

These staff members receive requests for patient transfers from referring hospitals. They allocate resources and create paperwork to accompany each transfer. The system will allow them to create a new patient transfer records which the nursing staff update with patient data during the transfer.

4.1.3 Requirements

4.1.3.1 **Functional Requirements**

Functional requirements for the system are specified using the Volere shell.

No: 1	Type: Functional	Origin: CATS Interview

Description: The system shall provide a way to create a new patient record		
Rationale: The data for each patient must stored and presented separately		
No: 2	Type: Functional	Origin: CATS Interview
Description: The system shall display a list of patients whose data is stored in the database		
Rationale: Users should be able to browse a list of all patients they have permissions to view so they can locate a specific patient record they are looking for.		
No: 3	Type: Functional	Origin: CATS Interview
Description: The system shall allow a patient's record to be retrieved using his/her CATS number		
Rationale: This will allow users to locate a specific patient record they are looking for more quickly		
No: 4	Type: Functional	Origin: CATS Interview
Description: The system shall allow a receiving hospital to see a list of patients that are in transit to that hospital		
Rationale: For privacy reasons the receiving hospital should only be able to see patients that have been transported or are being transported to their hospital		
No: 5	Type: Functional	Origin: CATS Interview
Description: The system shall allow the user to determine the start time and interval that the patient's vital signs are recorded.		
Rationale: The first set of observations is recorded at different times, depending on the time retrieval occurs. And the interval between observations varies from transfer to transfer		
No: 6	Type: Functional	Origin: CATS Interview
Description: The system shall allow the user to set a specific time at which a set of observations are recorded		
Rationale: Users can record a set of observations at a time that does not correspond to set of observation times for that patient.		
No: 7	Type: Functional	Origin: CATS Interview
Description: The system shall allow the user to add a comment when adding any data to the patient's record		
Rationale: Users may sometimes wish to record a note with additional information when entering patient data		
No: 8	Type: Functional	Origin: CATS Interview
Description: The system shall record a patient's vital signs, ventilator settings, blood gases, neurological information, infusions and interventions		
Rationale: Recording patient data is one of the main goals of the application.		
No: 9	Type: Functional	Origin: CATS Interview
Description: The system shall display a patient's vital signs, ventilator settings, blood gases in tabular format		
Rationale: Users must be able to see the data that they have entered for the patient that is being transferred.		
No: 10	Type: Functional	Origin: CATS Interview
Description: The system shall display a patient's vital signs, ventilator settings, blood gases in graphical format with up to three sets of patient data on each graph		

Rationale: Users require that sets of patient data which has been recorded should be displayed in graphic format. This is to allow data to be compared and trends in data to be observed.		
No: 11	Type: Functional	Origin: CATS Interview
Description: The system shall display the comments that users have entered when recording data, on the graph of patient data sets.		
Rationale: The comments that users have recorded give extra information about the patient's condition and environment. Displaying the comments on the graphs allow the impact of these conditions and the environment to be noted.		
No: 12	Type: Functional	Origin: CATS Interview
Description: The system shall display a printable version of a patient's vital signs, ventilator settings, blood gases		
Rationale: The receiving hospital requires that a printable version of the patient's vital signs be given to the hospital during handover of the patient		

Table 7 Functional requirements based on CATS interview

4.1.3.2 **Non-functional Requirements**

This section outlines the non-functional requirements

No: 1	Type: Data	Origin: CATS Interview
Description: The system shall store the patient data on the mobile clinical assistant		
Rationale: In order to ensure fastest storage of data and to remove any dependencies on networks, the patient data will be stored locally on the mobile clinical assistant.		
No: 2	Type: Data	Origin: CATS Interview
Description: The system shall transfer a copy of patient data from the mobile clinical assistant to a central database server		
Rationale: The receiving hospital and staff at CATS base will need to be able to view the data of patients in transfer. In order to achieve this, the patient's data will be transferred to a central database. This will minimise the effect of any network congestion or outages the MCA will have when connecting over the 3G network as users will view the data from the central database and not the MCA.		
No: 3	Type: Usability	Origin: CATS Interview
Description: The system shall ensure that it is easy to determine which patient's data is being viewed		
Rationale: The user should be easily able to determine whose patient data is being viewed and amended		
No: 4	Type: Usability	Origin: CATS Interview
Description: The system shall allow the user to compare up to three sets of a patient's data e.g. heart rate, blood pressure, temperature		
Rationale: Users want to be able to compare sets of vital signs with other sets.		
No: 5	Type: Usability	Origin: CATS Interview
Description: The system shall be efficient and easy to use to use especially when adding data to the patient's record.		
Rationale: Entering a patient's vital signs and other intervention information into the system is a critical task that is undertaken frequently in a sometimes pressurised environment. It must be easy and quick to enter this data. This is also true because the system is being compared to data entry on the paper nursing form.		
No: 6	Type: Usability	Origin: CATS Interview

Description: The system shall make it easy to see the data which they have just entered		
Rationale: The user should be able to see the data that they have just entered in order to visually confirm what they have entered is correct.		
No: 7	Type: Usability	Origin: CATS Interview
Description: The system shall update the graphs of patient data with new data without user intervention		
Rationale: As the patient is being transported new set of observations will be recorded. These should be updated on any graphs that are being viewed without the user's intervention in order to save them from having to constantly refresh the page.		
No: 8	Type: Usability	Origin: CATS Interview
Description: The system shall help the user avoid making mistakes when adding/editing patient data		
Rationale: The user may be under considerable time pressure to add/edit patient data. They should be assisted in entering correct/appropriate data with defaults and pre-filled values where possible.		
No: 9	Type: Performance	Origin: CATS Interview
Description: The system shall respond to any user requests to add/view/edit data within 2 seconds.		
Rationale: The response time is critical in ensuring that the user can carry out their tasks as quickly as possible		
No: 10	Type: Performance	Origin: CATS Interview
Description: The system shall transfer all data from the MCA to the central database within 10 seconds of it being entered on the MCA		
Rationale: The clinical staff at the CATS base and the receiving hospital need to monitor the vital signs and interventions of the patient who is being transferred. In order to get an up to date picture of the data it need to be transferred to the central database as quickly as possible.		
No: 11	Type: Security	Origin: CATS Interview
Description: The system shall allow a receiving hospital to see a list of patients that are in transit to that hospital		
Rationale: For privacy reasons the receiving hospital should only be able to see patients that have been transported or are being transported to their hospital		
No: 12	Type: Security	Origin: CATS Interview
Description: The system shall transfer all data from the MCA to the central database server securely		
Rationale: In order to protect the data that is being transferred over the 3G network from being intercepted, it should be transferred using the HTTPS protocol.		
No: 13	Type: Security	Origin: CATS Interview
Description: The system shall require all users to log-in with a username and password		
Rationale: To protect the privacy of patient data, all access to the system should be restricted to authenticated users.		
No: 14	Type: Security	Origin: CATS Interview
Description: The system shall allow users to be assigned to one or more user groups which will control access to the application		

Rationale: Access to application's functions will not be universal. Some functions will be restricted according to the user's role. To make the management of these easier, users will be assigned to groups and access to functions will be restricted to the appropriate groups		
No: 15	Type: Display	Origin: CATS Interview
Description: The system shall present data in a clear and uncluttered layout		
Rationale: The user should be able to enter and view the patient data easily and so the screen layout should be uncluttered..		

Table 8 Non-functional requirements based on CATS interview

4.1.3.3 **Data Requirements**

The retrieval nursing form (see Appendix C) is a paper form that is currently used by nurses and advanced nurse practitioners to record patient data during the retrieval process. This was a valuable source of information for determining the data requirements. The form was split into 6 sections:

Section	Description
Patient info	Basic patient data such as name, date of birth and parent's names
Interventions	Details of medical procedures undertaken by the referral hospital and/or CATS team
Infusions	Details of infusions (drugs) administered to the patient
Observations	Vital signs: heart rate, blood pressure, respiratory rate
Ventilation	Details of the ventilator settings
Blood gases	Readings from blood gas monitor
Neurological	Observations of patient's neurological condition

Table 9 The sections of the paper nursing retrieval form

During the first interview, CATS nurses had clearly identified the portion of the form which they wanted converted to an electronic form. This allowed me to build a clear list of the data which the application would need to collect. Using the anonymised forms, I was able to see the types of data recorded in each field; some fields were alphanumerical, others were Boolean (yes/no) or datetime fields. For the majority of the text fields, the values could only come from a pre-determined list. For example, drug infusions can only come from a set list of drugs carried by CATS nursing staff. To confirm each field's data type and allowed values / value range, a spreadsheet describing each form field and its data / data type was sent to CATS. A CATS nurse responded with corrections where necessary and a PDF document containing drug names and drug doses (See Appendix I).

4.1.3.4 **Data visualisation requirements**

The paper nursing form is also used by nurses to create visualisations of the vital sign data as shown in the image from an anonymised completed form below:

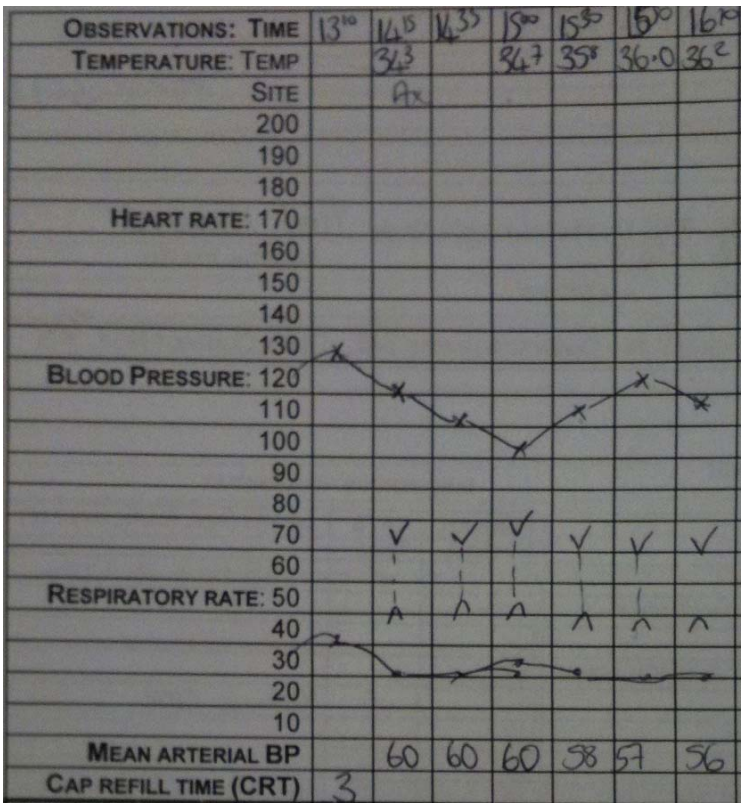

Figure 1 Visualisation of vital signs on the paper nursing form

The top line represents the heart rate. The bottom line represents the respiratory rate. And in between, the vertical lines with inverted arrows represent the range in diastolic and systolic blood pressures. Each of these lines uses the same scale based on the numbers on the left of the page, which indicate a range for the reading, 130-139, 140-149 etc. The exact value can be determined by the position of the mark in the box e.g. the bottom of a box is 130, the top is 139.

4.2 Context of Use

The system's context of use is described in this section. It was derived using the methods outlined in Section 3.4.

4.2.1 Identify User attributes

4.2.1.1 **CATS Nursing Staff**

The role of nursing staff is to provide clinical care for the patient during transport by ambulance from the referring hospital to the receiving paediatric intensive care unit where handover takes place. CATS nursing staff are the primary users of the system.

Nursing staff at CATS will be the main users of the system. They are based at the CATS base station near Great Ormond Street Hospital. Nursing staff travel in the ambulance to the referring hospital where they treat and stabilise the patient. They then accompany the patient in the ambulance to the receiving hospital where they handover the patient to the clinical staff. They record the vital signs and other interventions from the time they first attend the patient to the final handover. They are highly skilled and highly trained. They are IT literate are comfortable using technology which is a daily part of their job. The job is stressful and demanding and their absolute focus is on the care of the patient. They generally record sets of vital signs every hour, except for an hour after a patient has become unstable during which time they record vital signs every fifteen or twenty minutes. The vital sign data and information on any interventions forms part of the patient documentation.

CATS nursing staff will use the system to record and visualise patient vital signs. CATS nurses are highly trained and knowledgeable with extensive experience of recording vital signs and interventions on the paper nursing form. They are IT literate and use clinical information systems on a daily basis. They have no experience of using the mobile clinical assistant. However, they are keen to see the paper form replaced by a computerised system to record and visualise data.

4.2.1.2 CATS Clinical Staff

This group contains clinical staff at CATS other than the nursing staff. They have an interest in the clinical condition of patients and will monitor the condition of patients during transfer. They will also look at historic patient records. They are highly trained in clinical care and experts in providing care. These staff are IT literate and use clinical information systems on a daily basis

4.2.1.3 Receiving Hospital Clinical Staff

The staff at the receiving hospital provide care for the patient when he/she has arrived by ambulance. Patient handover is performed and patient documentation is received. Clinical staff at the receiving hospital are secondary users of the system.

Staff at the receiving hospital are based in the hospital's paediatric intensive care unit (PICU). Their role is to provide clinical care for the patient who is being transported to them by the CATS team. They receive information by telephone as to the expected arrival time of the patient and his/her current clinical status. They are IT literate and use computers and clinical information systems as part of their daily routine. A record of the patient's vital signs and clinical interventions during transport are part of the documentation which accompanies the patient when he arrives at the PICU. Clinical staff at the receiving hospital will use the system to view the patient's vital signs while he is in transit to the hospital. Clinical staff are highly trained and experts in providing care. The staff are IT literate and use clinical information systems on a daily basis.

4.2.1.4 CATS administrative staff

This group contains members of the CATS organisation who provide administrative support to clinical staff. They receive calls from the referring hospital requesting that a patient be transferred. They are responsible for staff resourcing of a transfer and for creating the initial paperwork to accompany clinical staff on the transfer. They are IT literate and use computers on a daily basis to fulfil their role.

4.2.2 User tasks

The table below shows the system tasks and their associated users.

Task No	Description	Users
1	Login to system	CATS nursing staff CATS clinical staff CATS administrative staff Receiving hospital clinical staff
2	Create patient record	CATS nursing staff CATS clinical staff CATS administrative staff
3	Search patient records	CATS nursing staff CATS clinical staff Receiving hospital clinical staff
4	List patient records	CATS nursing staff

		CATS clinical staff Receiving hospital clinical staff
5	Display patient records	CATS nursing staff CATS clinical staff Receiving hospital clinical staff
6	View patient record	CATS nursing staff CATS clinical staff Receiving hospital clinical staff
7	Enter patient data	CATS nursing staff
8	View patient data	CATS nursing staff CATS clinical staff Receiving hospital clinical staff
9	Print patient data	CATS nursing staff
10	View graph of patient data	CATS nursing staff CATS clinical staff Receiving hospital clinical staff

Table 10 Tasks and associated users

4.2.3 Technical Environment

The equipment to be used by stakeholders in this system is a PC with web browser and the Panasonic Mobile Clinical Assistant. All stakeholders are IT literate and are comfortable using a PC with web browser. The mobile clinical assistant is a new piece of equipment, unused by the nursing staff. It is designed specifically for use in clinical environments and many of its characteristics are suitable for this environment. It has a hard non permeable surface making it easy to clean – an on-screen reminder prompts the user to clean the surfaces at regular pre-determined intervals. The MCA has a toughened exterior casing making it able to sustain drops from up to one-metre. It can connect to wireless networks and the 3G/3.5G mobile networks, meaning it can receive and transmit data while it is being used in the back of an ambulance. It has a strap fitted to the back, allowing it to be held easily with one hand, while the other interacts with the touch screen.

The touch screen interface operates using a stylus/pen and on-screen keyboard. This may be difficult to use while the ambulance is in motion and the system must take account of this.

Figure 2 The Panasonic CF-H1 Mobile Clinical Assistant tablet PC

Figure 3 The QWERTY style on-screen keyboard

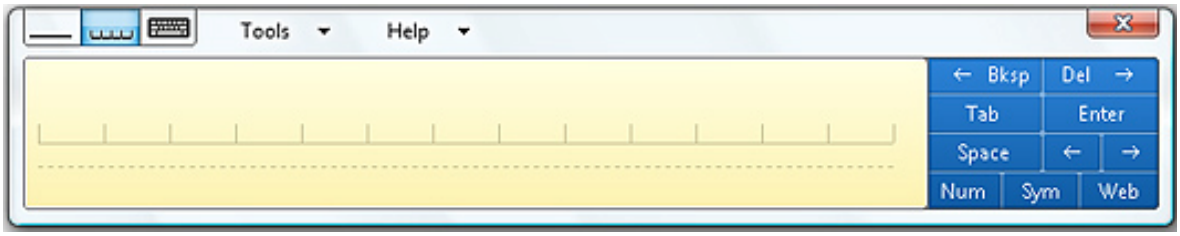

Figure 4 The Character Recognition on-screen keyboard

4.2.4 Physical Environment

Nursing staff will be using the system to enter data on hospital wards and the back of ambulance. In hospital wards, the environment will be hectic and crowded. Space in which to use the system will be limited. In the back of the ambulance, the environment will be cramped and hectic. The ambulance may be travelling at speed making the MCA's touch screen difficult to interact with accurately.

4.3 Design Solutions – Iteration 1

This section describes the design solutions resulting from the methods in section 3.5.

4.3.1 System Architecture

The network diagram below depicts the proposed system architecture

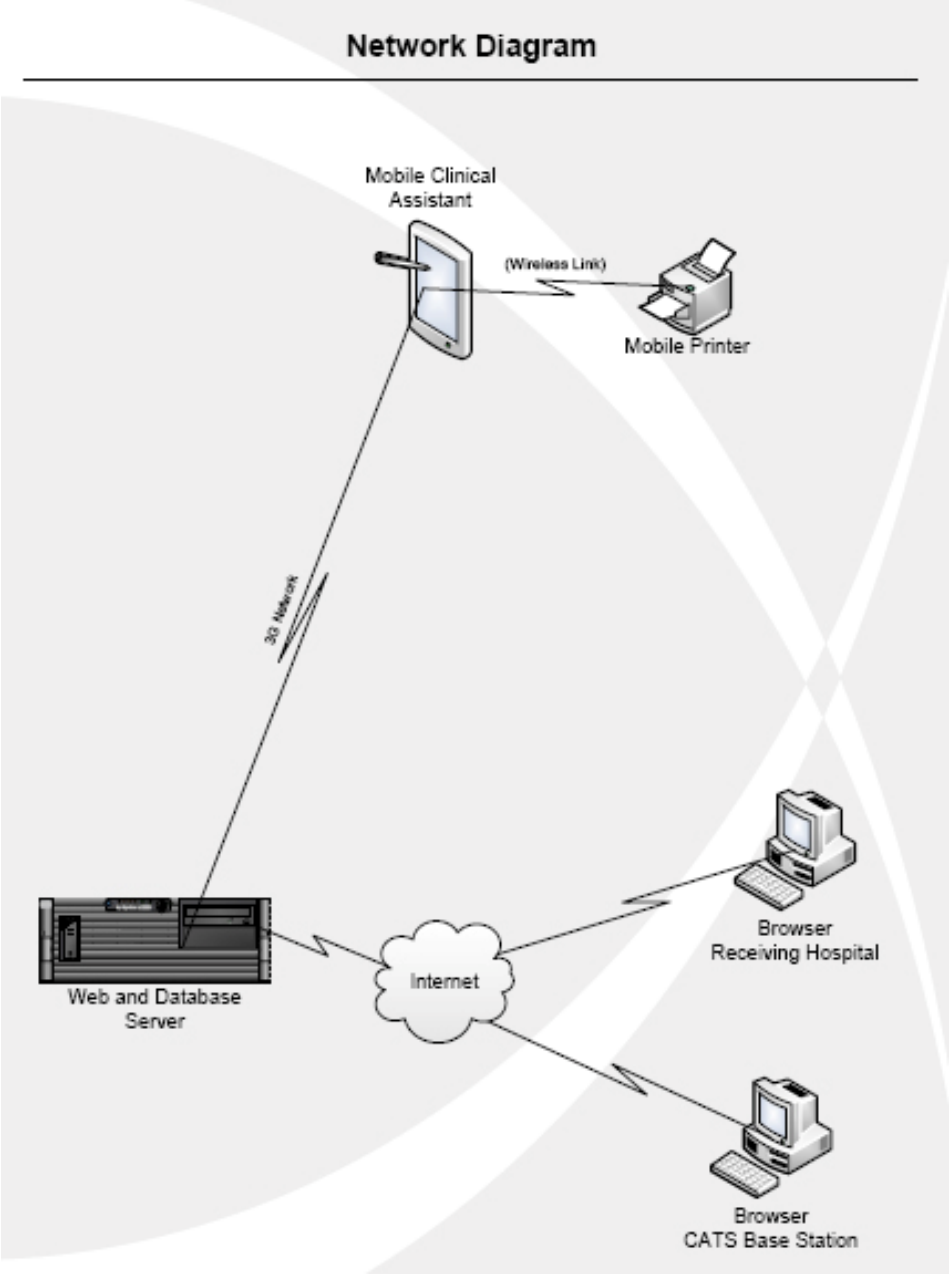

Figure 5 – Proposed System Architecture

The design was based around a set of one or more mobile clinical assistants running a web-based application to record and display patient data. This application will be known as 'CATS Mobile'. These mobile clinical assistants would record data on a local database to remove the need for any network connection and ensure the speedy response of the application. When they did have a network connection local data was synchronised with a centralised database. This database could be accessed over the web using an application called CATS Central.

4.3.2 Paper Prototypes

38 paper prototypes were developed using Balsamiq. These covered the CATS Central application (to be used by staff at receiving hospitals and the CATS base station) and CATS Mobile, the application to run on the MCA and used by CATS Nursing staff. The design of the paper prototypes was based on the analysis of the requirements and context of use.

The paper prototypes are available in Appendix D.

4.4 Evaluation of Paper Prototypes

Based on an analysis of the transcripts recorded during the user-tests, and other feedback provided by CATS nurses during the session, the following additional requirements were deteremined.

4.4.1.1 **Functional Requirements**

The following additional functional requirements were determined from the paper prototype evaluation

No: 1	Type: Functional	Origin: Paper Prototype Testing
Description: The system shall display the current time as the default time for observations		
Rationale: This will save the user time when entering data		
No: 2	Type: Functional	Origin: Paper Prototype Testing
Description: The system shall display data in a chart format that shows trends in the data		
Rationale: Nurses need to be able to observe changes in data values and whether they are ascending or descending		

Table 11 Functional requirements from prototype testing

4.4.1.2 **Non-functional Requirements**

The following non-functional requirements were determined from the paper prototype evaluation.

No: 1	Type: Device	Origin: Paper Prototype Testing
Description: The device shall be as small as possible		
Rationale: This will make the device easy to carry		
No: 2	Type: Device	Origin: Paper Prototype Testing
Description: The device shall be as rugged as possible		
Rationale: The users work environment means that equipment is often knocked against and dropped		
No: 3	Type: Data	Origin: Paper Prototype Testing
Description: The system shall store data for retrieval, audit and analysis later		
Rationale: This is to allow users to analyse the data		
No: 4	Type: Display	Origin: Paper Prototype Testing
Description: The system shall display tabs that allow the user to open accordion should be on the left		
Rationale: This is what users are familiar with from applications they currently use		
No: 5	Type: Display	Origin: Paper Prototype Testing
Description: The system shall scroll left to right if there are too many sets of observations to fit on one page.		
Rationale: Users need to see the full set of observations side by side		
No: 6	Type: Display	Origin: Paper Prototype Testing

Description: The system shall allow all data to be inputted on one screen		
Rationale: This will save time when inputting data		
No: 7	Type: Display	Origin: Paper Prototype Testing
Description: The system shall allow the user to select his/her username from drop-down		
Rationale: This will save the user typing their name in using the on screen keyboards		
No: 8	Type: Display	Origin: Paper Prototype Testing
Description: The system shall display patient data in accordion style, with tabs on the left to open/close each accordion slot		
Rationale: This will allow users to display just the part of the forms that they want to		
No: 9	Type: Display	Origin: Paper Prototype Testing
Description: The system shall display observations at the top of the screen		
Rationale: This is the most commonly used part of the form		
No: 10	Type: Display	Origin: Paper Prototype Testing
Description: The system shall display interventions at the bottom of the screen		
Rationale: This is the least commonly used part of the form		
No: 11	Type: Display	Origin: Paper Prototype Testing
Description: The system shall allow the user to see different sections of the form on the screen at the same time		
Rationale: Users compare data from different parts of the form		

Table 12 Non- Functional requirements from prototype testing

4.5 Development of fully functional prototype – CATS Mobile

This section describes the results of the development process described in section 3.7.3. As mentioned in that section, the remainder of this project focuses on the CATS Mobile application, the part of the system to be used by nurses to record vital signs. (The CATS Central application, which would be used by other staff at CATS or at the referring hospital has been specified, and paper prototypes produced, but a fully functional prototype of it will not be developed.)

The first stage of the development process was the database. The list of database tables which were constructed is shown below:

Database Table Names
Users
Infusions
Bloodgases
Interventions

Observations
Neurological
Ventilation

Table 13 Database tables

An abridged entity relationship diagram of the database schema is available, along with a full list of fields in each table, in Appendix J.

The next stage was the development of the PHP and HTML pages to allow nurses to enter and visualise patient data. To minimise the delays associated with loading web pages, the CATS Mobile application was designed to be used from just two web-pages.

The first page allowed new patient records to be created and a list of existing patient records to be viewed. The second page allows the user to enter and visualise patient vital signs data.

Layout of data entry screen
This page which allowed a patient's vital signs to be entered and visualised was split into 7 key sections: Charting, Interventions, Infusions, Observations, Neurological and Ventilation. This corresponds to the order of information on the paper nursing form. This is a lot of data to display on one web-page, especially on the tablet PC. To overcome this, I used a modified JavaScript object, the Accordion menu, based on Yahoo User Interface (Yahoo Developer Network n.d.) Library (Animation Object) and adapted it to allow the user to open/close sections of the page using tabs on the side of the page.

Input numeric data
The paper nursing is laid out as a set of tables which allow the nurse to record patient observations. The table metaphor was was considered a suitable metaphor to continue to use on the web application. To achieve this I used the Yahoo User Interface Library, selecting the DataTable object as the basis for displaying and entering data. I extended this object, by adding a custom cell editor which I created in JavaScript. The editor presented the user with a pop-up editor to enter data into the appropriate cell. I created a custom JavaScript keyboard to use as an editor for numeric data. This keyboard uses a convenient numeric key pad style to allow the user to enter numeric data. In the evaluation described in section 3.8.1, this keyboard is compared with two keyboards that are supplied with the tablet PC.

Data visualisation
I used Google's Annotated Timeline (Google n.d.) object as a novel way to visualise the patient data which nurses had entered. The annotated timeline is a publicly available library objectwhich developers can utilise to display an interactive time series as line chart with optional annotations overlaid on the chart. The chart is rendered within the browser using Adobe Flash.

The result of the development process was a set of PHP and HTML files which together make up the CATS Mobile application.

The following table describes the files which were coded during the development process;

File Name	Lines of code	Description of file
data.php	180	Supplies patient data and configuration data to the datatable objects

chartdata.php	163	Passes patient data to the annotated timeline object
patient.php	739	The main page of the application. Gets data from the database for the data tables and charts. Controls the editors that are used to update information in each table cell. Loads the annotated timeline visualsation
DBResponse.php	417	Updates the database with values from the editors and sends responses back to the patient.php page
index.php	111	The default page for the application. Loads the patients.php file and displays a form to add a new patient
addpatient.php	104	Takes new patient data and stores it in the database
patients.php	71	Displays list of patients in currently database
patient.css	297	Controls the look and feel of the patient page

The total number of lines of code was approximately 2100. The code listing is available in Appendix E.

At the end of development process a fully functional prototype called CATS Mobile was running on the tablet PC.

The screen shot below, Figure 6, shows the patient data screen, the main screen of the application. It shows the navigation tabs on the left and the accordion style display used to organise the different sections of the form. In this screen shot all the 'sections' of the accordion are displayed. The screen shot shows the chart and the 'annotations' (interventions and infusions) on the right hand side. Also shown are the data-tables for the observations, ventilation, blood gases and neurological data.

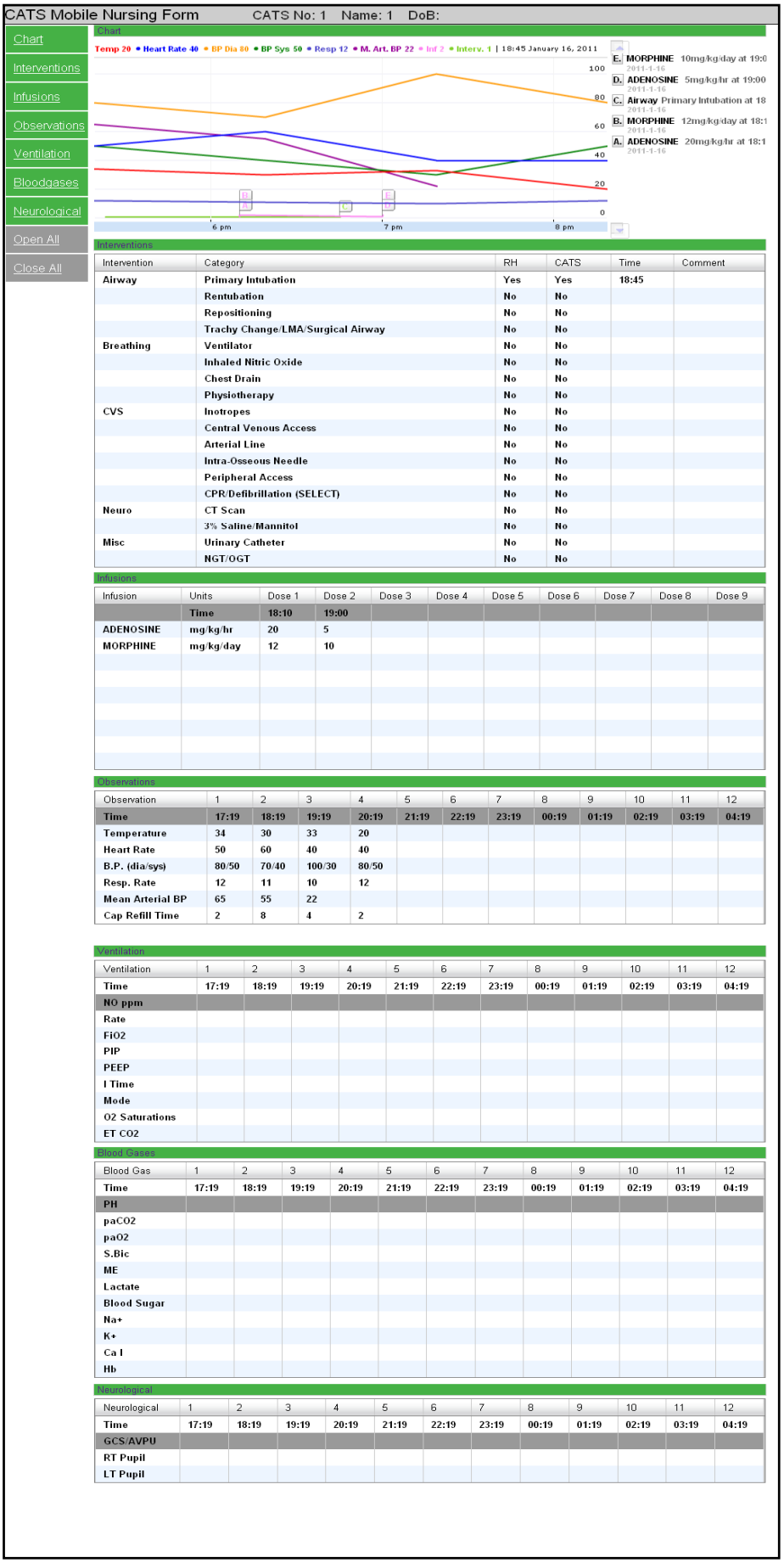

Figure 6 Patient Data screen from CATS Mobile application

The screen shot below, Figure 7, shows the same screen, but with all the sections of the accordion style display closed.

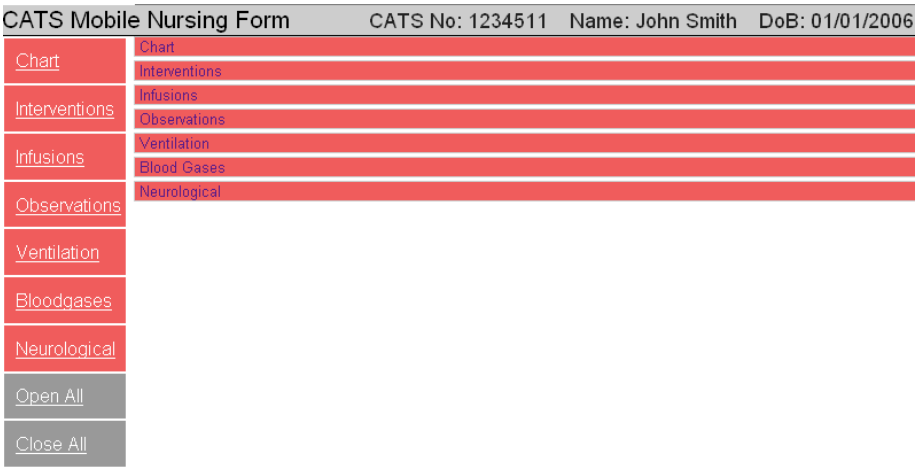

Figure 7 Patient Data screen from CATS Mobile application

The three screen shots below show data entry using three keyboard types. The first two use keyboards that are supplied as part of the tablet PC. The third one shows a custom number keypad which was developed as part of this study.

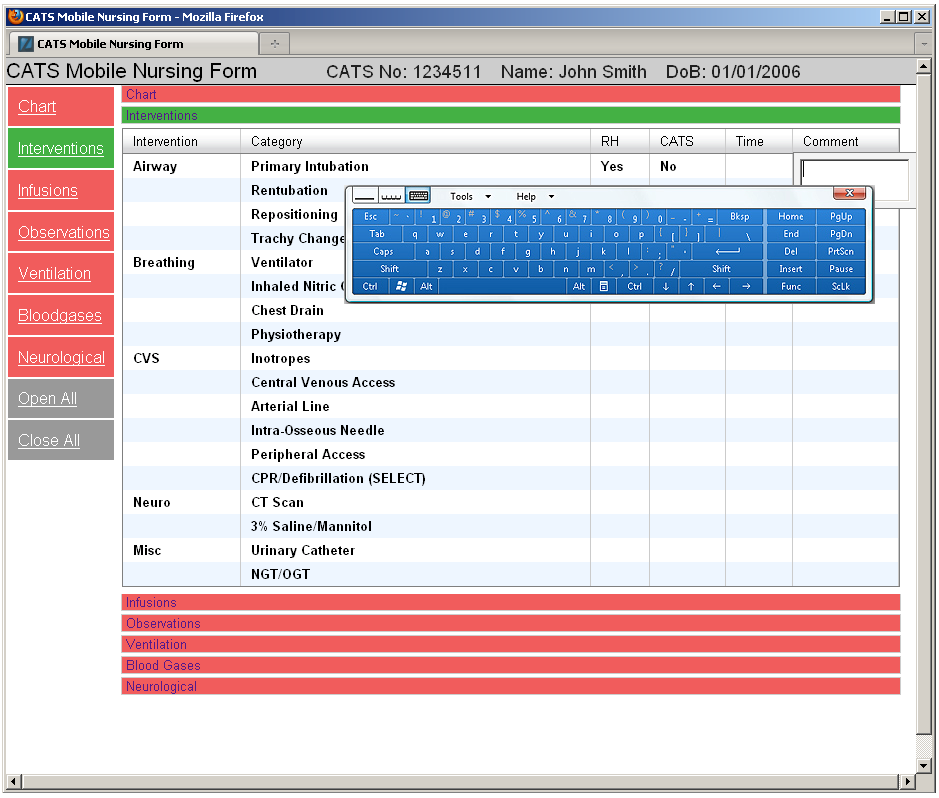

Figure 8 Text input using the QWERTY on-screen keyboard

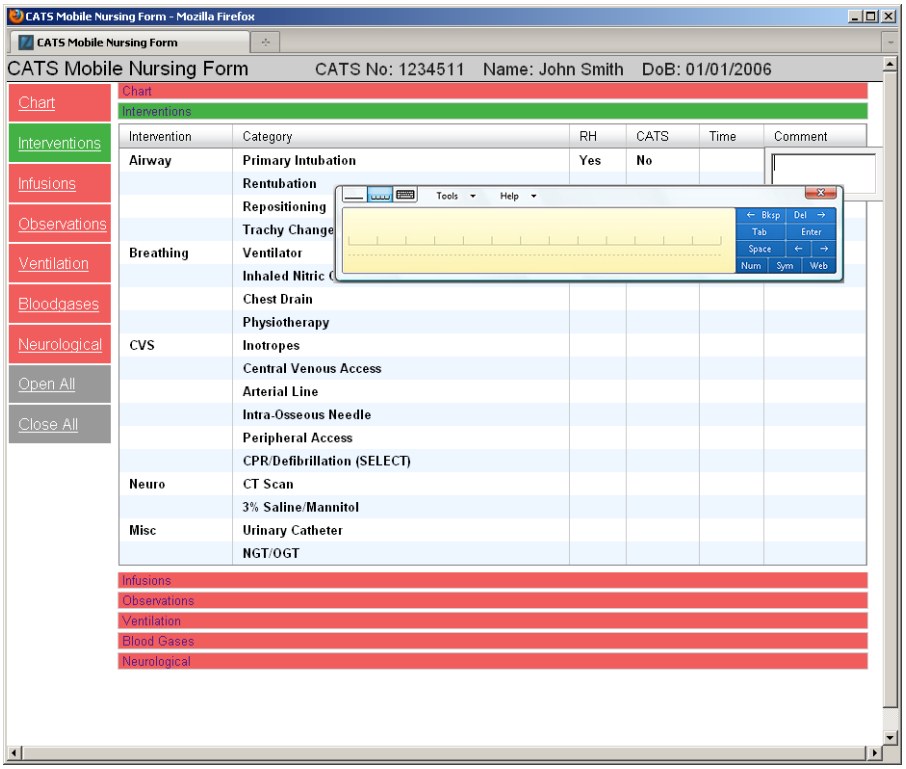

Figure 9 Text input using the character recognition on-screen keyboard

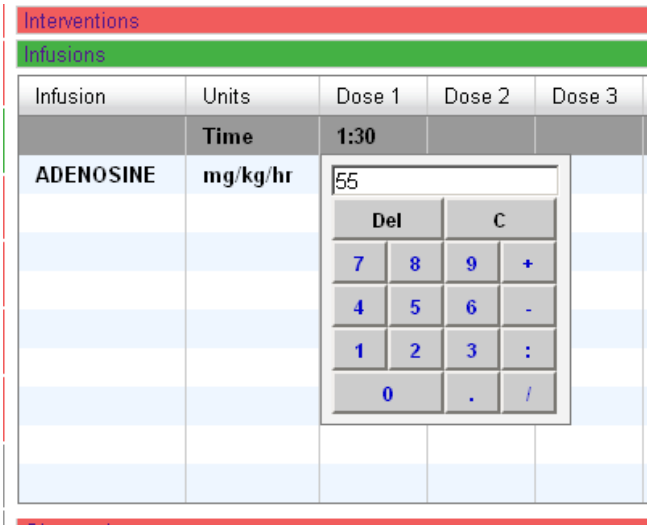

Figure 10 Number input using the custom number keypad

4.6 Evaluation of fully functional prototype

The results of the evaluation of the functional prototype as described in section 3.8 are given in this section.

4.6.1 Comparison of three data entry methods

The results from this section are derived from the user-tests described in section 3.8.1. The data for the chart below is in Appendix L

4.6.1.1 **Efficiency**

The chart below shows the average time to complete the task of entering vital signs using each of the three keyboards.

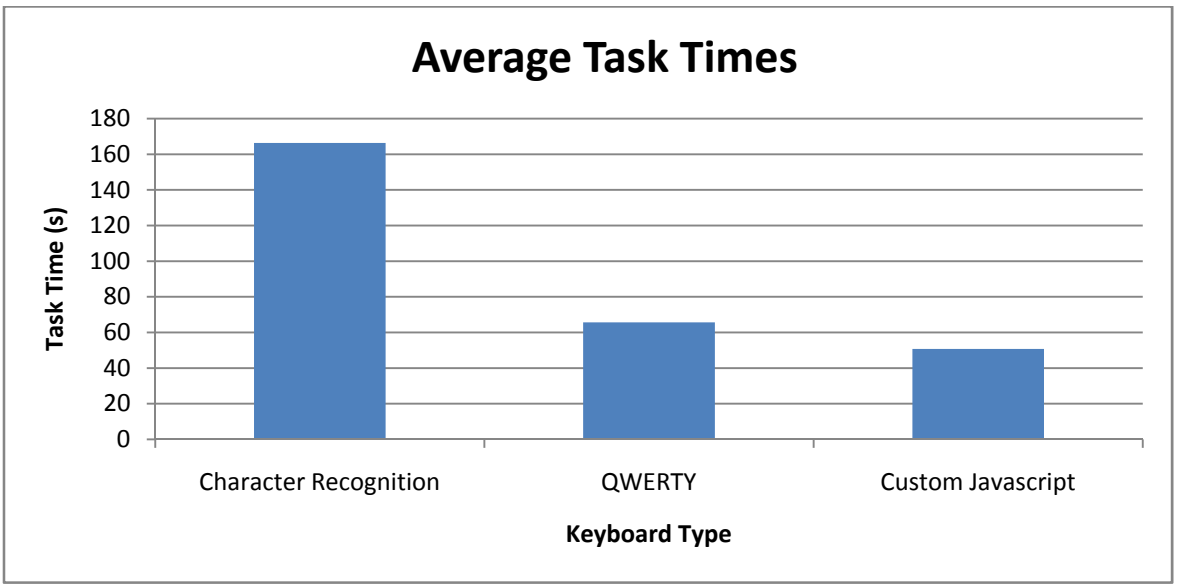

Figure 11 Average task time for each keyboard type

4.6.1.2 Effectiveness – Error Count

Figure 12 shows the average error count for each of the three keyboards that were compared.

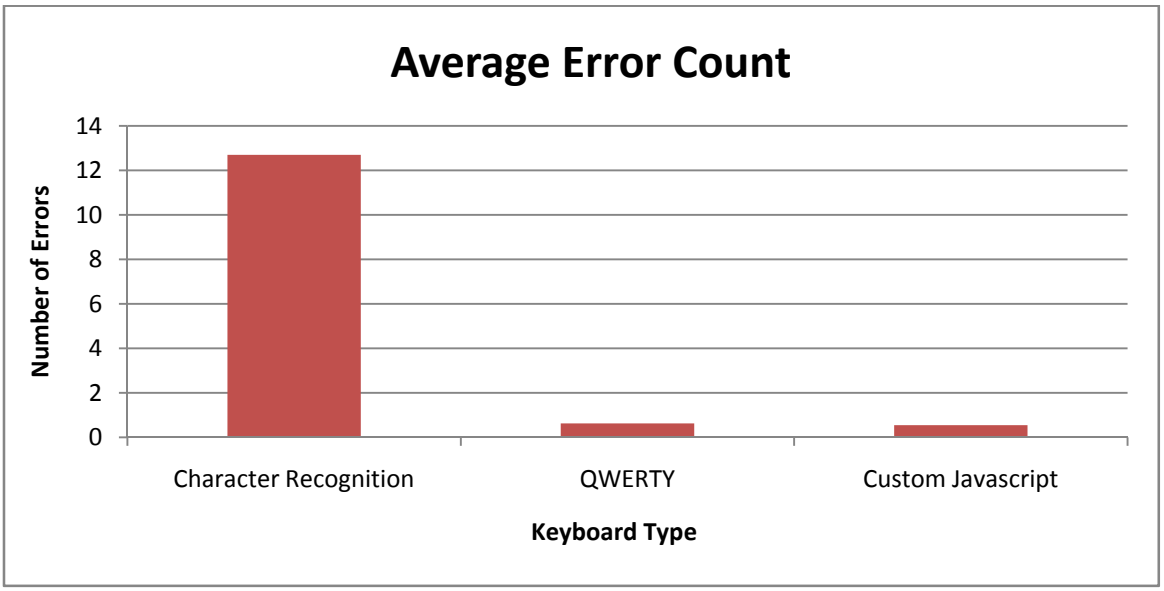

Figure 12 Average error count for each keyboard type

4.6.1.3 Effectiveness - Task completion

All of the twenty users were successfully able to complete each of the four tasks for all three keyboard types.

4.6.1.4 Learnability

The chart below shows the time data across the four different tasks for each keyboard type

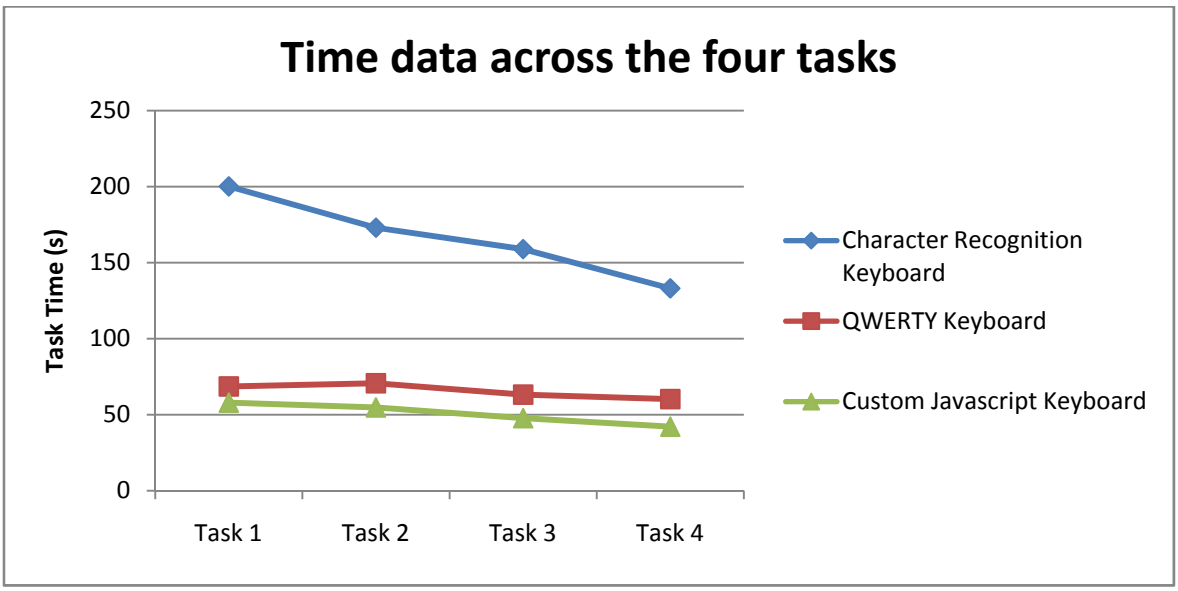

Figure 13 Time for each task on each keyboard type

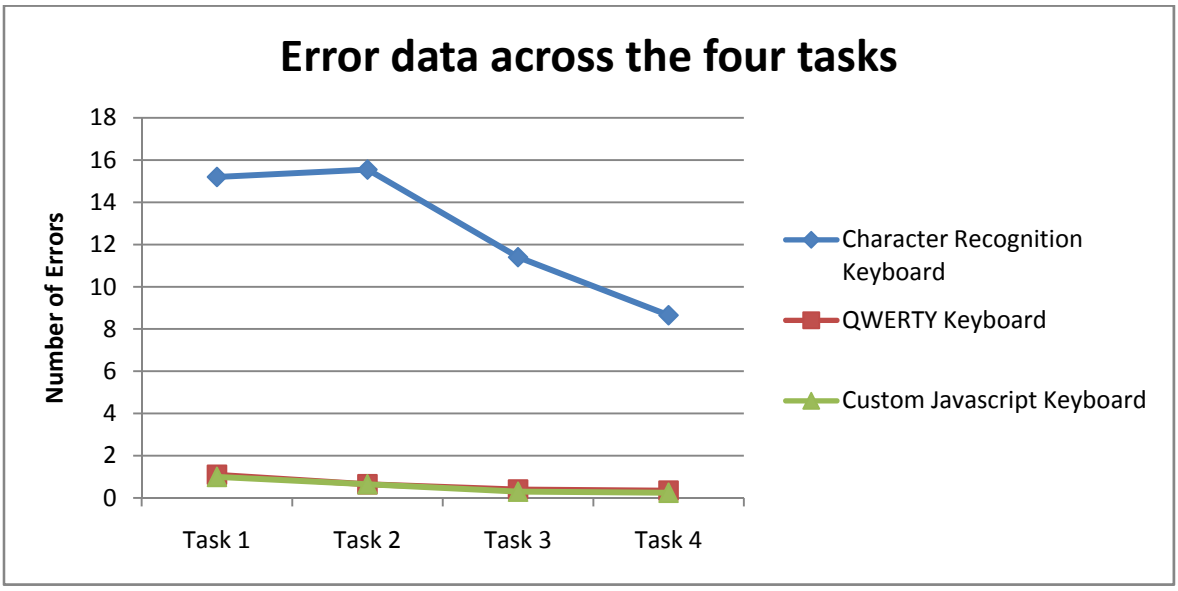

Figure 14 Error count for each task on each keyboard type

4.6.1.5 User Satisfaction

To determine a user satisfaction score, the results from the questionnaire were analyzed using the method outlined by Brooke (1996). To calculate the score, the score contributions from each item, ranging from 0 (Strongly Disagree) to 6 (Strongly Agree) were calculated. The sum of the scores was multiplied by 1.38 to obtain the overall value of user satisfaction score, 0 being the minimum, 100 the maximum.

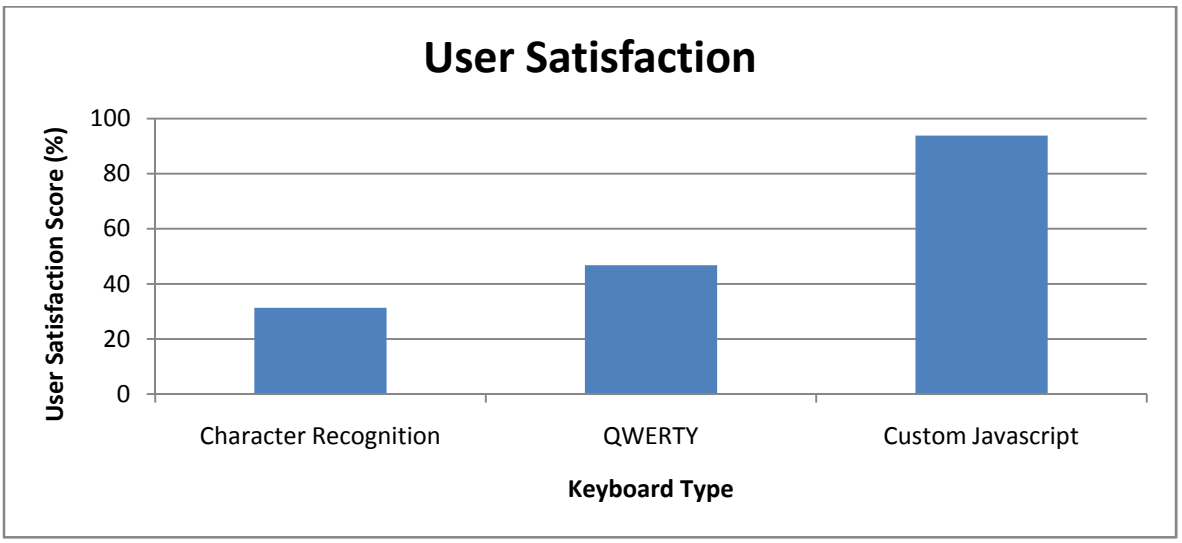

Figure 15 User satisfaction score for each keyboard type

4.6.1.6 Disadvantages/Advantages of each keyboard Type

Users' responses to the questions on the advantages and disadvantages of each keyboard type were collated.

Keyboard Type	Advantages	Disadvantages
Character Recognition	Write the same way as on paper Don't have to select small keys	Doesn't recognise many characters Doesn't know you are entering numbers Had to repeatedly enter characters before they were recognised correctly
QWERTY	Don't have to write All keys in front of you Familiar layout	Didn't know about shift button Have to select accurately from keys Have to select from lots of keys Too small
Custom JavaScript	Extremely quick Very few errors Only shows keys that are needed	Too small No letters

Table 14 Advantages/disadvantages of each keyboard type

4.6.1.7 Error descriptions

Keyboard Type	Common Errors
Character Recognition	Recognising numbers as letters Difficult to correct mistake Slow to interpret some characters Not clear how to write some characters/numbers Non alphanumeric characters are often recognised incorrectly
QWERTY	Selecting the neighbouring key by mistake Can't find the shift button to enter a colon
Custom JavaScript	Delete and clear buttons do not work as expected Slow to react Selecting the neighbouring key by mistake

Table 15 Common errors for each keyboard type

4.6.2 Comparison of pen and paper with tablet PC

The chart below shows average task times comparing data entry using the traditional pen and paper nursing form with the tablet PC. The data for the chart below is in Appendix L

The four sets of data on the chart compare the times taken to enter data from different parts of the form. The first set uses data from all sections of the form. The second set shows data from all parts of the form, except interventions. The third shows data excluding times for interventions and infusions. Finally, the last set of data shows the time to enter a set of observations only.

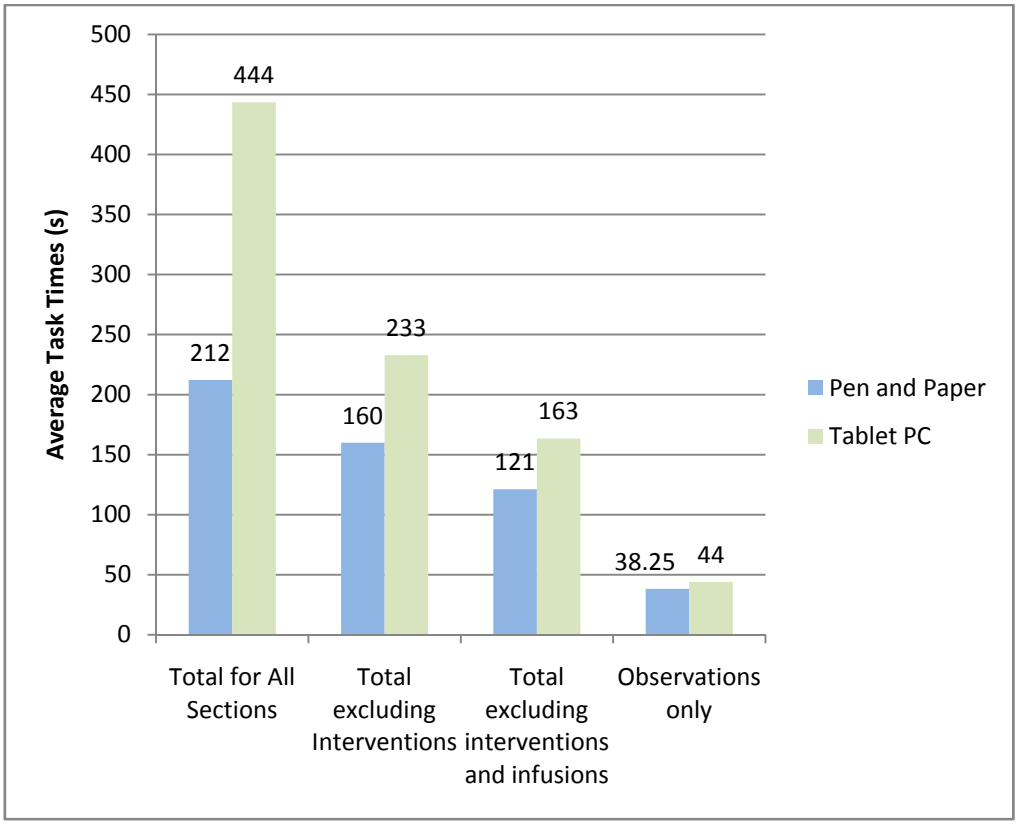

Figure 16 Comparison of task times using pen/paper and tablet PC

4.6.3 User test results

As described in section 3.8.3 a user test was conducted with nurses to evaluate the CATS Mobile application.

4.6.3.1 **Requirements**

The additional requirements were found as a result of analysing the transcripts from the user tests and post-test interviews (section 3.8.3.1 and 3.8.3.3)

Functional Requirements

No: 1	Type: Functional	Origin: Evaluation on Tablet PC
Description: Only blood pressure and heart rate need to be plotted on the chart		
Rationale: Trends in the other values are not needed and clutter the visualisation		

No: 2	Type: Functional	Origin: Evaluation on Tablet PC
Description: The system should display the last time it has updated the central server		
Rationale: Users need to know if data has been transferred to the central server		
No: 3	Type: Functional	Origin: Evaluation on Tablet PC
Description: Numbers outside allowed ranges should be shown in different colours		
Rationale: This will alert users to incorrect data		
No: 4	Type: Functional	Origin: Evaluation on Tablet PC
Description: Date pickers should be used for the date		
Rationale: This will ensure a correct date is selected		
No: 5	Type: Functional	Origin: Evaluation on Tablet PC
Description: The ability to carry forward readings from one set of observations to the next		
Rationale: This will speed up the data entry process		
No: 6	Type: Functional	Origin: Evaluation on Tablet PC
Description: Default time of observation to current and override if necessary.		
Rationale: This will speed up the data entry process		

Table 16 Functional requirements from evaluation of tablet PC

Non-functional Requirements

No: 1	Type: Display	Origin: Evaluation on Tablet PC
Description: The visualisation of data on the charts should use dots instead of a continuous line		
Rationale: This is what nurses are used to on the current form		
No: 2	Type: Display	Origin: Evaluation on Tablet PC
Description: The annotation on the interventions on the timeline should give the intervention type		
Rationale: This will let the user see the intervention type on the chart		
No: 3	Type: Display	Origin: Evaluation on Tablet PC
Description: Maximum value on chart should be 300		
Rationale: This is the maximum value data can have		
No: 4	Type: Display	Origin: Evaluation on Tablet PC
Description: Blood gases and ventilation should be in the same section		
Rationale: These are often entered at the same time		

No: 5	Type: Usability	Origin: Evaluation on Tablet PC
Description: The cells in the data tables need to be bigger		
Rationale: This will make it easier to select the cell to enter data into.		
No: 6	Type: Usability	Origin: Evaluation on Tablet PC
Description: The buttons on the custom JavaScript keypad need to be bigger		
Rationale: This will make it easier to enter data		
No: 7	Type: Usability	Origin: Evaluation on Tablet PC
Description: The navigation tabs should be on the right		
Rationale: This will prevent the user from blocking his/her view of the screen when using these tabs		
No: 8	Type: Usability	Origin: Evaluation on Tablet PC
Description: Observations should be directly under the chart		
Rationale: This is the most commonly used part of the form and the part from which most data for the chart does come.		
No: 9	Type: Usability	Origin: Evaluation on Tablet PC
Description: Observations, ventilation, blood gases, neurological, and then interventions and infusions,		
Rationale: This is the order in which these parts of the form are used, most frequently to least frequently.		
No: 10	Type: Usability	Origin: Evaluation on Tablet PC
Description: Temperature should be at the bottom of the observations table		
Rationale: This is the least important observation reading		
No: 11	Type: Usability	Origin: Evaluation on Tablet PC
Description: The keypad should have an enter key to confirm, rather than clicking outside the box		
Rationale: This is what users expect to see		
No: 12	Type: Usability	Origin: Evaluation on Tablet PC
Description: When a new section is opened using the navigation tabs, the screen should scroll down to the place automatically		
Rationale: This will save users from having to scroll to the section they want to see		
No: 13	Type: Usability	Origin: Evaluation on Tablet PC
Description: The bars on each accordion that open/close that section should be bigger		
Rationale: This will make it easier for the user to open/close sections of the form.		
No: 14	Type: Usability	Origin: Evaluation on Tablet PC
Description: On the navigation tabs, the whole tab should be clickable not just the word		

Rationale: This will make selecting the tab easier for the user.		
No: 15	Type: Display	Origin: Evaluation on Tablet PC
Description: The charting visualisation should only display blood pressures (diastolic, systolic and mean) and heart rate		
Rationale: This will prevent the chart from being over cluttered		
No: 16	Type: Display	Origin: Evaluation on Tablet PC
Description: The chart should not use trend lines between data points, but instead use symbols for each data point as used on the paper nursing form		
Rationale: This is what nurses are familiar with.		

Table 17 Non- Functional requirements from evaluation of CATS Mobile

4.6.3.2 **Post-task questionnaire**

All three nurses who took part in this user-test were asked to complete a post-test questionnaire as described in section 3.8.3.2. The average score was found to be 76%.

5 Analysis and Discussion

5.1 Introduction

This chapter discusses the results which were presented in the previous chapter. The results are discussed in the following three sections, each of which relates to one of the project objectives defined in section 1.2

5.2 Understanding the CATS Work environment

5.2.1 Gathering Requirements and Context of Use

The first aim of this study was to understand the CATS working environment and the current methods that nurses use to record patient data. The series of interviews which took place at the start of the project generated a significant number of requirements for the project. The transcript of the initial interview with the CATS team ran to over 8,000 words (See Appendix B) and generated a set of 27 functional and non-functional requirements as described in tables 8 and 9. Whilst a set of interview questions had been prepared in order to conduct a structured interview, the majority of these questions were not needed because the CATS nurses were very well able to describe the type of application they envisaged. In the end the questionnaire was only useful to double-check that all areas I had planned to cover had been discussed. This was most likely for two reasons. Firstly the CATS team are highly IT literate. They use IT applications as part of their daily work, including some which record vital signs on hospital wards. And so, they had a clear idea of what the application should do. Secondly, they have been consulted about requirements for IT applications on previous occasions, and so they are aware of the types of questions they could be asked, and of how to describe the type of application they would like to use.

The second interview (See Appendix B) was conducted with a former nurse who worked in a high acuity ward and now worked for a healthcare company. Her expertise was invaluable in investigating the context of use that nursing staff work in, especially user attributes and information on the physical environment.

The paper form was another important source of requirements for this project. This form had been refined over time, and was in essence, a well defined and concise representation of their requirements for CATS Mobile, showing the exact nature of the data they wanted to record and also how they visualised this data. Having the paper form made it easier to understand the data that would input into the vital signs application. If this project had been gathering requirements for a completely new system or work process, it would have been much more difficult to define the requirements so quickly.

The non-functional requirements included some of the same requirements expressed in Ammenworth's study (2000), namely that it should be user-friendly and fast to use.

5.2.2 Paper Prototypes

The development of the prototypes was a fast process, helped by using Balsamiq, a wire-frame generation tool. The evaluation of the paper prototypes was helpful in obtaining additional requirements. The transcript for this test contained over 5,000 words and gave rise to more than 15 new functional and non-functional requirements.

The evaluation of these paper prototypes was useful for refining and expanding upon the functional requirements which had already been determined. However, the nature of using a tablet PC with no keyboard as that the input mechanism is of key importance in how usable the application is. And because this evaluation did not use the tablet PC, it could not give

much insight into the usability of the tablet PC's data input mechanism because it was conducted using paper instead of a stylus and touch screen.

The results described above make up a detailed set of specifications that describe the CATS working environment, their current working practices and the requirements for a system to record patient vital signs.

5.3 Development of fully functional prototype

The next stage of the project was the development of CATS Mobile, a fully functional prototype. The development process was difficult and time consuming. A lot of research was done to find a suitable style to display so much information on one page, and on such a small-screen device. In the end an 'accordion style' display which allows parts of the screen to be hidden / revealed was chosen to achieve this. The data-table objects and visualisation objects that were chosen from object libraries (Yahoo and Google respectively) which did cut down on the development time. To visualise the patient data, a graphical annotated timeline was used. This allowed for observations to be plotted on a chart and for the medical interventions and infusions to be overlaid on this data. A novel JavaScript numeric keypad was also developed. This prototype fulfilled the requirements that had been determined in the previous phase of the study, resulting in a fully functional application, 'CATS Mobile'. For screen shots of the application, please see Appendix F. (An installation CD with instructions is attached to the hard-copy of this document).

5.4 Evaluation of CATS Mobile Prototype

The evaluation of the fully functional prototype centred around three distinct areas:

5.4.1 Comparison of three data entry methods

In this test twenty users were asked to enter four sets of patient vital sign observations in each of the three keyboards types in turn. The task completion time and number of errors encountered was recorded.

5.4.1.1 **Efficiency**

To compare the efficiency of each keyboard type, the task completion times were compared. Figure 11 shows the average task times for each of the three keyboard types. The averages are based on 4 tasks, in which twenty users entered a set vital sign observations. There is a clear difference between the results for the character recognition keyboard and the two other keyboards (QWERTY and custom). This is not unexpected. Users expressed considerable frustration when using the character recognition keyboard to enter patient vital sign data. The average task time for the character recognition keyboard was 166 seconds, almost three minutes. The QWERTY and custom JavaScript keyboards, had considerably lower average task times, 66 seconds and 51 seconds respectively.

Yatani and Truong (2007) reached similar conclusions when comparing task times for four different on screen keyboards. They found that users were able to enter text more quickly using the QWERTY keyboard compared with character or handwriting recognition keyboards.

5.4.1.2 **Effectiveness**

Two measures of effectiveness were used, the error count and task completion rate.

The average error count across all four tasks is shown for each keyboard type in figure 12. This chart follows a similar pattern to the previous chart. The number of errors encountered by users is significantly higher when using the character recognition keyboard, compared with the QWERTY and custom JavaScript keyboards. Averaged across the four tasks, users

encountered 13, 1, 1 errors for the character recognition, QWERTY and custom JavaScript keyboards respectively. 13 errors is an extremely high number, considering the task was a simple one of entering 7 pieces of simple numeric data. In effect, it would make the character recognition keyboard unusable in a clinical environment. The main source of errors with this keyboard was the incorrect recognition of characters that users had written using the stylus. Most often this resulted in numbers being mistaken for characters, for example, 0 mistaken for O, 1 mistaken for I, i, L or l, and 4 mistaken for F. Similarly, some non-alphanumeric characters were often mistaken for characters, for example, / mistaken for l or i. In some tests the user might have to write a number 9 or 10 times before it was recognised correctly.
The task time and error count data show that the character recognition keyboard is not suitable for entering patient vital signs data – it is very slow and produces too many errors. Application that involves inputting significant amounts of numeric or non-alphanumeric characters, should avoiding using this type of keyboard. Lu et al (2005) came to the same conclusion in their study noting that the "Data entry mechanism with graffiti was unintuitive and not easy to use".

In spite of the problems entering data using the character recognition the task completion rate was 100% for all keyboard types. Therefore, in cases where the user was unable to choose which keyboard they used, they would still manage to successfully to input data, however slow or difficult this might be.

5.4.1.3 **Learnability**

Figure 13 compares the task completion time for each keyboard type across each of the four tasks. The aim of this chart was to show the learnability of each keyboard. The most common measure of learnability is the 'learning time' i.e. the time taken before a user can successfully complete the task, or complete the task with a certain number of errors. The results from this study do not present a measure of the learning time, instead the relationship between the task completion time/error rate and the number of times a task has been completed is investigated.

Figure 13 shows a clear 'practice effect' (influence of repetition of a task on its outcomes) on the task completion time for the character recognition keyboard. The task completion time, averaged across the twenty test subjects, decreases from 200 seconds to 133 seconds. Over the course of the four tasks, users appear to be learning how to use the character recognition keyboard. Figure 14 shows the error data across the four tasks for each keyboard, and the same trend is visible. The number of errors on each task decreases from an average of 15 errors to 8 errors. With practice using the keyboard, users are able to reduce the number of errors they make. The slope of both data series for this keyboard type is still showing a downward trend between task 3 and 4. This shows there is still some degree of leaning going on. To consider that the users had fully learnt to complete this task with the on screen keyboard, the slope of the line should be horizontal between tasks 3 and 4. This shows that for the character recognition keyboard to be used as part of this application users would need to have a lot of practice inputting data.

By contrast, the slopes of QWERTY and custom JavaScript keyboards are close to horizontal. This could indicate one of two things – these keyboards are difficult to use and practice does not improve the users performance, or that they keyboards are already well understood by the user. It is clearly the latter, especially when the low error rates and completion times for these two keyboards types are considered.

As with the other measures of usability mentioned above, the learnability of the keyboards would indicate that the character recognition keyboard is not suitable for use in inputting vital signs data.

5.4.1.4 User Satisfaction

Figure 15 shows users' average satisfaction score for the three keyboards. Users reported least satisfaction from using the character recognition keyboard, just 31%. This was obviously influenced by the long time to complete tasks and the high number of errors using this method. The satisfaction scores for the QWERTY and custom JavaScript keyboards were 47% and 94% respectively. Although the error count for these two methods was practically the same (<1 per task), there was a large difference between the average task completion times – 65 seconds for the QWERTY and 50 for the custom JavaScript keyboard. In addition, users reported fewer disadvantages of the custom JavaScript keyboard compared to the QWERTY keyboard. These results must be factors in the difference between the user satisfaction scores.

The comparison of three data entry methods identified a clear difference between their usability. The character recognition keyboard was identified as least usable. It would be unsuitable for use in the CATS Mobile application, and in any application in which users had to enter mainly numeric data. The QWERTY keyboard allowed users to complete the data entry task with few errors, but users found it slower to use than the custom JavaScript keyboard which had been developed as part of this project. Test subjects rated their satisfaction with this keyboard at over 90%, indicating that it would be suitable for data entry in the CATS mobile application.

These results of these evaluations were based on entering a set of data into the observations section of the CATS Mobile application. This data was mainly numeric and contained no alphabetical characters. It is therefore not surprising, that the custom keypad, containing only the necessary characters for this task, was considered most satisfying to use.

The relative satisfaction ratings for each keyboard type are supported by Wu et al (2007) who proposed compatibility ("The degree to which the use of MHS is perceived to be consistent with healthcare professionals' existing values, prior experiences and needs") as being the most significant determinant of success for mobile healthcare applications. In this dissertation, the custom JavaScript keyboard is more compatible with the nurses needs, allowing them to enter data more quickly and with fewer errors, indicating higher compatibility and consequently higher user satisfaction.

5.4.2 Comparison of pen and paper with tablet pc

The second part of the evaluation of the prototype compared the efficiency of the traditional pen and paper method with the data input using the tablet PC. Figure 16 shows the average task times for the pen and paper compared with the tablet PC.

The first set of data compares the full set of data i.e. the total time to enter data on all sections of the form (interventions, infusions, observations, ventilation, blood gases, and neurological). Pen and paper is considerably quicker, more than twice as quick. The last set of data compares time to enter a set of observations only. In this case, the difference between the pen and paper is small.

There are two possible reasons why the difference between these two methods is less pronounced when looking just at the observations section only. The first is that, although users had used the tablet PC in the previous evaluation, it was only to enter observations and not infusions, interventions, ventilation etc., so they would have been unfamiliar with the entering data into this part of the form. The second reason is that the interventions section required alphabetical text to be entered using the QWERTY style keyboard, which is slow, when compared with the JavaScript keypad which was used for the observations section of the form.

Cole et al (2006) compared data entry using pen and paper and a tablet PC. They found task completion times to be very similar (pen and paper was slightly quicker). This agrees with the comparison made in this dissertation, when the part of the form which users are most familiar with (observations) was compared.

To gain a better understanding of how the pen and paper method compares with the tablet pc running CATS Mobile, it would be better if users were asked to complete the task in this evaluation a number of times.

5.4.3 User tests with Nurses

The final part of the evaluation process of the tablet PC was a user test which was conducted with three nurses. This was followed by a post-test questionnaire to measure user-satisfaction. Tables 16 and 17 show the new functional and non-functional requirements that were derived from the user tests. These were in addition to the 42 requirements acquired and mentioned in the previous section. The response of the nurses to the application was positive and user-satisfaction was measured to be 76% using the post-test questionnaire. The questions on the survey which recorded the lowest marks were related to speed and visualisation. It was clear that the nurses felt that the application would not save them time compared with the pen and paper method. However they did not expect this method to be quicker than pen and paper. Nurse 1 indicated in the post-test interview,

> *"it's not about speed, it's about clarity of documentation and traceability"*

The question regarding visualisation (I can easily read the patient's vital signs by looking at the graph) was also given a low average mark of 2. Nurses commented that there was too much information on the chart;

> *"The only things that need to be on that are chart systolic, diastolic, mean, heart rate, they are the only ones that we need".*

They also wanted the values displayed in a similar way to the paper form, instead of using trend lines. However, they did like the annotations on the chart, and the explanations of the annotation on the right hand side;

> *"The advantages are by viewing the graph and the observations directly beneath it we can visual see trends in data ... when there has been a change (i.e. hypotension) the annotations let you know what the team did to alleviate it. It basically explains the reason for the change in vitals."*

Following Yen and Gorman's finding (2005), that mobile healthcare devices should "compatible with the work environment, tasks, and goals of clinical practice", the 76% user satisfaction obtained in this evaluation would indicate the implementation of the requirements gathered in the first phase of this project, have been successful in meeting the needs of the CATS nursing staff. While the user satisfaction questionnaire used in this study was not the same as the one used by Dykes et al (2006) and so a direct comparison cannot be easily made, their study reported a user-satisfaction score of 44% following the introduction of a digital pen system to record vital signs. This satisfaction score from nurses in this study compares favourably with this one.

6 Evaluation and Conclusions

6.1 Introduction

This chapter reviews the extent to which the objectives set out in section 1.3 have been met. For each objective an analysis of the approach undertaken is given along with a reflection on the lessons learnt. The chapter also discusses the contribution this project has made to current knowledge on the subject and recommendations for further work.

6.2 Review of project objectives

This section restates the objectives of this project and assesses the extent to which they have been met, lessons learnt and possible further areas of work.

6.2.1 Objective 1

To understand the CATS work environment and the requirements nurses have when recording and visualising patient vital signs during retrieval and transport.

An in-depth understanding of the CATS staff working environment and their requirements for a mobile vital signs application was achieved. This was done by conducting a series of extensive interviews with nursing staff (2 CATS staff and 1 external) and comprehensive evaluation of paper prototypes and the CATS Mobile application. The requirements which have been documented for the CATS mobile application include over 50 functional and non-functional requirements, a detailed set of tasks for, a description of the system architecture for CATS Mobile and CATS Central, and a set of paper prototypes to describe the layout and functionality of the application. The Context of Use includes detailed information on the project stakeholders and their attributes as well as technical and physical environment in which CATS staff operate. As a result objective 1 is considered to have been successfully met.

6.2.2 Objective 2

To build a fully functional web-based prototype to run on the mobile clinical assistant that allows nurses to input patient vital sign software and visualise this data. The purpose of the software will be to provide an alternative to the paper form that nurses currently use to record vital sign data.

The development process which was undertaken as part of this project, used the requirements and specifications described above. The result was CATS Mobile, a fully functional prototype application which provides a viable alternative to the paper nursing form currently used by CATS. The application is web-based, running through a browser interface on the MCA. CATS Mobile runs on the tablet PC, using PHP and MySQL. The web interface allows the user to view all the patient's data on one page, employing a set of interactive navigation tabs to control and accordion style interface that opens and closes sections of the form. The form allows data to be entered and visualised using a chart, without the need to refresh the page. There is further work development work to be done before this application could be evaluated in real-world situations. CATS Central (see section 4.2.5), a supporting application that receives data updates from MCA's in the field, still needs to be developed. This wasn't possible within the time constraints of this project.

But the objective 2 is considered to have been successfully met, as the application does allow nurses to input patient vital signs and visualise the data.

6.2.3 Objective 3

To evaluate usability issues that arise when using the mobile clinical assistant to input and visualise vital sign data. [The test of this objective will be a test-script for user-testing of the data entry and visualisation screens, and the results from the user-tests]

In evaluations of this application by nursing staff at CATS, the data input mechanism using the custom JavaScript keypad developed as part of this application was considered to be a quick and efficient means of entering data. The level of user-satisfaction with the keypad was 94% for entering numeric data. When the application as a whole was considered by CATS nursing staff, they rated their user satisfaction at 74% on average. The application did have some usability issues which were revealed in the post-test interviews. These were mainly concerned with the data visualisation. In a post-test interview one nursing staff member found the annotated timeline a helpful way of visualisation. However, the format of the data series on the chart did not fulfil the requirements. He found the chart too cluttered and did not like the trend lines on the chart.

Because the evaluations were completed successfully, objective 3 is considered to have been met.

6.3 Reflections and recommendations for further work

A key reason why the objectives of this study were met was the use of a human-centred design methodology. Focusing on user involvement at each stage was critically important in achieving success. From ensuring that users were consulted as much as possible during the requirements phase, to undertaking user testing as part of the evaluations, the involvement of users has produced relevant requirements and useful evaluation feedback. Of course, the CATS nursing staff were the most critical users to involve. Their qualitative feedback during the evaluation of the prototypes and CATS Mobile application were extremely valuable. But the non-nurse users who took part in the comparison of data input methods, were also able to provide useful test results.

The process could have been improved further by having more iterations of the design and test cycle. This study involved two iterations, one centred on the paper prototypes, the other on the CATS Mobile application. It would have been useful if time had permitted to have another two iterations – a second set of paper prototypes, refined after user-testing of the first set, and an iteration based on a set of prototypes running on the MCA. Also it would have been useful to use some of the add-ons for Balsamiq that create HTML prototypes based on the paper prototypes. This would have allowed for the user to interact with the MCA before the evaluation of the CATS Mobile application.

It is worth mentioning that the timescales in which the specification, development and evaluation processes in this study were much shorter than originally planned for when the project was started. Although the work plan in the Project Definition (see Appendix A) originally envisaged the first meeting with CATS staff taking place during June, it was not possible for the University to arrange this meeting until September 15th. As a result, the time available to work on the main parts of this project was reduced. If more time was available, it might have been possible to include more iterations in the development cycle as mentioned above, and to carry out more user tests, in particular user-testing of the full application with CATS staff.

The rate at which technology is changing is extremely fast. iPhones and iPads have been released since the MCA launched, and many users are familiar with the on-screen keyboards

and user interfaces of the apps that they run. It would be interesting to see a study undertaken into the use of an iPhone/iPad application for recording patient vital signs.

6.4 Contribution to knowledge

The contributions that this dissertation has made to existing knowledge are described in this section.

The literature survey has summarised the current state of research into mobile healthcare applications, looking in particular at; adoption barriers and success factors, usability of PDAs, tablet PCs, digital pens, and the usability of on-screen keyboards.

A detailed analysis of the CATS working environment and user characteristics has been explored.

The requirements of a web-based application on a tablet PC to record patient vital signs have been clearly defined. These requirements could be helpful in defining applications for other patient retrieval and ambulance services, or for collecting patient data at the hospital bed-side. The CATS mobile application provides a working example which can be used as a prototype for further evaluation, or as a starting point for the development or similar application.

The interactive navigation tabs and accordion style layout demonstrate an efficient way of arranging a lot of information on one web page. And the annotated timeline shows a novel and useful way of enhancing the visualisation of patient vital signs.

The evaluation of the CATS Mobile application has shown that character recognition keyboards are unusable for entering numeric data, but that a keyboard which is specifically design for the task, such as the custom JavaScript keypad, can make entering data almost as quick as with pen and paper.

6.5 Conclusion

The CATS Mobile application is a fully functional application, satisfying most of the requirements defined in the initial stages of this project. It has been extremely well received by the CATS nursing staff who evaluated it. They would like to use it as a prototype and evaluate it in real-world use, using it alongside the paper form as part of a trial.

There are further refinements that can be made to it, especially concerning the visualisation chart. Also, the CATS Central application, defined in section 4.2.5 should be in place before CATS Mobile could be deployed. (CATS Central is a central repository of data contributed from one or more CATS Mobile applications).

Information technology is being adopted into healthcare more and more each year and it may not be long before mobile applications are being routinely used to record patient vital signs.

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7 Appendix A – Project Definition

8 Project Definition

8.1 Patient Vital Sign Software

8.1.1 Gerard Isdell

8.1.1.1 *5th June 2010*

8.2 Working Title

A web-based system to monitor patient vital signs - Development and evaluation of a working prototype for data collection and visualisation.

8.3 Introduction

Delivery of healthcare to patients throughout the UK is undergoing profound change due to the introduction of information technology. The NHS Connecting for health programme has seen over 1 million summary care records created on the spine, over 80% of GP practices and pharmacies using the first phase of the electronic prescription service, and 22 million bookings made using Choose and Book (Connecting For Health 2010). Two of its key aims are to enable better, safer care for patients and to enable clinicians to increase efficiency and effectiveness. And throughout the NHS, other services are using information technology to meet these aims. The Queen Alexandra Hospital in Portsmouth is using a system called VitalPac to provide early warning signs of deteriorating patients and to reduce the patients' length of stay (Connecting For Health 2010).

One outcome of City University's GHandI project, which studied clinical handover, was the deployment of 'PaperChain' (School Of Informatics, City University n.d.), a novel ICT system to support handover, at the Children's Acute Transport Service (CATS), Great Ormond Street (Children's' Acute Transport Service n.d). The system transfers notes written on a referral form that CATS doctors use when retrieving patients from other hospitals.

During this patient retrieval process, nurses complete the 'CATS Retrieval Nursing Form', part of which records patient vital sign observations to be taken every 15-20 minutes during transport. This project will investigate and prototype a web-based prototype of this form.

8.4 Aims and Objectives

1. This project will produce a working, prototype web-application to run on the Panasonic Mobile Clinical Assistant that allows CATS nursing staff to input and visualise patient vital sign data.

i. To understand the CATS work environment and the requirements nurses have when recording and visualising patient vital signs during retrieval and transport. [The test of this

objective will be a document that describes the functional requirements of the application's data-entry and visualisation screens and the non-functional requirements of the application itself]

ii. To build a web-based prototype to run on the mobile clinical assistant that allows nurses to input patient vital sign software and visualise this data. The purpose of the software will be to provide an alternative to the paper form that nurses currently use to record vital sign data. [The test of this objective will be the production of a web application with fully operational data input and visualisation modules]

iii. To evaluate usability issues that arise when using the mobile clinical assistant to input and visualise vital sign data. [The test of this objective will be a test-script for user-testing of the data entry and visualisation screens, and the results from the user-tests]

8.5 Scope and Definition

The project will be restricted to specification, development and evaluation of a prototype web application that replicates the 'observations/patient vital signs' section of the nursing form. The application will include both data entry and data visualisation modules.

8.6 Research Questions/Research Context

The project is being undertaken in order to examine the usability and feasibility of a web-based interface to input and visualise patient vital sign data, running on a touch-screen tablet device. Nurses on the CATS team have expressed an interest in using this type of device as part of their work practice. The system aims to benefit nurses by making a prototype web-based data entry interface which is efficient to use, and by providing a means of visualising the data which they have entered, in order that trends in the data can be observed.

Abbot et al conducted used observational ethnography study to examine the usability of a mobile clinical assistant by nurses in a simulated clinical environment. Their results suggest a positive level of usability (Abbot et al. 2007). Constantinescu et al have looked at how rich internet applications can be used on mobile devices to impact mobile clinical practice. The prototype that they developed was successful in allowing communication between a handheld device and hospital information systems (Constantinescu et al. 2009). In the UK Khawar Hameed has looked at how mobile computing and technology can benefit the UK health service (Hameed 2002). Sookyung et al developed a prototype for a mobile nursing information system (Sookyung 2000).

Chen has examined various techniques for evaluating information visualisation techniques (Chen 2000). Zuk et al have examined how heuristics can be used to evaluate the usability of information visualisation (Zuk 2006).

8.7 Methodology/Work Plan

Literature Survey – Comprehensive review of published work in the areas of nursing working practices, especially patient vital-sign collection, web-based applications on mobile devices, data visualisation.

Requirements Gathering – interview members of CATS team to determine their working practices, in particular how they currently use the paper-based nursing form. Determine their requirements for the web-based prototype. To gain an understanding of the nurses' working environment and how they interact with the paper form an interview will be conducted with one or more nurses from the CATS team. The aim of the interview is to understand how they use the paper form in their current working practice, and their functional and non-functional requirements of the web-based data entry screens with particular emphasis on usability issues of a touch-screen interface. The interview will determine the most appropriate type of data visualisation for patient vital sign history.

Produce interview script - June 18th 2010

Conduct interview with CATS nurse - June 25th 2010. (This date and is dependent of the availability of the CATS nursing staff. A delay here will affect the date of all deliverables below)

System Specification – produce documentation that describes the functional and non-functional requirements of the prototype application.

Produce requirements document with functional and non-functional requirements. - July 5th 2010

Product application design document - July12th 2010

System Design and Development – develop layout and information architecture for application, install software and build application. The next stage will be the development of the web-based application, which will be developed using a standard user-centred design methodology. To develop the application the following software/tools will be used

Windows XP (OS)

PHP 5 (application server)

Apache 2.0 (web server)

MySQL 5.1 (database server)

Zend Studio (PHP Development Environment)

Develop and build application. - September 6th 2010

Deploy Application - The application will be deployed on the Panasonic CF-H1 Mobile Clinical Assistant.

Deploy Application. – September 8th 2010

Functional Testing – test application to ensure it satisfies the requirements documents.

Functional testing of application. - September 13th 2010

Evaluation – user testing to determine usability of data input and visualisation modules. The evaluation of the application will be conducted using user-testing. The test will consists of tasks to enter anonymised data taken from a completed paper form. Depending on the availability of the nursing staff at CATS, a staff member will be used as a test participant.

Product test-script - September 20th 2010

Conduct user-testing. - September 22nd 2010

Write test-results - October 11th

Report Writing

Complete 1st draft project report. December 13th 2010

Complete 2nd draft of project report. January 4th 2011

Submit Final version of report. January 17th 2011

8.8 Ethics and Confidentiality

The project will seek to avoid any issues of ethics or confidentiality by not coming into contact with patients during the course of the project, by ensuring that any real-world data that is used during development or testing has been completely anonymised by removing all personally identifiable information. Finally while conducting the project I will ensure that any interaction that I have with nursing or other staff of the CATS team, does not impact their ability to do their work and provide patient care.

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9 Appendix B – Interview Transcripts

Questions for CATS nursing staff
Patient Vital Sign Software Project
Gerard Isdell
11th July 2010

Transfer

1. Could you describe the patient transfer process at CATS?
2. Describe the people involved and their roles?
3. Who takes measurements / enters data on the form?
4. What part does the nursing form play before/during/after transfer?
5. What methods are used to measure patient vital signs?

a. What equipment is involved?
b. Is any data recorded electronically?

6. How often do you take these measurements?
7. When is data entered in the nursing form?
8. Who enters the vital sign data on the form?
9. Does the same person take measurements and enter data on the form?
10. What types of data are recorded for each of the observations and what are the allowed values? (typical values, ranges, validation)
11. How many values are recorded for each vital sign in a typical transfer session?
12. What happens the form when you return to Great Ormond Street?
13. Is the (vital sign) data on the form used by anyone when you return to Great Ormond Street?
14. When the patient is at the hospital what methods are used to measure/record patient vital signs?
15. What are the advantages/disadvantages of using the paper form?
16. Have you used a tablet PC or PDA before (esp during nursing)? What was your experience?

Visualisation/Charting

17. Which of the vital signs measurements would you like to see in chart/graph format?
18. How would you see the data input screens and visualisation screens relating to each other in the application?
19. When would you use the charts?
20. What would be the purpose of the data visualisation?
21. Which data sets are most important?
22. Are there trends in the data that should raise an alarm?

23. Could different types of observations be displayed on the one graph?

A web-based application

24. What are the advantages that you think using the tablet PC will offer?
25. Are there particular features that you would like to see?

10 Interview with CATS Nursing Staff

10.1 Interview 1

Thursday September 16th 2pm
CATS Base
With Lynn (L) and Fergal (F)
G: (0:00) So I believe you're using the digital pen system which was developed as part of a previous project?
F: I think we're in at the moment with regarding using the digital pens – we're not using them at the moment. We're waiting for a revision on the paperwork on the medical side I think. We haven't used them for a little while. I think when we did use them they worked fine, they worked quite well. But what we realised in terms of data the stuff that has probably the most usefulness in terms of if you're someone whose remotely looking to see what's going on the most information you're going to get will be from the nursing paper work.
F: (1:00) We record the vital signs, the ventilator settings, blood gases etc a nd so we realised we perhaps missed an opportunity with the first project in that of focused, as a lot of research money does tend to come and go 'right what's big and sexy' but actually the nursing stuff is where I think a lot of the information that the consultant will be interested in , that the receiving team will be interested in, because they'll get a feel for how sick is the patient we're accepting and what do we need to do, what do we need to get ready, So it's great that we're moving forward with considering bringing on board the nursing information.
G: So that's how you would see it being used. This going out on one of the transports and somebody here at the base station or the hospital looking at it?
F: So is this using one of these, what do they call it MCA? Mobile Clinical Assistant

G Yes it is. There is nothing on it at the moment apart from windows, but I thought I'd bring it so you could see it. It's running Windows, I don't think it's the most usable thing in the world. That's going to be one of the issues, because obviously it's easy enough to write something on a piece of paper, but trying to get something that's usable (2:05) on a system like this.

F: So what exactly, you're going your masters and what project are you looking at doing with us?

G: It's called 'Patient Vital Signs' and basically it is to do a web application that would run on one of these that would record patient vital signs during a patient transfer.

F: And will it be inputted by the individual or straight from the monitor?
G: It would be inputted by an individual.
F: So it's basically, using one of these mobile clinical assistants with a pen interface where we would record readings on this
G: I don't know if Stephanie has explained. The main focus for me will be to look at taking this part of the form and making it as usable as possible. That's part of my project looking at the different ways on inputting data, making sure it's usable. And them some way of visualising the data as well, so you get some sort of charting or graphing application as well.
F: So when you put in blood pressure numbers, you can look at it.
G Yes. And this has Wi-Fi, it's also got a SIM card in it, so it can pick up the mobile network, 3G and 3.5G. So it can pick up the network and send data back. But what I was thinking of doing was installing the web-server software on this (3:48) so that people would just basically pull up a web page, on some computer in here or in the nursing station, and they'd be able to see the data for the patient

F: So we would have a form of some sort on that which we would fill in with information and then people on the PICU would access a secure web page which would actually link in with what we're going here. And would it be real-time to send data?
G: It would be real-time yes. It's going to save it instantly to the database.
F: Because one of the things with the digital ink was that every time you made a change you had to tick the box to send the data through. If you didn't tick the box, you could have written reams of stuff but the person at the other end wouldn't have a clue what's going on until you tick the box to try and send the data.

G Well it all sort of depends on the usability. Do you want – I don't know how you work when you go out – this was one of the things I was hoping to talk to you about today – how it actually takes place, how you record the data – do you record a lot on the form. You may want to enter each measurement and press 'o.k.' which would be the equivalent of checking a box. (5:06) It's just from a usability point of view
F: I think the less we have to do that is foreign the better and so what we tend to do is we arrive at the patient, we receive the handover information and during that time the nurse will write down a baseline set of observations for how we found the patient. At no point obviously in the current form do we tick a box, and click send or whatever else, so the less we have to do. Putting in heart rate-send, blood pressure-send, we don't have to have to be doing that
L: I don't think it's unreasonable though to press send after recording a full set of ops
F: Sure. Not unreasonable, however, I suppose this is where you'd have to think about, if there's a SIM card and there's a network.
G: Regardless of whether there's any networks involved, it's going to be recording and then whether the people at the other end can see it is going to depend on the network connectivity. So if your network is up.
L: Are we going to be using this instead of this form?
G: Well, the bit I'll be concentrating on for my project will be this bit of the form and obviously there will need to be a bit at the beginning so you can tie it in. But it's a huge form
F: So this is something we need to talk about because I think there would be reluctance, because we would have this, which is a big change, **and I've got paper to fill out. Because realistically speaking, I suppose on the retrieval itself we tend to fill out front and back of that (page 1 nursing form) (6:51) . Do we do much of that on retrieval (rest of the form?)**
L: No
F: So that's the paper we use on retrieval (front and back of page 1) and then in the back of the vehicle we'll write a narrative note and we might fill in some of the rest, so really ..
G: So it's not the whole form?
F: What this will mean is we'll have the MCA plus **paper**work.
L: If we could somehow have the front of the sheet and the vital signs and then just have a condensed form
F: So a condensed paper form
L; Yes
G: There's one thing to bear in mind – it's the usability of this. (Narrative text field)
L: No that would need to stay there (on the paper form). That's all text. So if you look at the front page, without the patients name bit on it, I think, because that would need to stay on your bit (paper form) because that has the parent's contact details on it and then just the tick boxes, did you put lines in, what size tube and what infusions you're on
G: Should I start making a note of these things (8:03)
F: Well I think
L: Whether pharmacy will let you chart your infusions on that (MCA)
F: Why?
L: Because they're pharmacy.

F: Because if this document forms part of the legal patient record and has patient identifiers on it, the same as Carevue does, I see no reason why they shouldn't. And in fact you could just make the form that's on this (MCA) to be, obviously rejigged.
L: If you could make this look like Carevue our lives are easy because every unit uses Carevue.
F: That's another big step
L: But that's how easy it should be to enter stuff
F: Yeah. Have you seen Carevue?
G: Is that a web application or a windows application?
F: It does run on Windows
G: Or a web – browser?
F: Basically there's a central server and there's work stations all over the place and it's a clinical information system. But it's very nice in that down onside you've got in text – 'heart-rate', 'blood-pressure' blah blah blah and in a box you type the number in. You can look across. You've got time here (x-axis) and then different fields for data. You can put the numbers in or comments and everyone's used to using it (9:49)
F: They've all got Carevue. Each item, each cell has got a different colour, so light blue, white so you can, purely from a style perspective. I'm sure we can get some screen shots. Looking at Carevue itself you have heart rate and the background would be light blue and then the next one down would be white, so you can follow across
G: How does it decide the timescale?

F: You can decide that so you can decide to write something in real-time, if you click on the time now button you can have a column that you can use to record data immediately or you can have half hours to record observations every half hour , that kind of thing . You've got the flexibility of doing. generally in a paediatric IC unit you'll do observations every hour, however if something happens you can actually chart it in that time, so when you look back at the patient record you can see the child had a problem at this time and then further down in the ventilation section, you can see we made some changes to the ventilator settings, and you can see the blood gas readings.
G: And the data for that isn't coming off patient sensors, the data is being actually entered
F: Some of the data comes off the monitor and it will come up in a soft grey font as a default and then it's up to the individual user to accept that default and say that was the correct hear rate at that time, they press enter and they have to sign in with their password, so it does link in. It's a very good thing. It's gone through many many revisions. At the moment there is a tender out for a new clinical information system.

G: Whose system is that?
F: I'm pretty sure it's Hewlett Packard. Ram will definitely know. But I think it's an HP system.
G: It would be great to get some screen shots of that. Because obviously something familiar...
L: If it looked like something that people were used to using, then data input...
G: We would have to investigate any copyright issues and stuff like that
L: It's just a graph.
G: It produces a graph as well?
L: Yeah, it can give you a graph.
F: I think Simon Evans is one of the IT guys over at GOSH and he's the guy putting together every idea, for what do you want from your ideal clinical information system, because we are getting tenders in now from different people who want to put the new system in GOSH. I think a lot of them would want to stay with Carevue because they've been using it for years and they've had upgrades (12:40) and new version and Carevue is now being used, in north Thames, GOSH, Royal Brompton and St Mary's. They all use Carevue so you are going so way towards ... so Carevue is an interface that people are very used to seeing.

G: So briefly, just tell me who would you envisage using this system? You said nurses

F: Nurses, doctors and ambulance technicians, because generally speaking the nurses input the data onto the nursing form however, if we do a blood gas, sample some blood and run it through a blood analyser, we'll get values and sometime the ambulance technical will write them down
L: I would not envisage the ambulance tech's using that at all

F: Fair point, scribble that out,
L: Disaster, it would be a disaster. We can't do that. They can barely work an iphone.
G: And at the base station, not for inputting data, but for looking at the charts>
F: Nurses and doctors.
G: Did you say the pharmacy?
F: If you want to, that's a fair point. The information we're putting on is just going to be that plus that (both sides of the form) so it's just going to be clinical staff. Pharmacists are not going to want to look at what the heart rate was on retrieval .
L: It'sbecause of the infusions
F: Ok yeah, put down nurses, doctos, pharmacists, potentially
L: But I doubt it. Pharmacists just tend to look at ourprescriptions more than anything
F: And I don't know if they're going to be overly interested in that but we can put them down and exclude them at a later date
G: So if I just mark off the bits of the form that you will need to replicate in the system. You'll need the CATS number
F Yeah
G: What about the stuff here, the referral date. It would just.
F: The thing is, if we're putting this paper form, both sides of this as some kind of pc application (15:14) then is either going to say that we still need to keep that box up there (parent data)
L: I think keep that box on the paper form, because what if something happens, and we lose all out data and something happens and you can't contact the family because you haven't hand written down their contact details. Because normally you would enter it, in Carevue you would enter it but you would still have a paper copy
F: You could argue then that.
L: I just thought maybe just the CATS interventions bit.
F The argument will be so we're recording all vital signs, all gases on this if we lose that the, do you know what I mean, so what' I'm saying is . If the query is we need to include some of the things on the paper form because what if the system crashes and we loose everything then we're screwed anyway
LL: You're not because you can scroll your results back off the propack if you don't switch them off so you can then just transcribe them onto paper if you want and you can get your blood gases out of the stat
F: I'm saying if we're worried about. Let's say you've done retrieval and a week later we lose everything
L: This has to be able to. Can you print whatever is on this?

G: Yeah there are docking stations you can use
F: You can make it so you can print of the web browser can't you?
G: If you had wifi
F: what I mean is
L Because we need paper documentation
G: So you need somewhere you can click and get a print view and print this out basically
L Because we need to leave something behind at the local hospital

F: and also with the digital ink, we were always writing on stuff, so even if the system fell over, we still had something
G: I think there is s printer attachment to go along with this, but I'll double check
F: Because you could have it so that the form we're filling out on this, when we arrive on the ICU, they could access this web browser, they could see what we've done, and they can just print that off and they can keep that as a copy

G: This is the ICU where you're bringing the kid to?
F: Yeah
G: I think I saw a study where they are using this in a hospital and the nurses were carrying it around with a printer
F: So what we need is we need a paper copy for our records because as Lynn says if the system falls over we're screwed, we also need to leave a paper copy behind when we arrive, so we need some way of printing of a form that we can print off, that would essentially collect all the information that we'd inputted on retrieval so that when we arrive in the picu when we're dropping the patient off we can give hand over and is right, if you just go to the browser and click on print, you can print off all the information, thank you very much and they can keep that as a copy, but we'll also need a copy as well
L: Because we can't log into computers at other hospitals
G: So when do you need this paper copy.
L: There, because that's the patient's notes and need to stay with the patient
G So if you're picking up at A and going to B
L: I will leave a copy at B, because they now have the patient
G: Couldn't they look it up on their web browser and print it
L You've never worked in an NHS hospital
L That's what every sensible person would tell you but the reality of that is not fantastic
F It's difficult enough getting them to have a bed
L: You can't get a photocopier never mind asking them to logon and go on the internet and print
G: So that's something I need to look into
F Thad's definitely going to be an issue. And look, I know what you mean, just tell them to go to www.catsarecoming.com and print off the thing for the patient but in a busy intensive care unit where the burse in charge has got surgeons pulling them one way (20:28) actually to get them to.... Because we call them as we are leaving the hospital, and say we are on our way now, this is the patients' condition, airway breathing circulation, give them a quick synopsis, of what they are on and we'll see you in 45 minutes by the way can you logon to www... they'd be like yeah right. It's something to consider, but I think it's going to be very difficult to get them to be compliant enough to do that
G: No that's fine; I'll look into the printer thing. I'm sure there must be one. I mean there's everything on this: RFID readers, barcode scanners, they must have thought about the printer issue. There's a monitor to go with it, there's a keyboard
G: So you were saying something about people being able to look at the data, while the patient was in transport, who would they be?
F: So it might be in some cases, it would be nursing and medical staff
G: at B?
F: Yeah, wherever we are dropping the patient off at. So, in one breath we're saying they're not going to have access to a web browser and in another saying they would, so I appreciate we're giving a mixed message
G: It's a choice rather than something they have to do
L: It's quite nice isn't it (MCA)
G: Yeah it is. The pen isn't the easiest thing in the world to use, I wouldn't like to be trying to write a letter with it, but what I'm going to try and do is get away from using the pen so the numbers you can choose from something like a calculator or keypad

F: So I suspect the people that are going to want to access it will be. It could be the nurses because they might be wondering what's keeping them so long. What we do is we ring them when we're leaving the office and say' hit its Fergal here. I'm just on my way out to Northwick park for a patient with asthma, have you accepted a patient with asthma, they'd say yes we have, It will take us about 30 minutes to get there and obviously it will take us about an hour and a half to stabilise the patient prior to transfer so I'll give you a ring when we're ready and I'll give you an eta and they'll say yeah that's fine. Now if they haven't hears from me for about 2 hours they might be wondering what the hell is going on
G: are you bring the patient back here
F: So were' brining them to wherever they have been accepted. So let's say that point A is the referrer and point B is the accepting PICU. So on the way to point A, I ring the staff at point B and say were on our way we'll let you know how the patient is after we've stabilised them and prior to bring them to you we'll give you a clinical update and an eta. Now if I ring them at 3 o'clock and it's now 5 o'clock which should be enough time to get there and stabilise them and it gets to 6oclick they might be well thinking what the hell's keeping them. They might think I know there's a website I can log on to and I can have a sneaky peak at what's going on, what ventilation is going on (24:00). So that may be the nursing staff, maybe even medical staff, consultants registrars nurses, who would want to access it remotely. And that's nursing and medical staff at point B and maybe the consultants here (CATS) So there will need to be a key group of people who will know the web address and password
G: and then type in the CATS number and pull it up that way
F: Exactly
G: Is it worth having some sort of status like we've left cats or we've picked up the patient or could they just infer that from the data they are looking at
F I know what you mean, yeah
L Is this going to work with the medical forms, the digital ink forms,
G No
L Because that's what's on that other form. The medical form has the times when you arrive and when you leave
G: that would be an easy way of doing it. If you note the time,
F: and that's something you could add into the form as well. You could have a box on the form with a tick for stabilisation and then 'in transit' and tick it. SO basedon this form (medical) when you're ...you see 'time left' , 'arrived at' at certain time. So I can see they have already left basedon these times. When you look at the actual interface you can see 'they've left' 'they've arrived' indicated by little dots. But I don't see any reason, why in this form... it's kind of obvious if you're writing obs you're with the patient,
G: You want to keep the data to be entered to a minimum
L: If we're going to change this (paper nursing form) in your design, you see just above where we take out observations, we should maybe put another row that says 'Referrer Hospital 'Ambulance' and then you know where the patient is
F: So you'd literally have a box with R for referring hospital and another box with A for ambulance and so when we arrive we would check the R and when we leave we would dot the a to say we're in the ambulance and then just by looking at this on the chart, they will know that we have left. They are the key things (27:15)
L Because I always write 'on arrival' and 'ambulance'
F: So we'll write a time here, let's say 12:00 hours and we'll write the first set of obs, that's clear that's our first point of contact with the patient and then we'll have observations while were there and then generally when we transfer to the ambulance I'll write amb on the top and the time so it's clear at what point I as in the hospital and at what point I was in transit so something along those lines at some point on the form we could have a little box and then referrer hospital and then amb. And you could click on one and it would highlight it some kind of thing that would give clear indication
G: So this bit of the form here, the CATS interventions. So are these check boxes here

(Lynn leaves)
F: Yes are checkboxes and these are where you write comments e.g. 3.5 Oral ETT Tube or we'll write Annatropes and we'll write the names of the Annatropes so it's very much alpha numerical. That needs to go in there as well. Now you could put in drop down lists but the problem is ... we'll it's whatever is easiest for you to do... you could have it free text or you could have a drop down but from your perspective as a developer you need to think what works better with the program
G: I think I'll leave them as text boxes and see how you get on with that. Though it's not the easiest thing to enter text onto. So you're somewhere on the MCA where you can write text, like an input box on a web form, if you tap somewhere in there you get, see that icon, and that gives you the keypad, so that's what you're going to be entering data with4
(Lynn returns)
L: So is it possible to have a drop down menu for Annatropes.
F: That's just what we're discussing
G: If you give me the values you want inthe drop down, I can certainly do it
L And this is what we do for infusions basically we just write in what it is and in a box here we have a drop down whether it's mills an hour or other units
G So you choose a time a drug and units. Could these come from a drop down
L Yeah you could choose these from a drop down and then just free text if its not in the list
F That's always the case isn't it when you have drop down menus you're restricted but I think if you have an opt out of other that allows you to put infree text that's great. Once this becomes operational people will think ofmore things to add . That's certainly the experience I had configuring the Carevue application.
L So this is what a chart looks like when the data has been filled in (data annonymised)
G: I was wondering what sort of values would go in those
L It's all over the place. And up here i normally write 'on arrival' here and then 'ambulance' here when we go in the ambulance. And we normally takes obs every 15-20 minutes when we are in the ambulance (32:09) And yet there's big gaps here 6:00 op and then none done until 7:00
G SO the temperature is just a number and you can do point something . It can be nasal in can be pharangeal, you need a drop down menu for that. And heart rate... these are numbers we use as a scale, so heart rate here is 160, 164, 168 and then blood pressure is like a graph
G So the heart rate runs from 200 to....?
L: I can be anywhere on there
G: Ok, and how do you record blood pressure at the same time?
L: Little arrows, sometimes they can overlap
F We're so used to it. It's like hieroglyphics
G I really wondered how you would do that
L: So that would be like the top level of blood pressure and that would be the bottom level . The blood pressure here will be 81 over 64
G And are these values for respiratory rate.
L Yeah. I never record that because I always have it in here at the ventilator ate
G BP. Cap refill time. It's a number?
L Yeah
F So what we can do is we can go through with you the ranges of the values for all these, so you know .So something like FI02 the maximum value would be 1.20 whereas everything else it will be different.
L I'd like to thing I hadn't got a top pressure of over 60
F Once you know it's in the....
G And so that's a set of values?
F That's a model of ventilation that would be in a drop down again for model. And some of them will be a plus or a minus so basically so basic ??? can be a plus or a minus

G So I think for a lot of these it looks like a key pad, like you click on this box and you do 24.1

F Yeah so obviously as you say a calculator key pad and we'd just go through that
G And the other ones are you click on a box and you get a little drop down
F Because if we're doing it properly it would be quite nice to have mode as a drop down so you have INV, INV with peep INV with active peep rather than writing it in the side and stuff like we're going just now
F Yeah and actually what I've just realised on our form is that we don't have a numerical value for blood pressure or heart rate ... It's all graphs isn't it.
L I write it
F: Where?
L There. I'd write 81, 64 and then and here I write 161
F On all your forms?
L Yeah Well maybe not here. Heart rate I definitely write it
G So obviously it looks like the trend is important while you're charting it so
L Yeah
G So that would be something good you'd get out of this. What do you need to chart?
F Everything there. (Vital signs)
G Everyone of them? 35.26
F Yeah., That's why it's there.
L It's disappointing isn't it
F It's because you know every patent we move we will measure temperature hear rate blood pressure and respiratory rate and cap refill. They may or may not be mechanically ventilated so not all of these are essential; however for every generic form you take out you have to have the flexibility to record it
G SO this is mechanical ventilation,
F Yes. And this is blood gases – lab values from measuring patient's blood. And this is a description of neurological condition.
G So you've got general observations is that what you'd call them... or vital signs
F Vital signs. The sections would be vital signs, respiratory, ventilation and then blood gases and then neurology
L And that's the only two pages we're going yeah? We're not doing any others
F No, and I think as long as we're printing off the whole report, then we can leave the front bit with the patient. Although I do think that Eithne is going to want on our paper form that we have is she going to be happy just having a CATS number or is she going to want, the patients name as well
L: On the paper form?
F: Actually I suppose
L On the paper form (new) you're going to have to have this (patient identifier info from original form) so this is all going to have to be rejigged. Name must go on the form
F If we are going to have an electronic form that allows us to record this information and on arrival at the PICU we press print and it print off two copies and we staple one copy to our nursing form it's the same as this (original nursing form) isn't it. So we can in fact record all the information on the electronics form as long as it gets printed off at the end of retrieval and then stapled to that (paper nursing form)
L You need to have mum and dad's name, contact numbers and drug allergies and all that. That all has to be part of their paper record.
F: It will be part of the paper record once you print it off
L Yeah, I know. Unless we have completely printable forms for absolutely everything ... and that doesn't happen in medicine. It's all paper trails.
F So what you're saying is that because there is a risk at some point during retrieval that this (MCA) is going to die.

L Yeah every patient has a set of case notes now. I don't know what the legal requirement is but I would not be happy not having mums name, dads name and contact numbers. Because if mum and dad don't come with me and something happens to that (MCA) I can't call them. That one box (parent info) just needs to go somewhere else on our form (new paper). We can change these forms
F Believe me. I know.
L On the printable form, there needs to be the CATS number and then we just staple onto the front sheet. Because even on the front sheet it's not actually got, mum, dad contact numbers. It's only the nursing form that has that
G: So are you talking about putting this (parent info) on the eform
F No we're talking about putting this box here (parent info) on the new paper copy .So, you can leave that off. There's no point in doubling up
L And this should be on the paper copy
G: When you say the paper copy, you mean the printable version of this?
L No. What is, is you don't have to worry about this box and this box (patient details, parent info)
F: So the first part of your form is going to be CATS number, followed by interventions, infusions and then the rest of the form,
G So you know the Carevue system you were talking about. When you're entering blood pressure and heart rate, how does that work is that a keypad again, or...
F: So basically you click here with your mouse... so you would click onto heart rate... in fact let me see if I can log on. Or see if I can even pull up from the internet a screen.
L Let me see if I can have a look and print some stuff about Carevue because that's not connected to the printer is it
F Thank you Lynn. Carry on asking questions
G Could we just talk about how you record data, which are the most frequently taken observations (42:18) so if you're talking about which readings should be given most prominence just in terms of the space on the screen. Is this something that happens at any point during the whole transport?
F So the interventions. So this will generally be recorded by most people *in the ambulance* on the way to the picu. So we don't tend to record this on retrieval we record it when you've got some quiet time.
G Because I was thinking of to fit all these things on one screen I don't think is possible, so you're either going to be scrolling up and down the screen or you're possibly going to be on a page with tabs moving between tabs e.g. one that says interventions', one that says infusions.
F Because with Carevue you have something like this (drawing) Its says vital signs and then ventilation, a series of tabs, and when you click on them you close them, so you could basically have a whole bunch of space here with nothing and when you click on vital signs it would open up and then you'd have heart rate, blood pressure, going all there, a bit like an excel spreadsheet. And then you'd have time here (across the top) So I could just open vital signs so if I just wanted to open vital signs I could do so and if I wanted to close vital signs I could click here and if I click on ventilation I could see all the ventilation stuff. So I can choose which one I want to bring up
G So if you click vital signs it's going to hide ventilation?
F It will just squash everything down
G So do you take the measurements and enter them on the form yourself or is it two people
F When we're with the patient we look at the patient's blood pressure or whatever and then record the blood pressure, so it's very much a manual way of entering. So when we're doing a set of observations we tend to do a set of observations on arrival and then we try and get one set done every hour and that's pretty much the standard. If there's been some instability we obviously make some interventions, give some fluids, give some drugs, whatever and once we've got stability we quickly record yeah at say 3:30 we had a bit of a brown trouser moment, but we managed to sort that out by giving some fluid, so we would record the heart rate and

the blood pressure at the time and then we would record that we gave some fluid and then when we record our next set of observations we can see that things have improved. So we try and be as clear in our documentation as possible,
G So the interventions would be some of here (vital signs) and some infusions
F So the interventions we tend to not put them over there because
G This is when you come back or?
F In the ambulance we tend to do it
G And then when you're doing a set of observations do you work all the way down the sheet, do you take all these observations.
F: Not every hour. So every hour we won't do a blood gas for example. Every time we do a set of observations we won't, so in each time slot, there won't be a value for everything.
G: So you can have different times here and here (the time sections for each observation section)
F: So we'll put the times along the top here. So when we arrive I may have a heart rate a blood pressure and a respiratory rate with a mean blood pressure and a cap refill time. I may have some ventilation settings; I probably won't have a blood gas value. If I do a set of observations in an hour's time, again, I may now have put a temperature probe on the patient, so I'll have temperature, so that will be a new piece of information (49:58). I'll definitely have heart rate, blood pressure, respiratory rate, cap refill time. I may now have some ventilator settings, I may now have gas. Then next time we do some observations, I will still have ventilator settings, I may not have a gas again for another little while, so each time slot there has to be the capacity to enter data in every field.
G: So when you're entering the data, is that the time that the measurement took place at.
F: Not necessarily, like I said if you had an instability, then so if you had patient instability then you would have to intervene, give fluid drugs, change ventilation, do whatever you had to do, and then once you had achieved stability at some point you would go back and try and record that . You're definitely not going to record it as it happens.
G But the time you are entering values in here. That will be the current time.
F: Well not really, so let's say now it's 10 to three, let's say at half pas three our patient became very unstable and required us to do a lot of things, then what I would do is at say at half past two the patient was a bit naughty we sorted everything out it's now 5 to 3 I would go back and say it's 2:30 and record what happened at 2:30
G: OK
F: Because ultimately we have to treat the patient first but we may also want to record what happened to the patient at the time for now because say if we arrive at 2 o'clock and the patient was unstable and we did quite a lot of interventions and then 3o'clock came and we got everything back on track we'd want the paperwork to demonstrate that timeline
G And the charting all of the things on these pages can be charted. (52:12) the user would be able to see a chart with the temperature heart rate, blood pressure?
F You mean plotted on a graph.
G. It would probably we easy to give you a chart with all these. If the values are in the database we could show all values on charts. And in the top right hand corner we could have a drop down list with all the types in it, heart rate, BP and you could use this to change the data on the chart.
F And if you could make it so that we can have two or three values that we can overlap, so definitely from a looking back point of view we want to see this is what the heart rate was, this is the blood pressure, let's have a look a t how they are changing together, what we were doing at the time, that kind of thing
G You say what you were doing at the time.
F So what I mean is
G Actually there is a really nice chart sometimes you see it on google for stocks and shares they show you the data and they have a little, they have the values of the shares and they have a little letter a, b, c on the chart, when you click on them, it gives you the news, that affects

that stock, so you could show the data and you'd see the letter a and that would correspond to this infusion
F So that's almost a bit like if you use excel and you add a comment into a cell is that what you mean
G Yeah sort of
F So say at 2:30 we have an increase in heart rate and a drop in blood pressure and at that point we gave some fluids and by three o'clock everything had reverted back so then I could put a comment in the heart rate box saying fluids given.
G Well I was thinking of pulling it from this (infusions on interventions) data
F So the thing is, that is constant infusions, this isn't all fluids given. These are just background infusions that run. They are like drugs that keep the patient asleep, drugs that keep the blood pressure going but in terms of physical interventions ye s we can adjust the rate of infusions, but the other thing we can do is give stat dose drugs , so this can be medicines this could be fluids. So let's say we had a patient that became very tachycardia so fast heart rate with high blood pressure that's when they start to become very awake so we give then extra sedation, so we give them the sedation, but we record this information here (a part of the nursing form not being adapted) so in terms of, you could argue for completion, you would want to know anything that could affect these (vital signs), could be on that form (mca version), and I can see you know the consultants here would go, they would go absolutely ,
G Well maybe what I can do is, as you suggested, when you're putting you values in for these on the keyboard or whatever, is have a little comment box where if you want to add the value and put a comment in that would appear as a little red corner in the text box and then show it as a time line on the chart. That would be a nice way,
F Yeah something that would highlight it would be fantastic (55:56)
L I've just been looking online for info about the Carevue 9000 system and I can't find any of the nice graphs that we get
F (Goggling Carevue) No this is configuration
L Ah, this is what it looks like
F Feel free to move closer
G It's definitely not a web browser anyway.
F It does come up in a window on a windows machine.
G Well it could be a windows application like word.
F SO you can see here temperature, site and value in centigrade so that box would open up and you'd write and it would be a drop down box of rectal, nasal, skin.
G So that would come up if you clicked where?
F If you click in a time zone. And so this is currently viewed in hourly, you click on view you can do in half hourly 2 hourly 8 hourly or exact time and a slot will come up there, opening up a new column for that time. If you click vital signs it would disappear if you click I/O that would appear. Let's see if we can find they have multiple tabs open. There's a patient chart, you can view reports so there's vital signs there and you can also see I/O. 1:00:00 So there's vital signs there and input and output on as well. What we put into the k and what we take out of the patient. So we haven't put any IV infusions in, that's just totals. It gives you an hourly total it works out fluid balance and all. What we'd have here is all the drugs, adrenaline, dopamine. And if you had lots of stuff in here, these keys would be black, so you'd scroll down within here. So how they've set up their vital signs, they've got stuff like, key things, is the child on pr and medications. Generic stuff for every patient and that will automatically come up and vital signs so I'll just scroll to give you another feel of what they do. So you can actually see here, they can actually put in a comment. Exclamation mark means there's a comment. So once I click here, and they don't really show it, so after it's been saved you can see that at 11 o'clock 'rmp' saved something in here and that's Rhonda M Curran and that's here details. But I think the time slot here at 13:52 she saved, so this here is describing procedures, this is looking at IV canullas, so drips if you will. So this person recorded, so she

recorded at 13:52 that at 11 o'clock when she checked the patients drip (1:02:47) it was patent, so it was still working. So it tells you what time cell she recorded it in, but also at what time she recorded it at.
G And when you're entering the data, are you getting a drop down list
F yeah its mostly drop down, so when they were configuring it they realised they wanted to move away from free text and I remember spending a long time with Andy, she was one of the developers, one of the people who would look at configuration sets for Carevue and she kept saying look we can't have all this free text you as nurses have to decide what you want, and we'd much rather drop down boxes because in terms of making it a searchable database it's much easier having drop down boxes . Free text makes life much more complex when you're going back to look for certain things.
G So when you're entering like a heart rate of 122
F That would still be a numerical value
G But the text is always from drop downs
F Yeah exactly, So for example I decide here that it's going to be right foot left foot right arm left arm, it would give you all the options and you clock on the one that you want.
G So over time they'd become comprehensive and there's no need to write anything
F There's no need to write things, it should all be in there, so you'd have the first version where people say what needs to be in there and so if we go to what we'd need in this drop box here you'd say to me, Fergal we need to know all the stuff for the drop down menus and I'll give you stuff and people will say it doesn't work because you haven't included x, y, That just happens
G And this is all on the internet so it's publically available.
F Yeah so that was a search for Carevue screen shots
G What about alarms on the data. If the blood pressure falls below a certain level?
F No. We're looking at the patient and we are visually looking at the patient and we are writing on this. If we fail to notice we wouldn't be doing our job. Because then you have to thing what might be a low blood pressure for you and I would be a perfectly normal blood pressure for an infant, so then we've got to think about the age of the child what are the normal limits, so normal alarms.
G: So I think we've covered everything now. Thanks Fergal.

10.2 Interview 2

Tuesday September 28th 1pm
CATS Base
With Lynn (L)
Summary: A brief meeting with Lynn to obtain completed nursing forms which have been anonymised. Lynn supplied me with forms from two recent patient transfers and with the form from a transfer she had just returned from.
She explained the way in which blood pressure, heart rate and ventilation are recorded. Two readings are taken for blood pressure (diastolic, systolic). They are marked with an up/down arrow and joined with a vertical bar. Heart rate readings are marked with an X. This allows readings of different types to be drawn on the same chart. In some cases there can be confusion. An alternative way to record the blood pressure is numerically e.g. 190/120

Questions for Healthcare IT specialists
Patient Vital Sign Software Project
Gerard Isdell

1. What are the usability concerns of nurses regarding healthcare IT
2. What is the current usage of mobile/portable applications by these nurses
3. Can you describe the types of applications that nurses are currently using
4. Have nurses a positive attitude to adopting new technologies
5. What would the advantages/disadvantages of a mobile vital signs application be.

INTERVIEW WITH NURSE AND HEALTHCARE IT SPECIALIST

G: What are the usability problems that nurse face using IT in general, or specific usability problems that nurses encounter when using applications?

L: The number one first impression that we hear about is that people are so accustomed to pen and paper that they assume before they have even tried something that anything other than pen and paper is going to take more time and I think time is one of the biggest factors that maybe inspires feat in a clinician that they have to transform to some other method and its going to take them more time and they won't be able to finish their work

B: Which is where it feeds into what they are looking for which is ease of use, number one, and for it to follow a clinical workflow. I think there is an impression that IT solutions will be designed by developers, so it's not going to follow the way that clinicians take care of their patients. And I think there is always a feeling that in a clinical environment things change all the time, so there's not just one workflow for an ICU patient, if that patient crashes or the patient is under 6 or the patient is on a particular medication, their course of care changes, and I think one of the big fears is that on paper, you can always manipulate where you're writing something and I think the fear of the IT world is that they wouldn't have the flexibility to manage different patient care situations.

L: I think there is an age factor as well, the average age of a nurse in America is 50, so they didn't grow up with computers, like we did, they watched their kids and their grandkids to this, again there is a little bit of fear initially, of gee what if I can't do this,

G: What are nurses using, in terms of IT, what are they using on a daily basis.

B: In an ICU environment we have a situation where, we are going to focus particularly on the ICU. There are device manufacturers, the people who manufacture the ventilators and the patient monitoring systems, they also tend to sell software, lower level software, to be able to manipulate some information, and I think about 40% of UK hospitals have some level of monitor related software, the rest of them are on paper, so most of them are on paper.

G: Right, Ok, that's really interesting, still? So all the charting that's done at the patient's bedside is done?

L: Manually, but they may have to go to a computer in the unit in the ward to get lab results, or to get demographic information about their patients. So there may be soe interaction with limited technology but a big part of what they do every day to generate the medical record in most instances it's done with pen and paper.

G: Why do you think that is?

B: I think in the UK it's a couple of different things, Number one, there was never a belief that an ICU system drove patient care.

G: Would that be the same in a general ward?

B: A general ward is slightly different. IN a general ward, the patient administration system tends to be more present so you can discharge the patient from the bed and admit a patient to a bed, so I think you see more prevalane, but the ordering, which is the biggest thing on a general ward, to be able to order drugs, order tests, that's all been very, due to the expense and the clinical concern. SO in the UK when they started NPFIT, the National Programme, the big goal was to be able to answer some of those order communication questions, order coms, medication management, the ability to automate the things that aren't automated. And that's clinical risk and expense.

L: I think healthcare is late to adopt technology because of fear of not protecting the outcome which is supposed to be good patient care, and I think fear or protecting the outcome

B: And I think in a lot of ways the financial incentive is always important, so you can look at the UK, there is patient administration system everywhere, so that's the ability to admit, transfer, discharge a patient

L: and to keep a medical record and just some of the demographics around a stay, the logicistics

B: and you need that to be able to bill your Primary Care Trust, so if you don't have that you have to bill you PCT on paper, which means you're less likely to get your money. So that driver is there. So if you look in America, the areas which have a financial driver tend to be very automated which is why theatre software where you can get a lot of money based on consumable supplies, so there is a lot of incentive to do it. Just using ICU as an example there is no financial incentive in the NHS, so as a result of that the only driver is improving patient care and its' difficult to prove the relation between automation and better patient care.
L: I think also if you look at the progression of healthcare, it really started in the back end or back office systems, either the front end with registration, demographics or the back- end billing, but the migration to the clinical areas has been the last because its most challenging. It's harder to automate or to support workflow in the clinical areas, its really kind of easy to do that if yo're talking about front-end registration or tracking of patients, or back end billing.
G: What about monitors and stuff like that, what are the things the send the signals from the a patient vital sign monitoring system to the computer so there's no patient work involved.
B: Well patient monitors have been automated for a long time
G: Are they keeping a history?
L: They keep a little history of the data they have within their own network but it tends to be a closed network so the monitors that you use in an IC unit might have a dozen parameters or metrics that they measure but that's a very small percentage of the patient data, that's only a small piece of what a clinical needs to know in order to support their decision.
G: So there's going to be paperwork for the patient
L: Exactly.
B: If you look at the way they would keep a chart in a non-automated ICU, they would always have a patient monitor which is monitoring your vital signs , bp, o2 sat level, now if that patient is ventilated you're going to have a ventilator with their settings, and their information and there is no connection between those two and you might have an infusion pump that is infusing the medication or a dozen infusion pumps , you might have a rack of pumps. And what that nurse if typically doing is taking that information of the monitor and writing it on a piece of paper/
G: Are there any mobile applications or portable applications that are being used by nurses or generally within healthcare?
L: When you say mobile, it just mean that it's not physically fixed to a particular location?
G: Yeah, some device that a nurse would carry around with them
L: There are certainly computers on wheels in most hospitals nowadays.
G: What about those not on a cart?
L: Not on a cart. A truly in the pocket mobile device. Ahm I think there are some. I think a lot of nurse charting systems, patient administration systems, now have a tablet, wireless feature so when you're rounding with your staff you can sit next to the bedside and the doctor can enter information and read of information when he's doing the round.
G: So he can read the patient record and update it.
B: Yeah and that's only in the last couple of years that that's become, prevalanet
L: Yeah and if you think of the most recent, exhibition we were at you know a handful of the vendors were showing ipad information, so the ability to get some subset of data onto an ipad
B: And I think that's where we'll be going in the high acuity areas, the biggest limiter was wireless signals because there is so much equipment running in these area. If you've got a 12 bed ware and every patient has a monitor and a ventilator, and infusion pump and other things let alone you're rolling in a mobile x-ray machine, I mean its always very difficult to maintain a wireless connection in a threatre or an icu, and they're getting stronger now so I think some applications that I know intimately aren't there yet. But I do know that vendors are moving over to that area.
G: What would the advantages and disadvantages of having something mobile, be for a clinican?

L: You know clinicians what is it something like 90 plus % of decision that impact the course of the patient are made at the bedside, or at the point of care, so you know if yo can't have your data device be with you at the point of care, then obviously you are somehow breadking that workflow, so to me the biggest motivator is you have to have access to that information as well as the ability to input that information where you're making clinical decisions
G: And a disadvantage?
L: Disadvantage is the volume of information you're dealing with doesn't always lend itself to a mobile device
B: and the risk of dropping a connection. If you're going to make your deicisions based on the data you're seeing you can't risk. When you're dealing with, when you're going to make yoru decisions based on the data that you're seeing you cant risk to miss a minute, right, the patient could have a dip in a particular vital sign because you've dropped your network connection so youre making a uninformed patient care.
G: Is that recording it or looking at it?
B: Anything, so if I have a mobile device that's pulling information that's being stored on a network from an additional device, I need to have network connectivity to see the most recent updates, so if that wireless decision drops for whatever reason.
G: If you're looking at the most recent information, would that always be a situation where the clinician would be at the bedside?
B: Depends, so typically you have a patient where you have one doctor to many patients, so if I'm the doctor who is currently on the ICU ward, there's one doctor and there's 12 beds, so I could be looking at my mobile application for a patient that I'm not sitting next to.
L: Or you could be at the patient's bedside, and you could be getting the data from the monitor and the ventilator but you're missing lab results that come from somewhere else and they're key to the decision that you have to make about the next course of care.
B: And then the other thing that has been brought up from a data protection point of view but I think you can mitigate this mobile application are not secure . People can walk off with them. Which lends themselves a bit more to data protection issues.
G: What are nurses attitudes to adopting new technologies?
L: I think initially there is fear and I can say this having been in the profession. Nurses get very good at knowing what to do when they are in a known workflow and know process and know procedure and as soon as this is broken theyre going to be your toughest customer because they're first question is going to be prove to me why this is going to make it better
B: And that is it right there.
G: Better being?
L: Better for them , better for the patient. Is this going to support my ability to take care of my patients because they understand the responsibility the magnitude of the responsibility they have and if something changes, they hate change. But my experience is if they've adopted the technology you can't pry it out of their hands. You know and I remember once when our team was in to update a system and there was going to be a small period of downtime and it was really a small period but before the nurse understood that, the response was 'over my dead body are you going to stop the system because we need it to take care of these patients'
G: Interesting because I keep hearing about Carevue which they are obviously highly attached to, but I suppose if they are used to inputting vital signs in one system, why have it different in another system.
B: Only other things in terms of initial adoption is, the only things in terms of the clinical staff is that that an IT system is going to benefit someone else whether that be an IT or billing, and that they feel often times that was a deicision made by someone else for someone else's benefit - not the clinicans and not the patients.
G: Because it's probably not that often that the nurses are commissioning the software?
L: Well they don't have the financial decisions and at the end of the day these are financial deicisions because they are big investments and the smart chief exec or IT director will always engage the clinicans in the decision making process and I think I'm sure there are studies to

show that the most successful implementations are those where the clinicans were engaged from the decision making process all the way through the implementation. You can imagine if you know the powers that be make the decision about what system they are going to use and all of a sudden you're going to have to engage the clinical staff in implementing it, they're going to be resistant if they had no say in it.
B: So an intelligent sales process gets them in at the beginning that's for sure.
G: So it's a user centred design methodology from start to finish
L: Absolutely they should certainly have a say in what the requirements for the system are and they should have a vote or a roll in the evaluation.

11 Appendix C – Paper Retrieval Nursing Form

See Hard Copy

12 Appendix D – Paper Prototypes

See Hard Copy

13 Appendix E – Code Listing

This section gives codes listing for code writing by me as part of this project.
All code, including Library code is available on the CD.

INDEX.PHP

```
<?php
/*
Default file for application
Display form to add patient and table with list of patients
* */
?>
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
"http://www.w3.org/TR/html4/strict.dtd">
<html>
<head>
      <title>CATS Mobile Nursing Form</title>
      <link rel="stylesheet" type="text/css" href="reset-fonts-
grids.css">
      <link rel="stylesheet" type="text/css" href="common.css">
      <link rel="stylesheet" type="text/css" href="mca.css">

</head>
<script>
function validateForms()
{
      catsno = document.forms["addpatient"].elements["catsno"];
if (catsno.value==null||catsno.value=="")
   {
   alert('CATS No. is required');return false;
   }
else
  {
  return true;
  }

}
</script>
<body>
<!-- the id on the containing div determines the page width. -->
<!-- #doc = 750px; #doc2 = 950px; #doc3 = 100%; #doc4 = 974px -->
<div id="doc3">
      <div id="hd">
            <?php include_once 'header.php';?>
      </div>
      <div id="bd">

            <!-- Use Standard Nesting Grids and Special Nesting Grids to
subdivid regions of your layout. -->
            <!-- Special Nesting Grid D has two children, the first is
1/3, the second is 2/3 -->
            <div class="yui-gd">

                  <!-- the first child of a Grid needs the "first" class
-->
                  <div class="yui-u first" >
                  <div class="heading2">Add New Patient</div>
                        <span id="newpatient">
                              <table >
                              <tr>
```

```
                                    <form name=addpatient action=addpatient.php
method=get onSubmit="return validateForms();">
                                          <td><b>CATS No.<super>*</super></td>
                                    </tr>
                                    <tr>
                                          <td><input type="text" name="catsno"
value="" maxlength="20"></td>
                                    </tr>
                                    <tr>
                                          <td><b>Name</td>
                                    </tr>
                                    <tr>
                                          <td><input type="text" name="name"
value=""  maxlength="45"></td>
                                    </tr>
                                    <tr>
                                          <td><b>Date of Birth</td>
                                    </tr>
                                    <tr>
                                          <td><input type="text"
name="dateofbirth" value=""  maxlength="20"></td>
                                    </tr>
                                    <tr>
                                          <td><b>Referring Hospital</td>
                                    </tr>
                                    <tr>
                                          <td><input type="text"
name="referringhospital" value=""  maxlength="45"></td>
                                    </tr>
                                    <tr>
                                          <td><b>Receiving Hospital</td>
                                    </tr>
                                    <tr>
                                          <td><input type="text"
name="receivinghospital" value=""  maxlength="45"></td>
                                    </tr>
                                    <tr>
                                          <td><b>Observation Rate</td>
                                    </tr>
                                    <tr>
                                          <td><select name="observationrate">
                                                <option value="60"
selected>Hourly
                                                <option value="30">30 mins
                                                <option value="20">20 mins
                                                <option value="15">15 mins
                                                </select></td>
                                    </tr>
                                    <tr width="175px" >
                                          <td align="left"><input type="submit"
name="addpatient" value="Add Patient"></td>
                                    </tr>
                                    </form>
                                    </table>
                              </span>

                        </div>

                        <div class="yui-u">
                              <?php include_once 'patients.php'; ?>
                        </div>

                  </div>
```

```
119
120         </div>
121         <div id="ft">
122         </div>
123 </div>
124 </body>
125 </html>
126
127
```

PATIENT.PHP

```
1   <?php
2   /*
3   The main page of the application.
4   Controls Layout, the accordion style display and the datatables and
5   editors
6   * */
7   ?>
8   <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
9   "http://www.w3.org/TR/html4/strict.dtd">
10  <html>
11  <head>
12        <title>CATS Mobile Nursing Form</title>
13        <link rel="stylesheet" type="text/css" href="reset-fonts-
14  grids.css">
15        <SCRIPT TYPE="text/javascript"      SRC="utilities.js"></SCRIPT>
16  <SCRIPT TYPE="text/javascript"      SRC="bubbling.js"></SCRIPT>
17  <SCRIPT TYPE="text/javascript"      SRC="accordion.js"></SCRIPT>
18
19  <aLINK REL="stylesheet" TYPE="text/css"   HREF="bubbling-library.css">
20  <link rel="stylesheet" type="text/css" href="fonts-min.css" />
21  <link rel="stylesheet" type="text/css" href="calendar.css" />
22  <link rel="stylesheet" type="text/css" href="datatable.css" />
23  <script type="text/javascript" src="yahoo-dom-event.js"></script>
24  <script type="text/javascript" src="connection-min.js"></script>
25  <script type="text/javascript" src="yahoo-min.js"></script>
26  <script type="text/javascript" src="calendar-min.js"></script>
27  <script type="text/javascript" src="element-min.js"></script>
28  <script type="text/javascript" src="datasource-min.js"></script>
29  <script type="text/javascript" src="datatable.js"></script>
30  <script type="text/javascript" src="json-min.js"></script>
31  <script type="text/javascript" src="editors.js"></script>
32  <link rel="stylesheet" type="text/css" href="common.css" />
33  <link rel="stylesheet" type="text/css" href="patient.css" />
34
35  </head>
36        <script type="text/javascript" src="jsapi.js"></script>
37        <script type="text/javascript" src="uds.js"></script>
38        <script type="text/javascript" src="file.js"></script>
39
40      <script type='text/javascript'>
41        google.load('visualization', '1',
42  {'packages':['table','annotatedtimeline']});
43        google.setOnLoadCallback(drawChart,true);
44              var chart;
45              var datatable;
46        function drawChart() {
47
48                    query = new
49  google.visualization.Query('chartdata.php?userId=<?php echo
50  $_GET['userId'];?>');
```

```
                query.send( function(response) {
                        if (response.isError()) {alert('Error getting
data for patient chart');

                        } else {
                              datatable = response.getDataTable();
                              //console.log(datatable);
                            chart = new
google.visualization.AnnotatedTimeLine(document.getElementById('chart_div
'));

chart.draw(datatable,{displayZoomButtons:false,thickness:2,displayLegendV
alues:true,displayRangeSelector:false,displayAnnotations:
true,allowRedraw:true,colors:["red","blue"]});

                        }
                });
                }
    </script>
<body class="yui-skin-sam">
<!-- the id on the containing div determines the page width. -->
<!-- #doc = 750px; #doc2 = 950px; #doc3 = 100%; #doc4 = 974px -->

<!-- To set the Preset Template, add a class to the containing node -->
<!-- .yui-t1 = left 160px; .yui-t2 = left 180px; .yui-t3 = left 300px; --
>
<!-- .yui-t4 = right 180px; .yui-t5 = right 240px; .yui-t6 = right 300px;
-->

<div id="doc3" class="yui-t1">
      <div id="hd">
            <?php include_once 'header.php';?>
      </div>
      <div id="bd">

            <!-- Preset Templates control the width and alignment of the
two blocks (div.yui-b). -->
            <!-- The wide column is wrapped in div#yui-main -->
            <div id="yui-main">
                  <div class="yui-b">
                        <DIV CLASS="myAccordion">
                        <DIV CLASS="yui-cms-accordion multiple fade
fixIE"
                              ID="mylist-first-accordion">


                        <DIV CLASS="yui-cms-item" ID="ChartElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="ChartToggleItem" TITLE="click to expand" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('ChartToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Chart');YAHOO.ut
il.Dom.setStyle('ChartNav', 'backgroundColor', changebgcolor(bgcolor));
">Chart</A></H3>
                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Chart" style="height:290px;">
                        <div id='chart_div' style='width: 100%; height:
280px;'></div>
                        </div>
                        </DIV>
                        </DIV>
                        </DIV>

```

```
                        <DIV CLASS="yui-cms-item"
ID="InterventionsElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="InterventionsToggleItem" TITLE="click to expand" ONCLICK="var bgcolor
= YAHOO.util.Dom.getStyle('InterventionsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Interventions');
YAHOO.util.Dom.setStyle('InterventionsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Interventions</A></H3>
                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Interventions"
style="height:465px;"></div>
                        </DIV>
                        </DIV>
                        </DIV>


                        <DIV CLASS="yui-cms-item" ID="InfusionsElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="InfusionsToggleItem" TITLE="click to expand" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('InfusionsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Infusions');YAHO
O.util.Dom.setStyle('InfusionsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Infusions</A></H3>

                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Infusions" style="height:275px;"></div>
                        </DIV>
                        </DIV>
                        </DIV>

                        <DIV CLASS="yui-cms-item"
ID="ObservationsElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="ObservationsToggleItem" TITLE="click to expand" ONCLICK="var bgcolor
= YAHOO.util.Dom.getStyle('ObservationsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Observations');Y
AHOO.util.Dom.setStyle('ObservationsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Observations</A></H3>

                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Observations"
style="height:225px;"></div>
                        </DIV>
                        </DIV>
                        </DIV>

                        <DIV CLASS="yui-cms-item"
ID="VentilationElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="VentilationToggleItem" TITLE="click to expand" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('VentilationToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Ventilation');YA
HOO.util.Dom.setStyle('VentilationNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Ventilation</A></H3>

                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Ventilation"
style="height:273px;"></div>
                        </DIV>
```

```
                        </DIV>
                        </DIV>

                        <DIV CLASS="yui-cms-item" ID="BloodgasesElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="BloodgasesToggleItem" TITLE="click to expand" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('BloodgasesToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Bloodgases');YAH
OO.util.Dom.setStyle('BloodgasesNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Blood Gases</A></H3>

                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Bloodgases" style="height:323px;"></div>
                        </DIV>
                        </DIV>
                        </DIV>

                        <DIV CLASS="yui-cms-item"
ID="neurologicalElement">
                        <H3><A HREF="#" CLASS="accordionToggleItem"
ID="NeurologicalToggleItem" TITLE="click to expand" ONCLICK="var bgcolor
= YAHOO.util.Dom.getStyle('NeurologicalToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Neurological');Y
AHOO.util.Dom.setStyle('NeurologicalNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Neurological</A></H3>

                        <DIV CLASS="bd">
                        <DIV CLASS="fixed">
                        <div id="Neurological"
style="height:130px;"></div>
                        </DIV>
                        </DIV>
                        </DIV>

                        </DIV>

                        </DIV>

                  </div>
            </div>

            <script>
                  function OpenAllbgcolor(){
                        YAHOO.util.Dom.setStyle('ChartNav',
'backgroundColor', '#45b145');
                        YAHOO.util.Dom.setStyle('InterventionsNav',
'backgroundColor', '#45b145');
                        YAHOO.util.Dom.setStyle('InfusionsNav',
'backgroundColor', '#45b145');
                        YAHOO.util.Dom.setStyle('ObservationsNav',
'backgroundColor','#45b145');
                        YAHOO.util.Dom.setStyle('VentilationNav',
'backgroundColor', '#45b145');
                        YAHOO.util.Dom.setStyle('BloodgasesNav',
'backgroundColor', '#45b145');
                        YAHOO.util.Dom.setStyle('NeurologicalNav',
'backgroundColor', '#45b145');

                  }
                  function CloseAllbgcolor(){
                        YAHOO.util.Dom.setStyle('ChartNav',
'backgroundColor', '#f05c5c');
```

```
                        YAHOO.util.Dom.setStyle('InterventionsNav',
'backgroundColor', '#f05c5c');
                        YAHOO.util.Dom.setStyle('InfusionsNav',
'backgroundColor', '#f05c5c');
                        YAHOO.util.Dom.setStyle('ObservationsNav',
'backgroundColor','#f05c5c');
                        YAHOO.util.Dom.setStyle('VentilationNav',
'backgroundColor', '#f05c5c');
                        YAHOO.util.Dom.setStyle('BloodgasesNav',
'backgroundColor', '#f05c5c');
                        YAHOO.util.Dom.setStyle('NeurologicalNav',
'backgroundColor', '#f05c5c');

                  }

                  function changebgcolor(bgcolor){
                        //alert(bgcolor);
                        if(bgcolor == "rgb(69, 177, 69)"){
                              newbgcolor="#f05c5c";
                              //alert('#f05c5c');
                              return newbgcolor;
                        }else if(bgcolor == "rgb(240, 92, 92)"){
                              //alert('#45b145');
                              newbgcolor="#45b145";
                              return newbgcolor;
                        }

                  }
            </script>
            <!-- the unwrapped div.yui-b takes a fixed width and
alignment based on the class of the top-level containing node -->
            <div class="yui-b">
                  <DIV CLASS="accordionNav">
                              <Div id=ChartNav class="Nav"><A HREF="#"
ONCLICK="var bgcolor = YAHOO.util.Dom.getStyle('ChartToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Chart');YAHOO.ut
il.Dom.setStyle('ChartNav', 'backgroundColor', changebgcolor(bgcolor));
">Chart</A></div>
                              <Div id=InterventionsNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('InterventionsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Interventions');
YAHOO.util.Dom.setStyle('InterventionsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Interventions</A></div>
                              <Div id=InfusionsNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('InfusionsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Infusions');YAHO
O.util.Dom.setStyle('InfusionsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Infusions</A></div>
                              <Div id=ObservationsNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('ObservationsToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Observations');Y
AHOO.util.Dom.setStyle('ObservationsNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Observations</A></div>
                              <Div id=VentilationNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('VentilationToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Ventilation');YA
HOO.util.Dom.setStyle('VentilationNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Ventilation</A></div>
```

```
                              <Div id=BloodgasesNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('BloodgasesToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Bloodgases');YAH
OO.util.Dom.setStyle('BloodgasesNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Bloodgases</A></div>
                              <Div id=NeurologicalNav class="Nav"><A
HREF="#" ONCLICK="var bgcolor =
YAHOO.util.Dom.getStyle('NeurologicalToggleItem',
'backgroundColor');YAHOO.widget.AccordionManager.toggle('Neurological');Y
AHOO.util.Dom.setStyle('NeurologicalNav', 'backgroundColor',
changebgcolor(bgcolor)); ">Neurological</A></div>

                        <P>
                              <Div id=OpenAllNav class="Nav"><A HREF="#"
ONCLICK="YAHOO.widget.AccordionManager.expand('mylist-first-
accordion');OpenAllbgcolor();">Open All</A></div>
                              <Div id=CloseAllNav class="Nav"><A HREF="#"
ONCLICK="YAHOO.widget.AccordionManager.collapse('mylist-first-
accordion');CloseAllbgcolor();">Close All</A></div>
                        </P>
                        <!-- <A HREF="#" ONCLICK="drawChart();">Draw
Chart</A>-->
                  </DIV>
            </div>

      </div>

      <div id="ft">
            <p><br><br></p>
      </div>
</div>


<script type="text/javascript">
      YAHOO.widget.AccordionManager.toggle('ObservationsElement');
      YAHOO.widget.AccordionManager.toggle('ChartElement');
</script>


<!--BEGIN SOURCE CODE FOR EXAMPLE ================================ -->



<script type="text/javascript" src="data.php?userId=<?php echo
$_GET['userId']?>"></script>
<script type="text/javascript">




YAHOO.util.Event.addListener(window, "load", function() {
    YAHOO.example.InlineCellEditing = function() {


      var disabled = false;

      var oldShowCellEditor =
YAHOO.widget.DataTable.prototype.showCellEditor;
      YAHOO.widget.DataTable.prototype.showCellEditor = function () {
            if (!disabled) {
                  oldShowCellEditor.apply(this,arguments);
```

```
365             }
366       };
367
368       /*
369                   UpdateTime responds to a change in time of any
370 observation style table
371                   If it is called it gets the data from the updated time
372 row and updates the time row in the other three datatablesf
373       */
374              function updateTime(data,column,table){
375                   data=eval(table+'Table').getRecord(0).getData();
376                   //console.log(data);
377                   if(table=="Observations"){
378                         VentilationTable.updateRow ( 0 , data );
379                         BloodgasesTable.updateRow ( 0 , data );
380                         NeurologicalTable.updateRow ( 0 , data );
381                   }else if(table=="Ventilation"){
382                         ObservationsTable.updateRow ( 0 , data );
383                         BloodgasesTable.updateRow ( 0 , data );
384                         NeurologicalTable.updateRow ( 0 , data );
385                   }else if(table=="Bloodgases"){
386                         ObservationsTable.updateRow ( 0 , data );
387                         VentilationTable.updateRow ( 0 , data );
388                         NeurologicalTable.updateRow ( 0 , data );
389                   }else if(table=="Neurological"){
390                         ObservationsTable.updateRow ( 0 , data );
391                         VentilationTable.updateRow ( 0 , data );
392                         BloodgasesTable.updateRow ( 0 , data );
393                   }
394             }
395
396             var submitter=  function (callback, newValue) {
397             var record = this.getRecord(),
398             column = this.getColumn(),
399             oldValue = this.value,
400             type = record.getData('columnname'),
401             datatable = this.getDataTable();
402             YAHOO.util.Connect.asyncRequest(
403             'POST',
404             'DBResponse.php',
405              {
406                   success:function(o) {
407                var r = YAHOO.lang.JSON.parse(o.responseText);
408                if (r.replyCode == 201) {
409                  drawChart();
410                  //console.log(r.data);
411                  //console.log(column);
412                  //console.log(datatable);
413                  //console.log(r.column);
414                  //console.log(r.table);
415                  //console.log(type);
416                  callback(true, r.data);
417
418       if((r.table!="Infusions")&&(r.column=="Time1"||r.column=="Time2"||r
419 .column=="Time3"||r.column=="Time4"||
420
421       r.column=="Time5"||r.column=="Time6"||r.column=="Time7"||r.column==
422 "Time8"||
423
424       r.column=="Time9"||r.column=="Time10"||r.column=="Time11"||r.column
425 =="Time12")){
426                                     //console.log('Update Time');
427                                     updateTime(r.data,r.column,r.table);
```

```
                    }

                } else {
                    alert(r.replyText);
                    callback();
                }
            },

                failure:function(o) {
                  alert('Failed response for DB');
                    alert(o.statusText);
                    callback();
                },
                scope:this
            },
            'action=cellEdit&column=' + column.key + '&newValue=' +
                encodeURIComponent(newValue) + '&oldValue=' +
escape(oldValue) +
                myBuildUrl(datatable,record)
            );
      }


        // Custom formatter for "address" column to preserve line breaks
        var formatAddress = function(elCell, oRecord, oColumn, oData) {
            elCell.innerHTML = "<pre class=\"address\">" + oData +
"</pre>";
        };


        var editors = {
                         1: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter : submitter})
                        ,2: new  widget.TextboxCellEditor( {
asyncSubmitter : submitter})
                        ,3: new  widget.TextboxCellEditor( {
asyncSubmitter : submitter})
                        ,4: new widget.TextboxCellEditor( {
asyncSubmitter : submitter})
                        ,8: new widget.TextboxCellEditor( {
asyncSubmitter : submitter})
                  };



        var myColumnDefs = [
            {key:"uneditable"},
            {key:"address",  editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
            {key:"city",
                        editor : new widget.TextboxCellEditor( {
asyncSubmitter : submitter}),
                        resizeable : true,
                        Type :4,
                        sortable : false,
                        formatter : formatValue},
            {key:"state", editor: new
YAHOO.widget.DropdownCellEditor({dropdownOptions:YAHOO.example.Data.state
Abbrs,disableBtns:true, asyncSubmitter : submitter })},
            {key:"amount", editor: new
YAHOO.widget.TextboxCellEditor({validator:YAHOO.widget.DataTable.validate
Number, asyncSubmitter : submitter})},
```

```
            {key:"active", editor: new
YAHOO.widget.RadioCellEditor({radioOptions:["yes","no","maybe"],disableBt
ns:true, asyncSubmitter : submitter})},
            {key:"colors", editor: new
YAHOO.widget.CheckboxCellEditor({checkboxOptions:["red","yellow","blue"],
asyncSubmitter : submitter})},
            {key:"fruit", editor: new
YAHOO.widget.DropdownCellEditor({multiple:true,dropdownOptions:["apple","
banana","cherry"], asyncSubmitter : submitter})},
            {key:"last_login",
formatter:YAHOO.widget.DataTable.formatDate, editor: new
YAHOO.widget.DateCellEditor({  asyncSubmitter : submitter})}
        ];

        var myInterventionsColumnDefs = [
                {key:"category", label:"Intervention" },
                {key:"intervention", label:"Category"},
                {key:"RH", editor: new
YAHOO.widget.RadioCellEditor({radioOptions:["Yes","No"],disableBtns:true,
asyncSubmitter : submitter}),Type :4,
                        sortable : false,
                        formatter : formatValue},
                {key:"CATS", editor: new
YAHOO.widget.RadioCellEditor({radioOptions:["Yes","No"],disableBtns:true,
asyncSubmitter : submitter}),Type :4,
                                sortable : false,
                                formatter : formatValue},
                {key:"CATSInterventionTime",label: "Time" ,editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"Comment",  editor: new
YAHOO.widget.TextareaCellEditor({disableBtns:true, asyncSubmitter :
submitter})}

            ];


        var myInfusionsColumnDefs = [
                {key:"infusion", label:"Infusion",  editor: new
YAHOO.widget.DropdownCellEditor({dropdownOptions:YAHOO.example.Data.infus
ionDrugs,disableBtns:true, asyncSubmitter : submitter})},
                {key:"units", label:"Units", editor: new
YAHOO.widget.DropdownCellEditor({dropdownOptions:YAHOO.example.Data.infus
ionUnits,disableBtns:true, asyncSubmitter : submitter })},
                {key:"dose1", label:"Dose 1",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose2", label:"Dose 2",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose3", label:"Dose 3",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose4", label:"Dose 4",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose5", label:"Dose 5",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose6", label:"Dose 6",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
```

```
                {key:"dose7", label:"Dose 7",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose8", label:"Dose 8",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"dose9", label:"Dose 9",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"key",hidden:true},

            ];

        var myObservationsColumnDefs = [
                        {key:"columnname",hidden:true},

{key:"columndisplayname",label:"Observation",minWidth:"130",width:"130"},
                {key:"val1", label:"1",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val2", label:"2",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val3", label:"3",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val4", label:"4",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val5", label:"5",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val6", label:"6",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val7", label:"7",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val8", label:"8",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val9", label:"9",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val10", label:"10",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val11", label:"11",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val12", label:"12",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"key",hidden:true},

            ];

        var myVentilationColumnDefs = [
                        {key:"columnname",hidden:true},
                        {key:"columndisplayname",label:"Ventilation"},
                        {key:"val1", label:"1",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
```

```
                {key:"val2", label:"2",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val3", label:"3",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val4", label:"4",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val5", label:"5",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val6", label:"6",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val7", label:"7",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val8", label:"8",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val9", label:"9",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val10", label:"10",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val11", label:"11",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val12", label:"12",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"key",hidden:true},

            ];

        var myBloodgasesColumnDefs = [
                        {key:"columnname",hidden:true},
                        {key:"columndisplayname",label:"Blood Gas"},
                        {key:"val1", label:"1",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val2", label:"2",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val3", label:"3",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val4", label:"4",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val5", label:"5",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val6", label:"6",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val7", label:"7",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
```

```
                {key:"val8", label:"8",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val9", label:"9",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val10", label:"10",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val11", label:"11",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val12", label:"12",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"key",hidden:true},

            ];
        var myNeurologicalColumnDefs = [
                        {key:"columnname",hidden:true},
                        {key:"columndisplayname",label:"Neurological"},
                        {key:"val1", label:"1",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val2", label:"2",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val3", label:"3",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val4", label:"4",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val5", label:"5",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val6", label:"6",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val7", label:"7",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val8", label:"8",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val9", label:"9",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val10", label:"10",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val11", label:"11",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"val12", label:"12",editor: new
Gcc.admin.CalcCellEditor({disableBtns:true, asyncSubmitter :
submitter})},
                {key:"key",hidden:true},

            ];

            var formatName = function(elCell, oRecord, oColumn, oData) {
                 var a = document.createElement("a");
```

```
                    a.href = "javascript:void(0);";
                    a.innerHTML = oRecord.getData("city");
                    a.id =  oRecord.getData("city");
                    a.title = oRecord.getData("city");
                    a.className = "yui-skin-sam ";
                    elCell.appendChild(a);
              };
              var myBuildUrl = function(datatable,record) {
                    var datatablename=datatable.configs.element;
              var url = '';
              var id=record.getId();
              var cols = datatable.getColumnSet().keys;
              for (var i = 0; i < cols.length; i++) {

                      url += '&' + cols[i].key + '=' +
escape(record.getData(cols[i].key));


              }
                    url
+='&table='+datatablename+'&id='+id+'&record='+record.getCount()+'&userId
='+<?php echo $_GET['userId'];?>;
              return url;
          };



              /*
              Need to put in some new code here or in buildURL
              It should determine if a time has been updated in an
observation or neurological setting
              and if a time has been updated in one of these datatables,
then it should update the time in all the other datatables
              Something like
              if datatablename=observations
                    if columnname=ob1
                          if row=1 (this make it a time)
                                Then

       neurologicaldattable.row1.col1.value=observations.row1.col1.value;
              */

          var formatValue = function(elCell, oRecord, oColumn, oData) {
                    if (oRecord.getData("Readable") == "false") {
                          elCell.innerHTML = "<span style='color:
#AAAAAA'>***NOT READABLE***</span>";
                          return;
                    }

                    if (oRecord.getData("Type") == 14) {

                          elCell.innerHTML = oData == 1 ? "True" : "False";
                    }
                    else if (oRecord.getData("Type") == 8) {
                          var domain = oRecord.getData('Domain');
                          if (domain != null) {
                                for(var i = 0; i < domain.length; i++) {
                                      if (domain[i].value == oData) {
                                            elCell.innerHTML =
domain[i].label;

                                            break;
                                      }
                                };
```

```
                        }
                        else {
                              elCell.innerHTML = oData;
                        }
                  }
                  else {
                        elCell.innerHTML = oData;
                  }
            };



        var myDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.addresses);
        myDataSource.responseType = YAHOO.util.DataSource.TYPE_JSARRAY;
        myDataSource.responseSchema = {
                  fields:
["address","city","state","amount","active","colors","fruit",{key:"last_l
ogin",parser:"date"}]
        };


        var InterventionsDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.interventions);
        InterventionsDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        InterventionsDataSource.responseSchema = {
                  fields: ["category","intervention",
{key:"RH",parser:"boolean"},{key:"CATS",parser:"boolean"},"CATSInterventi
onTime","Comment"]
        };

        var InfusionsDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.infusions);
        InfusionsDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        InfusionsDataSource.responseSchema = {
                  fields:
["infusion","units","dose1","dose2","dose3","dose4","dose5","dose6","dose
7","dose8","dose9","key"]
        };


        var ObservationsDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.observations);
        ObservationsDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        ObservationsDataSource.responseSchema = {
                  fields:
["columnname","columndisplayname","val1","val2","val3","val4","val5","val
6","val7","val8","val9","val10","val11","val12","key"]
        };

        var VentilationDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.ventilation);
        VentilationDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        VentilationDataSource.responseSchema = {
                  fields:
["columnname","columndisplayname","val1","val2","val3","val4","val5","val
6","val7","val8","val9","val10","val11","val12","key"]
        };

```

```
        var BloodgasesDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.bloodgases);
        BloodgasesDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        BloodgasesDataSource.responseSchema = {
                fields:
["columnname","columndisplayname","val1","val2","val3","val4","val5","val
6","val7","val8","val9","val10","val11","val12","key"]
        };

        var NeurologicalDataSource = new
YAHOO.util.DataSource(YAHOO.example.Data.neurological);
        NeurologicalDataSource.responseType =
YAHOO.util.DataSource.TYPE_JSARRAY;
        NeurologicalDataSource.responseSchema = {
                fields:
["columnname","columndisplayname","val1","val2","val3","val4","val5","val
6","val7","val8","val9","val10","val11","val12","key"]
        };



        var MyDataTable = new YAHOO.widget.DataTable("celledi ting",
myColumnDefs, myDataSource, {});
            var InterventionsTable = new
YAHOO.widget.DataTable("Interventions", myInterventionsColumnDefs,
InterventionsDataSource, {});
        var InfusionsTable = new YAHOO.widget.DataTable("Infusions",
myInfusionsColumnDefs, InfusionsDataSource, {});
        var ObservationsTable = new
YAHOO.widget.DataTable("Observations", myObservationsColumnDefs,
ObservationsDataSource, {});
        var VentilationTable = new YAHOO.widget.DataTable("Ventilation",
myVentilationColumnDefs, VentilationDataSource, {});
        var BloodgasesTable = new YAHOO.widget.DataTable("Bloodgases",
myBloodgasesColumnDefs, BloodgasesDataSource, {});
        var NeurologicalTable = new
YAHOO.widget.DataTable("Neurological", myNeurologicalColumnDefs,
NeurologicalDataSource, {});

        InterventionsTable.on('disableEvent', function() {
            disabled = true;
      });
        InterventionsTable.on('undisableEvent', function() {
            disabled = false;
      });

        InfusionsTable.on('disableEvent', function() {
            disabled = true;
      });
        InfusionsTable.on('undisableEvent', function() {
            disabled = false;
      });

        ObservationsTable.on('disableEvent', function() {
            disabled = true;
      });
        ObservationsTable.on('undisableEvent', function() {
            disabled = false;
      });

        VentilationTable.on('disableEvent', function() {
            disabled = true;
```

```
929         });
930           VentilationTable.on('undisableEvent', function() {
931               disabled = false;
932         });
933
934           BloodgasesTable.on('disableEvent', function() {
935               disabled = true;
936         });
937           BloodgasesTable.on('undisableEvent', function() {
938               disabled = false;
939         });
940
941           NeurologicalTable.on('disableEvent', function() {
942               disabled = true;
943         });
944           NeurologicalTable.on('undisableEvent', function() {
945               disabled = false;
946         });
947
948           // Set up editing flow
949           var highlightEditableCell = function(oArgs) {
950               var elCell = oArgs.target;
951               if(YAHOO.util.Dom.hasClass(elCell, "yui-dt-editable")) {
952                   this.highlightCell(elCell);
953               }
954           };
955
956           MyDataTable.subscribe("cellMouseoverEvent",
957   highlightEditableCell);
958           MyDataTable.subscribe("cellMouseoutEvent",
959   MyDataTable.onEventUnhighlightCell);
960           MyDataTable.subscribe("cellClickEvent",
961   MyDataTable.onEventShowCellEditor);
962
963           InterventionsTable.subscribe("cellMouseoverEvent",
964   highlightEditableCell);
965           InterventionsTable.subscribe("cellMouseoutEvent",
966   InterventionsTable.onEventUnhighlightCell);
967           InterventionsTable.subscribe("cellClickEvent",
968   InterventionsTable.onEventShowCellEditor);
969
970           InfusionsTable.subscribe("cellMouseoverEvent",
971   highlightEditableCell);
972           InfusionsTable.subscribe("cellMouseoutEvent",
973   InfusionsTable.onEventUnhighlightCell);
974           InfusionsTable.subscribe("cellClickEvent",
975   InfusionsTable.onEventShowCellEditor);
976
977           ObservationsTable.subscribe("cellMouseoverEvent",
978   highlightEditableCell);
979           ObservationsTable.subscribe("cellMouseoutEvent",
980   ObservationsTable.onEventUnhighlightCell);
981           ObservationsTable.subscribe("cellClickEvent",
982   ObservationsTable.onEventShowCellEditor);
983
984           VentilationTable.subscribe("cellMouseoverEvent",
985   highlightEditableCell);
986           VentilationTable.subscribe("cellMouseoutEvent",
987   VentilationTable.onEventUnhighlightCell);
988           VentilationTable.subscribe("cellClickEvent",
989   VentilationTable.onEventShowCellEditor);
990
```

```
        NeurologicalTable.subscribe("cellMouseoverEvent",
highlightEditableCell);
        NeurologicalTable.subscribe("cellMouseoutEvent",
NeurologicalTable.onEventUnhighlightCell);
        NeurologicalTable.subscribe("cellClickEvent",
NeurologicalTable.onEventShowCellEditor);

        BloodgasesTable.subscribe("cellMouseoverEvent",
highlightEditableCell);
        BloodgasesTable.subscribe("cellMouseoutEvent",
BloodgasesTable.onEventUnhighlightCell);
        BloodgasesTable.subscribe("cellClickEvent",
BloodgasesTable.onEventShowCellEditor);

        return {
            oDS: myDataSource,
            oDT: InterventionsTable
        };
    }();
});
</script>

<!--END SOURCE CODE FOR EXAMPLE ================================ -->
<div id="datatable-ux">

            <div id="datatable-ux-hd"></div>
            <div id="datatable-ux-bd">

                  <div id="output"></div>
                  <div id="yui-datatable" class="yui-dt">
                        <img src="images/icon-loading.gif" alt=""
align="absmiddle" style="margin: 30px 0;" />
                  </div>
            </div>

            <div id="datatable-ux-ft"></div>
    </div>

      <div id="node-apply-wrap" style="display: none">




<table class="calcTable">
<tr>
<td colspan=2>
      <input type=button value="Del" class="calcButtonOperator"
id="backspace">
</td>
<td colspan=2>
      <input type=button value=" C " class="calcButtonOperator"
id="clearAll">
</td>
</tr>
<tr>
<td><input type=button value="7" class="calcButtonNumber"
id="button7"></td>
<td><input type=button value="8" class="calcButtonNumber"
id="button8"></td>
<td><input type=button value="9" class="calcButtonNumber"
id="button9"></td>
<td><input type=button value="+" class="calcButtonNumber"
id="button11"></td>
```

```
</tr>
<tr>
<td><input type=button value="4" class="calcButtonNumber"
id="button4"></td>
<td><input type=button value="5" class="calcButtonNumber"
id="button5"></td>
<td><input type=button value="6" class="calcButtonNumber"
id="button6"></td>
<td><input type=button value="-" class="calcButtonNumber"
id="button12"></td>
</tr>
<tr>
<td><input type=button value="1" class="calcButtonNumber"
id="button1"></td>
<td><input type=button value="2" class="calcButtonNumber"
id="button2"></td>
<td><input type=button value="3" class="calcButtonNumber"
id="button3"></td>
<td><input type=button value=":" class="calcButtonNumber"
id="button14"></td>
</tr>
<tr>
<td colspan=2><input type=button value="0" class="widecalcButtonNumber"
id="button0"></td>
<td><input type=button value="." class="calcButtonNumber"
id="button10"></td>
<td><input type=button value="/" class="calcButtonNumber"
id="button13"></td>
</tr>
</table>




      </div>


</body>
</html>
<script>

</script>
```

ADD PATIENT.PHP

```
<?php
/*
Script to add patient to database
* */
include_once 'config.php';
mysql_connect($dbHost, $dbUser, $dbPassword);
mysql_select_db($dbSchema);
error_reporting(1);
ini_set('display_errors','true');


$SQL="INSERT INTO users
(catsNumber,name,dateOfBirth,referringHospital,receivingHospital,isActive
)
      VALUES
```

```
( '$_GET[catsno]' , '$_GET[name]' , '$_GET[dateofbirth]',
'$_GET[referringhospital]', '$_GET[receivinghospital]',1)";



$result = mysql_query($SQL);

if($result){
 $id=mysql_insert_id();

 //create the default times for observations, blood gases etc.
 //get the current time
 $now = time();
 $time1  = mktime(date("H", $now), date("i", $now), date("s", $now),
date("m", $now)  , date("d", $now)-$sub, date("Y", $now));

 $minutestoadvance=$_GET['observationrate'];
 $time1  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*0),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time2  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*1),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time3  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*2),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time4  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*3),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time5  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*4),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time6  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*5),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time7  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*6),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time8  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*7),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time9  = mktime(date("H", $now), date("i", $now)+($minutestoadvance*8),
date("s", $now), date("m", $now)  , date("d", $now)-$sub, date("Y",
$now));
 $time10  = mktime(date("H", $now), date("i",
$now)+($minutestoadvance*9), date("s", $now), date("m", $now)  ,
date("d", $now)-$sub, date("Y", $now));
 $time11  = mktime(date("H", $now), date("i",
$now)+($minutestoadvance*10), date("s", $now), date("m", $now)  ,
date("d", $now)-$sub, date("Y", $now));
 $time12  = mktime(date("H", $now), date("i",
$now)+($minutestoadvance*11), date("s", $now), date("m", $now)  ,
date("d", $now)-$sub, date("Y", $now));









 $SQLInterventions="INSERT INTO interventions (userId)
            VALUES      ($id)";

 $result = mysql_query($SQLInterventions);
```

```
80
81    $SQLInfusions="INSERT INTO  infusions
82  ( userId )
83  VALUES
84  (
85   $id)";
86   $result = mysql_query($SQLInfusions);
87
88   $SQLObservations="INSERT INTO  observations
89  ( userId
90  ,Time1,Time2,Time3,Time4,Time5,Time6,Time7,Time8,Time9,Time10,Time11,Time
91  12)
92  VALUES
93  (
94
95  $id,'".date('H:i',$time1)."','".date('H:i',$time2)."','".date('H:i',$time
96  3)."','".date('H:i',$time4)."','".date('H:i',$time5)."','".date('H:i',$ti
97  me6)."',
98  '".date('H:i',$time7)."','".date('H:i',$time8)."','".date('H:i',$time9)."
99  ','".date('H:i',$time10)."','".date('H:i',$time11)."','".date('H:i',$time
100 12)."')";
101  $result = mysql_query($SQLObservations);
102
103   $SQLVentilation="INSERT INTO  ventilation
104 ( userId
105 ,Time1,Time2,Time3,Time4,Time5,Time6,Time7,Time8,Time9,Time10,Time11,Time
106 12)
107 VALUES
108 (
109
110 $id,'".date('H:i',$time1)."','".date('H:i',$time2)."','".date('H:i',$time
111 3)."','".date('H:i',$time4)."','".date('H:i',$time5)."','".date('H:i',$ti
112 me6)."',
113 '".date('H:i',$time7)."','".date('H:i',$time8)."','".date('H:i',$time9)."
114 ','".date('H:i',$time10)."','".date('H:i',$time11)."','".date('H:i',$time
115 12)."')";
116  $result = mysql_query($SQLVentilation);
117
118   $SQLBloodgases="INSERT INTO  bloodgases
119 ( userId
120 ,Time1,Time2,Time3,Time4,Time5,Time6,Time7,Time8,Time9,Time10,Time11,Time
121 12)
122 VALUES
123 (
124
125 $id,'".date('H:i',$time1)."','".date('H:i',$time2)."','".date('H:i',$time
126 3)."','".date('H:i',$time4)."','".date('H:i',$time5)."','".date('H:i',$ti
127 me6)."',
128 '".date('H:i',$time7)."','".date('H:i',$time8)."','".date('H:i',$time9)."
129 ','".date('H:i',$time10)."','".date('H:i',$time11)."','".date('H:i',$time
130 12)."')";
131  $result = mysql_query($SQLBloodgases);
132
133
134   $SQLNeurological="INSERT INTO  neurological
135 ( userId
136 ,Time1,Time2,Time3,Time4,Time5,Time6,Time7,Time8,Time9,Time10,Time11,Time
137 12)
138 VALUES
139 (
140
141 $id,'".date('H:i',$time1)."','".date('H:i',$time2)."','".date('H:i',$time
```

```
3)."',".date('H:i',$time4)."','".date('H:i',$time5)."','".date('H:i',$ti
me6)."',
'".date('H:i',$time7)."','".date('H:i',$time8)."','".date('H:i',$time9)."
','".date('H:i',$time10)."','".date('H:i',$time11)."','".date('H:i',$time
12)."')";
 $result = mysql_query($SQLNeurological);

 //var_dump($result);
header("Location: http://localhost/MCA/patient.php?userId=".$id); /*
Redirect browser */

/* Make sure that code below does not get executed when we redirect. */
exit;

}
else{
      header("Location:
http://localhost/MCA/index.php?msg=urlencode(Could not add patient
record)");
}

?>
```

DBRESPONSE.PHP

```
<?php
/*
Return response from database after request to update tables
* */
include_once 'config.php';

mysql_connect($dbHost, $dbUser, $dbPassword);
mysql_select_db($dbSchema);
error_reporting(1);
ini_set('display_errors','true');
//get the table to update
$table=$_POST['table'];

switch ($table):
case 'Interventions':
      switch ($_POST['intervention']):
          case 'Primary Intubation':

            switch($_POST['column']):
                  case 'RH':
                        $column='primaryIntubationRH';
                        break;
                  case 'CATS':
                        $column='primaryIntubationCATS';
                        break;
                  case 'CATSInterventionTime':
                        $column='primaryIntubationCATSTime';
                        break;
                  case 'Comment':
                        $column='primaryIntubationComment';
                        break;
            endswitch;

              break;
          case 'Rentubation':
              switch($_POST['column']):
                  case 'RH':
```

```
                        $column='rentubationRH';
                        break;
                    case 'CATS':
                        $column='rentubationCATS';
                        break;
                    case 'CATSInterventionTime':
                        $column='rentubationCATSTime';
                        break;
                    case 'Comment':
                        $column='rentubationComment';
                        break;
              endswitch;
                break;
            case 'Repositioning':
                switch($_POST['column']):
                    case 'RH':
                        $column='repositioningRH';
                        break;
                    case 'CATS':
                        $column='repositioningCATS';
                        break;
                    case 'CATSInterventionTime':
                        $column='repositioningCATSTime';
                        break;
                    case 'Comment':
                        $column='repositioningComment';
                        break;
              endswitch;
                break;
            case 'Trachy Change/LMA/Surgical Airway':
                switch($_POST['column']):
                    case 'RH':
                        $column='tracyRH';
                        break;
                    case 'CATS':
                        $column='tracyCATS';
                        break;
                    case 'CATSInterventionTime':
                        $column='tracyCATSTime';
                        break;
                    case 'Comment':
                        $column='tracyComment';
                        break;
              endswitch;
                break;
            case 'Ventilator':
                switch($_POST['column']):
                    case 'RH':
                        $column='ventilatorRH';
                        break;
                    case 'CATS':
                        $column='ventilatorCATS';
                        break;
                    case 'CATSInterventionTime':
                        $column='ventilatorCATSTime';
                        break;
                    case 'Comment':
                        $column='ventilatorComment';
                        break;
              endswitch;
                break;
            case 'Inhaled Nitric Oxide':
                switch($_POST['column']):
```

```
                case 'RH':
                      $column='inhaledRH';
                      break;
                case 'CATS':
                      $column='inhaledCATS';
                      break;
                case 'CATSInterventionTime':
                      $column='inhaledCATSTime';
                      break;
                case 'Comment':
                      $column='inhaledComment';
                      break;
          endswitch;
            break;
        case 'Chest Drain':
            switch($_POST['column']):
                case 'RH':
                      $column='chestDrainRH';
                      break;
                case 'CATS':
                      $column='chestDrainCATS';
                      break;
                case 'CATSInterventionTime':
                      $column='chestDrainCATSTime';
                      break;
                case 'Comment':
                      $column='chestDrainComment';
                      break;
          endswitch;
            break;
        case 'Physiotherapy':
            switch($_POST['column']):
                case 'RH':
                      $column='physiotherapyRH';
                      break;
                case 'CATS':
                      $column='physiotherapyCATS';
                      break;
                case 'CATSInterventionTime':
                      $column='physiotherapyCATSTime';
                      break;
                case 'Comment':
                            $column='physiotherapyComment';
                      break;
          endswitch;
            break;
        case 'Inotropes':
            switch($_POST['column']):
                case 'RH':
                      $column='intropesRH';
                      break;
                case 'CATS':
                      $column='intropesCATS';
                      break;
                case 'CATSInterventionTime':
                      $column='intropesCATSTime';
                      break;
                case 'Comment':
                      $column='intropesComment';
                      break;
          endswitch;
            break;
        case 'Central Venous Access':
```

```
                switch($_POST['column']):
                    case 'RH':
                          $column='centralRH';
                          break;
                    case 'CATS':
                          $column='centralCATS';
                          break;
                    case 'CATSInterventionTime':
                          $column='centralCATSTime';
                          break;
                    case 'Comment':
                          $column='centralComment';
                          break;
              endswitch;
                break;
            case 'Arterial Line':
                switch($_POST['column']):
                    case 'RH':
                          $column='arterialRH';
                          break;
                    case 'CATS':
                          $column='arterialCATS';
                          break;
                    case 'CATSInterventionTime':
                          $column='arterialCATSTime';
                          break;
                    case 'Comment':
                          $column='arterialComment';
                          break;
              endswitch;
                break;
            case 'Intra-Osseous Needle':
                switch($_POST['column']):
                    case 'RH':
                          $column='intraRH';
                          break;
                    case 'CATS':
                          $column='intraCATS';
                          break;
                    case 'CATSInterventionTime':
                          $column='intraCATSTime';
                          break;
                    case 'Comment':
                          $column='intraComment';
                          break;
              endswitch;
                break;
            case 'Peripheral Access':
                switch($_POST['column']):
                    case 'RH':
                          $column='peripheralRH';
                          break;
                    case 'CATS':
                          $column='peripheralCATS';
                          break;
                    case 'CATSInterventionTime':
                          $column='peripheralCATSTime';
                          break;
                    case 'Comment':
                          $column='peripheralComment';
                          break;
              endswitch;
                break;
```

```
227             case 'CPR/Defibrillation (SELECT)':
228                 switch($_POST['column']):
229                     case 'RH':
230                           $column='CPRRH';
231                           break;
232                     case 'CATS':
233                           $column='CPRCATS';
234                           break;
235                     case 'CATSInterventionTime':
236                           $column='CPRCATSTime';
237                           break;
238                     case 'Comment':
239                           $column='CPRComment';
240                           break;
241               endswitch;
242                 break;
243             case 'CT Scan':
244                 switch($_POST['column']):
245                     case 'RH':
246                           $column='CTRH';
247                           break;
248                     case 'CATS':
249                           $column='CTCATS';
250                           break;
251                     case 'CATSInterventionTime':
252                           $column='CTCATSTime';
253                           break;
254                     case 'Comment':
255                           $column='CTComment';
256                           break;
257               endswitch;
258                 break;
259             case '3% Saline/Mannitol':
260                 switch($_POST['column']):
261                     case 'RH':
262                           $column='salineRH';
263                           break;
264                     case 'CATS':
265                           $column='salineCATS';
266                           break;
267                     case 'CATSInterventionTime':
268                           $column='salineCATSTime';
269                           break;
270                     case 'Comment':
271                           $column='salineComment';
272                           break;
273               endswitch;
274                 break;
275             case 'Urinary Catheter':
276                 switch($_POST['column']):
277                     case 'RH':
278                           $column='urinaryRH';
279                           break;
280                     case 'CATS':
281                           $column='urinaryCATS';
282                           break;
283                     case 'CATSInterventionTime':
284                           $column='urinaryCATSTime';
285                           break;
286                     case 'Comment':
287                           $column='urinaryComment';
288                           break;
289               endswitch;
```

```
290                 break;
291             case 'NGT/OGT':
292                 switch($_POST['column']):
293                     case 'RH':
294                           $column='NGTRH';
295                           break;
296                     case 'CATS':
297                           $column='NGTCATS';
298                           break;
299                     case 'CATSInterventionTime':
300                           $column='NGTCATSTime';
301                           break;
302                     case 'Comment':
303                           $column='NGTComment';
304                           break;
305               endswitch;
306                 break;
307             default:
308                 //echo "i is not equal to 0, 1 or 2";
309       endswitch;
310       break;
311       //end of interventions
312 case 'Infusions':
313       switch ($_POST['key']):
314     //this is an unusual row because it deals with the times
315       case '1':
316
317       switch($_POST['column']):
318             case 'infusion':
319                   //this field cannot be edited
320                   $column='';
321                   break;
322             case 'units':
323                   //this field cannot be edited
324                   $column='';
325                   break;
326             default;
327                   $column=str_replace("dose","Time",$_POST['column']);
328
329                   break;
330       endswitch;
331
332       break;
333     default:
334         switch($_POST['column']):
335             case 'infusion':
336                   $column='infusion'.$_POST['key'];
337                   break;
338             case 'units':
339                   $column='units'.$_POST['key'];
340                   break;
341             default;
342                   $column=$_POST['column'].$_POST['key'];
343                   break;
344       endswitch;
345         break;
346       endswitch;
347       break;
348 default:
349       switch ($_POST['key']):
350     //this is an unusual row because it deals with the times
351       case '1':
352         $column=str_replace("val","Time",$_POST['column']);
```

```
      break;
    default:
        $column=str_replace("val",$_POST['columnname'],$_POST['column']);
      break;
      endswitch;

break;
endswitch;


$newValue=$_POST['newValue'];
$userId=$_POST['userId'];
$SQL="update ".strtolower($table)." set $column = '$newValue' where
userId=$userId;";

//$row=mysql_fetch_assoc($result);

//Code to make sure that if one time is updated for an observation table,
the other time values gets updated in the database
//for the other tables

if($column=="Time1"||$column=="Time2"||$column=="Time3"||$column=="Time4"
||
$column=="Time5"||$column=="Time6"||$column=="Time7"||$column=="Time8"||
$column=="Time9"||$column=="Time10"||$column=="Time11"||$column=="Time12"
){

if($table=="Observations"){
            $SQL2="Update ventilation set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update bloodgases set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update neurological set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);


}else if($table=="Ventilation"){
            $SQL2="Update observations set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update bloodgases set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update neurological set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);


}else if($table=="Bloodgases"){
            $SQL2="Update ventilation set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update observations set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update neurological set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);


}else if($table=="Neurological"){
            $SQL2="Update ventilation set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update bloodgases set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);
            $SQL2="Update observations set $column= '$newValue' where
userId=$userId;";$result = mysql_query($SQL2);


```

```
}

}
$result = mysql_query($SQL);
//var_dump($SQL);
//var_dump($result);
if (mysql_errno()) {
      //var_dump(mysql_errno());

}
?>
{
    "replyCode":201, "replyText":"Data Follows",
    "data": "<?php echo $_POST['newValue']?>",
    "SQL": "<?php echo $SQL?>",
    "column": "<?php echo $column?>",
    "table": "<?php echo $table?>"
}
```

EDITOR.JS

```
// Short alias
   var lang = YAHOO.lang,
         util = YAHOO.util,
         widget = YAHOO.widget,
         Dom = util.Dom,
         Event = util.Event,

         fnRenderForm = function(container, el) {
         //console.log(container);
         //console.log(el);
               var oHd, oCurrNode, oApply, refNode = el;
               // fix for form render in webkit
               if(el.parentNode && el.parentNode.tagName.toUpperCase() ==
'FORM') {
                     refNode = el.parentNode;
               }

               oHd = document.createElement('DIV');
               container.insertBefore(oHd, refNode);
               oHd.id = container.id + '_admin_editor_head';
               Dom.addClass(oHd, 'admin-editor-hd');

               columnid=container.id.charAt(18)+container.id.charAt(19);

               oCurrNode = document.createElement('DIV');
               container.insertBefore(oCurrNode, refNode);

               Dom.addClass(oCurrNode, 'admin-editor-pd');

               oApply = document.createElement('DIV');
               container.appendChild(oApply);
               oApply.innerHTML = Dom.get('node-apply-wrap').innerHTML;
               Dom.addClass(oApply, 'admin-editor-fieldset');

               //get the id of the button element.
               function show(e) {
                        //alert(this.value);
                        var oInput = YAHOO.util.Dom.get("admin-editor-id-
"+columnid);
                        //console.log(oInput);
                        oInput.value=oInput.value+this.value;
```

```
                }


                   function backspace() {
                   var oInput = YAHOO.util.Dom.get("admin-editor-id-
"+columnid);
                      //ignore if zero already.//

                      if(oInput.value=="") {
                            return false;
                      }
                      //length of the text field//
                      var numlength = oInput.value;
                      //subtract one.//
                      var newresult = numlength.length-1;
                      //set to new value -1;//
                      oInput.value = numlength.substring(0,newresult);

                   }
                   function clearAll() {
                         var oInput = YAHOO.util.Dom.get("admin-editor-id-
"+columnid);
                         oInput.value="";
                   }



                var i=0;
                for (i=0;i<=14;i++)
                {
                      YAHOO.util.Event.addListener("button"+i, "click",
show);

                }

                YAHOO.util.Event.addListener("backspace", "click",
backspace);
                YAHOO.util.Event.addListener("clearAll", "click",
clearAll);

             },

          fnMove = function(container,el) {
                //console.log(container.id);
                columnid=container.id.charAt(18)+container.id.charAt(19);
                //console.log(columnid);
                el.style.width = '138px';
                el.id = 'admin-editor-id-'+columnid;
                Dom.addClass(el, 'admin-editor-pd');
                //YAHOO.util.dom.generateId(el,'asdf');

          };

    // Sample namespace of GenMC Demeter project
    var Gcc = {
          admin: {}
    };

    // Extend TextboxCellEditor
    Gcc.admin.CalcCellEditor = function(config) {
          //console.log(this);
```

```
104           Gcc.admin.CalcCellEditor.superclass.constructor.call(this,
105   config);
106      };
107      lang.extend(Gcc.admin.CalcCellEditor, widget.TextboxCellEditor, {
108            renderForm : function() {
109                     //console.log(this);
110                  Gcc.admin.CalcCellEditor.superclass.renderForm.call(this);
111                  fnRenderForm(this.getContainerEl(), this.textbox);
112            },
113
114            move : function() {
115                  Gcc.admin.CalcCellEditor.superclass.move.call(this);
116                  fnMove(this.getContainerEl(),this.textbox);
117            }
118      });
119
120
121
```

CHARTDATA.PHP

```
1   <?php
2   /*
3   Get data from database to pass to chart object
4   * */
5   $tqx=$_GET['tqx'];
6   $values=explode(':',$tqx);
7   include_once 'config.php';
8   $userId=$_GET['userId'];
9   mysql_connect($dbHost, $dbUser, $dbPassword);
10  mysql_select_db($dbSchema);
11  $SQL1="select  * from observations where userId =$userId";
12  $result1 = mysql_query($SQL1);
13  $row=mysql_fetch_assoc($result1);
14
15  $SQL2="select  * from interventions where userId =$userId";
16  $result2 = mysql_query($SQL2);
17  $row2=mysql_fetch_assoc($result2);
18
19  $SQL3="select  * from infusions where userId =$userId";
20  $result3 = mysql_query($SQL3);
21  $row3=mysql_fetch_assoc($result3);
22
23  //var_dump($row);
24  $year=date("Y");
25  $month=date("m");
26  $month=$month-1;
27  $date=date("d");
28  $hours=date("H");
29  $minutes=date("i");
30  $datestamp=$year.",".$month.","."$date";
31  ?>
32  google.visualization.Query.setResponse(
33   {
34          "version":"0.6",
35          "reqId":"<?PHP echo $values[1];?>",
36          "status":"ok",
37          "requestID":"0",
38          "table":{
39                  "cols":[{label: 'Date', type: 'datetime'},
40
41                                          {label: 'Temp', type: 'number'},
```

```
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                        {label: 'Heart Rate', type:
'number'},
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                         {label: 'BP Dia', type: 'number'},
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                        {label: 'BP Sys', type: 'number'},
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                        {label: 'Resp', type: 'number'},
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                        {label: 'M. Art. BP', type:
'number'},
                                        {label: 'title1', type: 'string'},
                                        {label: 'text1', type: 'string'},
                                        {label: 'Inf', type: 'number'},
                                        {label: 'title2', type: 'string'},
                                        {label: 'text2', type: 'string'},
                                          {label: 'Interv.', type:
'number'},
                                        {label: 'title2', type: 'string'},
                                        {label: 'text2', type: 'string'}

                                        ],
                "rows":[

            <?php
                        for ( $counter = 1; $counter <12; $counter += 1)
{ ?>
            <?php


           if(trim($row['Temp'.$counter])!=""){
            $timearray=explode(':',$row['Time'.$counter]);
                  echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)},
{v:".$row['Temp'.$counter]."}, , , ,,,,,,  ]},";
                }


           if(trim($row['HeartRate'.$counter])!=""){
            $timearray=explode(':',$row['Time'.$counter]);
                  echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)}, ,,,
{v:".$row['HeartRate'.$counter]."}, , , ,,,,,,  ]},";
                }

                  if(trim($row['BloodPressure'.$counter])!=""){
                  $bparray=explode('/',$row['BloodPressure'.$counter]);
            $timearray=explode(':',$row['Time'.$counter]);
                  echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)}, ,,,
,,,{v:".$bparray[0]."}, , , ,,,,,,  ]},";
                }
                        if(trim($row['BloodPressure'.$counter])!=""){
                  $bparray=explode('/',$row['BloodPressure'.$counter]);
            $timearray=explode(':',$row['Time'.$counter]);
```

```
                    echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)},,,, ,,,
,,,{v:".$bparray[1]."}, , , ,,,,,,  ]},";
                    }

                 if(trim($row['RespiratoryRate'.$counter])!=""){
                $timearray=explode(':',$row['Time'.$counter]);
                    echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)},,,,,,,
,,,,,,{v:".$row['RespiratoryRate'.$counter]."}, , , ,,,  ]},";
                    }

                if(trim($row['MeanArterialBP'.$counter])!=""){
                $timearray=explode(':',$row['Time'.$counter]);
                    echo "{c:[{v: new Date
      ($datestamp,$timearray[0],$timearray[1],0)},,,,,,,,,,,,
,,,{v:".$row['MeanArterialBP'.$counter]."}, , ,   ]},";
                    }



                ?>

                <?php } ?>

                <?php

                for ( $counter = 1; $counter <9; $counter += 1) { ?>
                <?php
                $Infusioncounter=1;
                if(trim($row3['Time'.$counter])!=""){
                       $timearray=explode(':',$row3['Time'.$counter]);
                       $counterarray=
array('a','b','c','d','e','f','g','h','i');
                                  foreach ( $counterarray as $value) {

      if(trim($row3['dose'.$counter.$value]!="")){
                                       echo "{c:[{v: new
Date($datestamp,$timearray[0],$timearray[1],00)},,,,,,,,,,,,,,,,,,{v:$In
fusioncounter} , {v: '".$row3['Infusion'.strtoupper($value)]."'},{v: '
".$row3['dose'.$counter.$value].$row3['Units'.strtoupper($value)]." at
".$row3['Time'.$counter]."'}]},";
                                  $Infusioncounter++;
                                  }
                            }
                }
                ?>
                <?php }?>




            <?php

            echo "{c:[{v: new
Date($datestamp,$hours,$minutes,00)},,,,,,,,,,,,,,,,,,,,{v:1} ,  ,
]},";

            ?>

              <?php if((trim($row2['primaryIntubationCATS'])=="Yes")&&
trim($row2['primaryIntubationCATSTime'])!=""){
```

```
166
167         $timearray=explode(':',$row2['primaryIntubationCATSTime']);
168                     echo "{c:[{v: new
169   Date($datestamp,$timearray[0],$timearray[1],00)},,,,,,,,,,,,,,,,,,,,,,{v:
170   1} , {v: 'Airway'},{v: 'Primary Intubation at
171   ".$row2['primaryIntubationCATSTime']."'}]},";
172               }?>
173
174               <?php if((trim($row2['rentubationCATS'])=="Yes")&&
175   trim($row2['rentubationCATSTime'])!=""){
176                     $timearray=explode(':',$row2['rentubationCATSTime']);
177                     echo "{c:[{v: new
178   Date($datestamp,$timearray[0],$timearray[1],00)},,,,,,,,,,,,,,,,,,,,,,{v:
179   1} , {v: 'Airway'},{v: 'Rentubation at
180   ".$row2['rentubationCATSTime']."'}]},";
181               }?>
182
183                <?php if((trim($row2['repositioningCATS'])=="Yes")&&
184   trim($row2['repositioningCATSTime'])!=""){
185                     $timearray=explode(':',$row2['repositioningCATSTime']);
186                     echo "{c:[{v: new
187   Date($datestamp,$timearray[0],$timearray[1],00)},,,,,,,,,,,,,,,,,,,,,,{v:
188   1} , {v: 'Airway'},{v: 'Repositioning at
189   ".$row2['repositioningCATSTime']."'}]},";
190               }?>
191
192                <?php if((trim($row2['tracyCATS'])=="Yes")&&
193   trim($row2['tracyCATSTime'])!=""){
194                     $timearray=explode(':',$row2['tracyCATSTime']);
195                     echo "{c:[{v: new
196   Date($datestamp,$timearray[0],$timearray[1],00)},,,,,,,,,,,,,,,,,,,,,,{v:
197   1} , {v: 'Airway'},{v: 'Trachy Change/LMA/Surgical Airway at
198   ".$row2['tracyCATSTime']."'}]},";
199               }?>
200               ]
201
202           }
203    }
204    )
205
206
```

DATA.PHP

```
1
2   <?php
3   /*
4   Get data from database to pass to datatable objects
5   * */
6   include_once 'config.php';
7   $userId=$_GET['userId'];
8   mysql_connect($dbHost, $dbUser, $dbPassword);
9   mysql_select_db($dbSchema);
10  $SQL="select  * from interventions where userId =$userId";
11
12  $result = mysql_query($SQL);
13  $row=mysql_fetch_assoc($result);
14  //var_dump($row);
15  ?>
16  YAHOO.example.Data = {
17
18
19        interventions: [
20                {category:"Airway", intervention:"Primary Intubation",
21  RH:"<?php echo $row['primaryIntubationRH'];?>", CATS:"<?php echo
```

```
$row['primaryIntubationCATS'];?>",CATSInterventionTime:"<?php echo
$row['primaryIntubationCATSTime'];?>", Comment:"<?php echo
$row['primaryIntubationComment'];?>"},
                {category:" ", intervention:"Rentubation", RH:"<?php echo
$row['rentubationRH'];?>", CATS:"<?php  echo
$row['rentubationCATS'];?>",CATSInterventionTime:"<?php echo
$row['rentubationCATSTime'];?>", Comment:"<?php echo
$row['rentubationComment'];?>"},
                {category:" ", intervention:"Repositioning", RH:"<?php echo
$row['repositioningRH'];?>", CATS:"<?php  echo
$row['repositioningCATS'];?>",CATSInterventionTime:"<?php echo
$row['repositioningCATSTime'];?>", Comment:"<?php echo
$row['repositioningComment'];?>"},
                {category:" ", intervention:"Trachy Change/LMA/Surgical
Airway", RH:"<?php echo $row['tracyRH'];?>", CATS:"<?php  echo
$row['tracyCATS'];?>",CATSInterventionTime:"<?php echo
$row['tracyCATSTime'];?>", Comment:"<?php echo $row['tracyComment'];?>"},
                {category:"Breathing", intervention:"Ventilator", RH:"<?php
echo $row['ventilatorRH'];?>", CATS:"<?php  echo
$row['ventilatorCATS'];?>",CATSInterventionTime:"<?php echo
$row['ventilatorCATSTime'];?>", Comment:"<?php echo
$row['ventilatorComment'];?>"},
                {category:" ", intervention:"Inhaled Nitric Oxide",
RH:"<?php echo $row['inhaledRH'];?>", CATS:"<?php  echo
$row['inhaledCATS'];?>",CATSInterventionTime:"<?php echo
$row['inhaledCATSTime'];?>", Comment:"<?php echo
$row['inhaledComment'];?>"},
                {category:" ", intervention:"Chest Drain", RH:"<?php echo
$row['chestDrainRH'];?>", CATS:"<?php  echo
$row['chestDrainCATS'];?>",CATSInterventionTime:"<?php echo
$row['chestDrainCATSTime'];?>", Comment:"<?php echo
$row['chestDrainComment'];?>"},
                {category:" ", intervention:"Physiotherapy", RH:"<?php echo
$row['physiotherapyRH'];?>", CATS:"<?php  echo
$row['physiotherapyCATS'];?>", CATSInterventionTime:"<?php echo
$row['physiotherapyCATSTime'];?>",Comment:"<?php echo
$row['physiotherapyComment'];?>"},
                {category:"CVS", intervention:"Inotropes", RH:"<?php echo
$row['intropesRH'];?>", CATS:"<?php  echo
$row['intropesCATS'];?>",CATSInterventionTime:"<?php echo
$row['intropesCATSTime'];?>", Comment:"<?php echo
$row['intropesComment'];?>"},
                {category:" ", intervention:"Central Venous Access",
RH:"<?php echo $row['centralRH'];?>", CATS:"<?php  echo
$row['centralCATS'];?>",CATSInterventionTime:"<?php echo
$row['centralCATSTime'];?>", Comment:"<?php echo
$row['centralComment'];?>"},
                {category:" ", intervention:"Arterial Line", RH:"<?php echo
$row['arterialRH'];?>", CATS:"<?php  echo $row['arterialCATS'];?>",
CATSInterventionTime:"<?php echo
$row['arterialCATSTime'];?>",Comment:"<?php echo
$row['arterialComment'];?>"},
                {category:" ", intervention:"Intra-Osseous Needle",
RH:"<?php echo $row['intraRH'];?>", CATS:"<?php  echo
$row['intraCATS'];?>", CATSInterventionTime:"<?php echo
$row['intraCATSTime'];?>",Comment:"<?php echo $row['intraComment'];?>"},
                {category:" ", intervention:"Peripheral Access", RH:"<?php
echo $row['peripheralRH'];?>", CATS:"<?php  echo
$row['peripheralCATS'];?>", CATSInterventionTime:"<?php echo
$row['peripheralCATSTime'];?>",Comment:"<?php echo
$row['peripheralComment'];?>"},
                {category:" ", intervention:"CPR/Defibrillation (SELECT)",
RH:"<?php echo $row['CPRRH'];?>", CATS:"<?php  echo $row['CPRCATS'];?>",
```

```
CATSInterventionTime:"<?php echo $row['CPRCATSTime'];?>",Comment:"<?php
echo $row['CPRComment'];?>"},
                {category:"Neuro", intervention:"CT Scan", RH:"<?php echo
$row['CTRH'];?>", CATS:"<?php  echo $row['CTCATS'];?>",
CATSInterventionTime:"<?php echo $row['CTCATSTime'];?>",Comment:"<?php
echo $row['CTComment'];?>"},
                {category:" ", intervention:"3% Saline/Mannitol", RH:"<?php
echo $row['salineRH'];?>", CATS:"<?php  echo
$row['salineCATS'];?>",CATSInterventionTime:"<?php echo
$row['salineCATSTime'];?>", Comment:"<?php echo
$row['salineComment'];?>"},
                {category:"Misc", intervention:"Urinary Catheter",
RH:"<?php echo $row['urinaryRH'];?>", CATS:"<?php  echo
$row['urinaryCATS'];?>",CATSInterventionTime:"<?php echo
$row['urinaryCATSTime'];?>", Comment:"<?php echo
$row['urinaryComment'];?>"},
                {category:" ", intervention:"NGT/OGT", RH:"<?php echo
$row['NGTRH'];?>", CATS:"<?php  echo $row['NGTCATS'];?>",
CATSInterventionTime:"<?php echo $row['NGTCATSTime'];?>",Comment:"<?php
echo $row['NGTComment'];?>"},
      ],

<?php
$SQL="select  * from infusions where userId =$userId";
$result = mysql_query($SQL);
$row=mysql_fetch_assoc($result);
//var_dump($row);
?>

 infusions: [
                {infusion:"", units:"Time", dose1:"<?php echo
$row['Time1'];?>", dose1:"<?php echo $row['Time1'];?>",dose2:"<?php echo
$row['Time2'];?>",dose3:"<?php echo $row['Time3'];?>",dose4:"<?php echo
$row['Time4'];?>",dose5:"<?php echo $row['Time5'];?>",dose6:"<?php echo
$row['Time6'];?>",dose7:"<?php echo $row['Time7'];?>",dose8:"<?php echo
$row['Time8'];?>",dose9:"<?php echo $row['Time9'];?>",key:"1"},
                {infusion:"<?php echo $row['InfusionA'];?>", units:"<?php
echo $row['UnitsA'];?>", dose1:"<?php echo
$row['dose1a'];?>",dose2:"<?php echo $row['dose2a'];?>",dose3:"<?php echo
$row['dose3a'];?>",dose4:"<?php echo $row['dose4a'];?>",dose5:"<?php echo
$row['dose5a'];?>",dose6:"<?php echo $row['dose6a'];?>",dose7:"<?php echo
$row['dose7a'];?>",dose8:"<?php echo $row['dose8a'];?>",dose9:"<?php echo
$row['dose9a'];?>",key:"A"},
                    {infusion:"<?php echo $row['InfusionB'];?>",
units:"<?php echo $row['UnitsB'];?>", dose1:"<?php echo
$row['dose1b'];?>",dose2:"<?php echo $row['dose2b'];?>",dose3:"<?php echo
$row['dose3b'];?>",dose4:"<?php echo $row['dose4b'];?>",dose5:"<?php echo
$row['dose5b'];?>",dose6:"<?php echo $row['dose6b'];?>",dose7:"<?php echo
$row['dose7b'];?>",dose8:"<?php echo $row['dose8b'];?>",dose9:"<?php echo
$row['dose9b'];?>",key:"B"},
                    {infusion:"<?php echo $row['InfusionC'];?>",
units:"<?php echo $row['UnitsC'];?>", dose1:"<?php echo
$row['dose1c'];?>",dose2:"<?php echo $row['dose2c'];?>",dose3:"<?php echo
$row['dose3c'];?>",dose4:"<?php echo $row['dose4c'];?>",dose5:"<?php echo
$row['dose5c'];?>",dose6:"<?php echo $row['dose6c'];?>",dose7:"<?php echo
$row['dose7c'];?>",dose8:"<?php echo $row['dose8c'];?>",dose9:"<?php echo
$row['dose9c'];?>",key:"C"},
                    {infusion:"<?php echo $row['InfusionD'];?>",
units:"<?php echo $row['UnitsD'];?>", dose1:"<?php echo
$row['dose1d'];?>",dose2:"<?php echo $row['dose2d'];?>",dose3:"<?php echo
$row['dose3d'];?>",dose4:"<?php echo $row['dose4d'];?>",dose5:"<?php echo
$row['dose5d'];?>",dose6:"<?php echo $row['dose6d'];?>",dose7:"<?php echo
```

```
$row['dose7d'];?>",dose8:"<?php echo $row['dose8d'];?>",dose9:"<?php echo
$row['dose9d'];?>",key:"D"},
                    {infusion:"<?php echo $row['InfusionE'];?>",
units:"<?php echo $row['UnitsE'];?>", dose1:"<?php echo
$row['dose1e'];?>",dose2:"<?php echo $row['dose2e'];?>",dose3:"<?php echo
$row['dose3e'];?>",dose4:"<?php echo $row['dose4e'];?>",dose5:"<?php echo
$row['dose5e'];?>",dose6:"<?php echo $row['dose6e'];?>",dose7:"<?php echo
$row['dose7e'];?>",dose8:"<?php echo $row['dose8e'];?>",dose9:"<?php echo
$row['dose9e'];?>",key:"E"},
                    {infusion:"<?php echo $row['InfusionF'];?>",
units:"<?php echo $row['UnitsF'];?>", dose1:"<?php echo
$row['dose1f'];?>",dose2:"<?php echo $row['dose2f'];?>",dose3:"<?php echo
$row['dose3g'];?>",dose4:"<?php echo $row['dose4f'];?>",dose5:"<?php echo
$row['dose5f'];?>",dose6:"<?php echo $row['dose6f'];?>",dose7:"<?php echo
$row['dose7f'];?>",dose8:"<?php echo $row['dose8f'];?>",dose9:"<?php echo
$row['dose9f'];?>",key:"F"},
                    {infusion:"<?php echo $row['InfusionG'];?>",
units:"<?php echo $row['UnitsG'];?>", dose1:"<?php echo
$row['dose1g'];?>",dose2:"<?php echo $row['dose2g'];?>",dose3:"<?php echo
$row['dose3g'];?>",dose4:"<?php echo $row['dose4g'];?>",dose5:"<?php echo
$row['dose5g'];?>",dose6:"<?php echo $row['dose6g'];?>",dose7:"<?php echo
$row['dose7g'];?>",dose8:"<?php echo $row['dose8g'];?>",dose9:"<?php echo
$row['dose9g'];?>",key:"G"},
                    {infusion:"<?php echo $row['InfusionH'];?>",
units:"<?php echo $row['UnitsH'];?>", dose1:"<?php echo
$row['dose1h'];?>",dose2:"<?php echo $row['dose2h'];?>",dose3:"<?php echo
$row['dose3h'];?>",dose4:"<?php echo $row['dose4h'];?>",dose5:"<?php echo
$row['dose5h'];?>",dose6:"<?php echo $row['dose6h'];?>",dose7:"<?php echo
$row['dose7h'];?>",dose8:"<?php echo $row['dose8h'];?>",dose9:"<?php echo
$row['dose9h'];?>",key:"H"},
                    {infusion:"<?php echo $row['InfusionI'];?>",
units:"<?php echo $row['UnitsI'];?>", dose1:"<?php echo
$row['dose1i'];?>",dose2:"<?php echo $row['dose2i'];?>",dose3:"<?php echo
$row['dose3i'];?>",dose4:"<?php echo $row['dose4i'];?>",dose5:"<?php echo
$row['dose5i'];?>",dose6:"<?php echo $row['dose6i'];?>",dose7:"<?php echo
$row['dose7i'];?>",dose8:"<?php echo $row['dose8i'];?>",dose9:"<?php echo
$row['dose9i'];?>",key:"I"},
 ],


<?php
$SQL="select  * from observations where userId =$userId";
$result = mysql_query($SQL);
$row=mysql_fetch_assoc($result);
//var_dump($row);
?>

    observations: [
      {columnname:"", columndisplayname:"Time", val1:"<?php echo
$row['Time1'];?>", val2:"<?php echo $row['Time2'];?>",val3:"<?php echo
$row['Time3'];?>",val4:"<?php echo $row['Time4'];?>",val5:"<?php echo
$row['Time5'];?>",val6:"<?php echo $row['Time6'];?>",val7:"<?php echo
$row['Time7'];?>",val8:"<?php echo $row['Time8'];?>",val9:"<?php echo
$row['Time9'];?>",val10:"<?php echo $row['Time10'];?>",val11:"<?php echo
$row['Time11'];?>",val12:"<?php echo $row['Time12'];?>",key:"1"},
          {columnname:"Temp", columndisplayname:"Temperature",
val1:"<?php echo $row['Temp1'];?>", val2:"<?php echo
$row['Temp2'];?>",val3:"<?php echo $row['Temp3'];?>",val4:"<?php echo
$row['Temp4'];?>",val5:"<?php echo $row['Temp5'];?>",val6:"<?php echo
$row['Temp6'];?>",val7:"<?php echo $row['Temp7'];?>",val8:"<?php echo
$row['Temp8'];?>",val9:"<?php echo $row['Temp9'];?>",val10:"<?php echo
$row['Temp10'];?>",val11:"<?php echo $row['Temp11'];?>",val12:"<?php echo
$row['Temp12'];?>",key:"2"},
```

```
            <?php /* ?>
            {columnname:"TempSite", columndisplayname:"Temp. Site",
val1:"<?php echo $row['TempSite1'];?>", val2:"<?php echo
$row['TempSite2'];?>",val3:"<?php echo $row['TempSite3'];?>",val4:"<?php
echo $row['TempSite4'];?>",val5:"<?php echo
$row['TempSite5'];?>",val6:"<?php echo $row['TempSite6'];?>",val7:"<?php
echo $row['TempSite7'];?>",val8:"<?php echo
$row['TempSite8'];?>",val9:"<?php echo $row['TempSite9'];?>",val10:"<?php
echo $row['TempSite10'];?>",val11:"<?php echo
$row['TempSite11'];?>",val12:"<?php echo $row['TempSite12'];?>",key:"3"},
              <?php */?>
            {columnname:"HeartRate", columndisplayname:"Heart Rate",
val1:"<?php echo $row['HeartRate1'];?>", val2:"<?php echo
$row['HeartRate2'];?>",val3:"<?php echo
$row['HeartRate3'];?>",val4:"<?php echo
$row['HeartRate4'];?>",val5:"<?php echo
$row['HeartRate5'];?>",val6:"<?php echo
$row['HeartRate6'];?>",val7:"<?php echo
$row['HeartRate7'];?>",val8:"<?php echo
$row['HeartRate8'];?>",val9:"<?php echo
$row['HeartRate9'];?>",val10:"<?php echo
$row['HeartRate10'];?>",val11:"<?php echo
$row['HeartRate11'];?>",val12:"<?php echo
$row['HeartRate12'];?>",key:"4"},
            {columnname:"BloodPressure", columndisplayname:"B.P.
(dia/sys)", val1:"<?php echo $row['BloodPressure1'];?>", val2:"<?php echo
$row['BloodPressure2'];?>",val3:"<?php echo
$row['BloodPressure3'];?>",val4:"<?php echo
$row['BloodPressure4'];?>",val5:"<?php echo
$row['BloodPressure5'];?>",val6:"<?php echo
$row['BloodPressure6'];?>",val7:"<?php echo
$row['BloodPressure7'];?>",val8:"<?php echo
$row['BloodPressure8'];?>",val9:"<?php echo
$row['BloodPressure9'];?>",val10:"<?php echo
$row['BloodPressure10'];?>",val11:"<?php echo
$row['BloodPressure11'];?>",val12:"<?php echo
$row['BloodPressure12'];?>",key:"5"},
            {columnname:"RespiratoryRate", columndisplayname:"Resp. Rate",
val1:"<?php echo $row['RespiratoryRate1'];?>", val2:"<?php echo
$row['RespiratoryRate2'];?>",val3:"<?php echo
$row['RespiratoryRate3'];?>",val4:"<?php echo
$row['RespiratoryRate4'];?>",val5:"<?php echo
$row['RespiratoryRate5'];?>",val6:"<?php echo
$row['RespiratoryRate6'];?>",val7:"<?php echo
$row['RespiratoryRate7'];?>",val8:"<?php echo
$row['RespiratoryRate8'];?>",val9:"<?php echo
$row['RespiratoryRate9'];?>",val10:"<?php echo
$row['RespiratoryRate10'];?>",val11:"<?php echo
$row['RespiratoryRate11'];?>",val12:"<?php echo
$row['RespiratoryRate12'];?>",key:"6"},
            {columnname:"MeanArterialBP", columndisplayname:"Mean Arterial
BP", val1:"<?php echo $row['MeanArterialBP1'];?>", val2:"<?php echo
$row['MeanArterialBP2'];?>",val3:"<?php echo
$row['MeanArterialBP3'];?>",val4:"<?php echo
$row['MeanArterialBP4'];?>",val5:"<?php echo
$row['MeanArterialBP5'];?>",val6:"<?php echo
$row['MeanArterialBP6'];?>",val7:"<?php echo
$row['MeanArterialBP7'];?>",val8:"<?php echo
$row['MeanArterialBP8'];?>",val9:"<?php echo
$row['MeanArterialBP9'];?>",val10:"<?php echo
$row['MeanArterialBP10'];?>",val11:"<?php echo
$row['MeanArterialBP11'];?>",val12:"<?php echo
$row['MeanArterialBP12'];?>",key:"7"},
```

```
            {columnname:"CapRefillTime", columndisplayname:"Cap Refill
Time", val1:"<?php echo $row['CapRefillTime1'];?>", val2:"<?php echo
$row['CapRefillTime2'];?>",val3:"<?php echo
$row['CapRefillTime3'];?>",val4:"<?php echo
$row['CapRefillTime4'];?>",val5:"<?php echo
$row['CapRefillTime5'];?>",val6:"<?php echo
$row['CapRefillTime6'];?>",val7:"<?php echo
$row['CapRefillTime7'];?>",val8:"<?php echo
$row['CapRefillTime8'];?>",val9:"<?php echo
$row['CapRefillTime9'];?>",val10:"<?php echo
$row['CapRefillTime10'];?>",val11:"<?php echo
$row['CapRefillTime11'];?>",val12:"<?php echo
$row['CapRefillTime12'];?>",key:"8"},

        ],

<?php
$SQL="select  * from ventilation where userId =$userId";
$result = mysql_query($SQL);
$row=mysql_fetch_assoc($result);
//var_dump($row);
?>

          ventilation: [
         {columnname:"", columndisplayname:"Time", val1:"<?php echo
$row['Time1'];?>", val2:"<?php echo $row['Time2'];?>",val3:"<?php echo
$row['Time3'];?>",val4:"<?php echo $row['Time4'];?>",val5:"<?php echo
$row['Time5'];?>",val6:"<?php echo $row['Time6'];?>",val7:"<?php echo
$row['Time7'];?>",val8:"<?php echo $row['Time8'];?>",val9:"<?php echo
$row['Time9'];?>",val10:"<?php echo $row['Time10'];?>",val11:"<?php echo
$row['Time11'];?>",val12:"<?php echo $row['Time12'];?>",key:"1"},
            {columnname:"noppm", columndisplayname:"NO ppm", val1:"<?php
echo $row['noppm1'];?>", val2:"<?php echo $row['noppm2'];?>",val3:"<?php
echo $row['noppm3'];?>",val4:"<?php echo $row['noppm4'];?>",val5:"<?php
echo $row['noppm5'];?>",val6:"<?php echo $row['noppm6'];?>",val7:"<?php
echo $row['noppm7'];?>",val8:"<?php echo $row['noppm8'];?>",val9:"<?php
echo $row['noppm9'];?>",val10:"<?php echo
$row['noppm10'];?>",val11:"<?php echo $row['noppm11'];?>",val12:"<?php
echo $row['noppm12'];?>",key:"2"},
            {columnname:"rate", columndisplayname:"Rate", val1:"<?php echo
$row['rate1'];?>", val2:"<?php echo $row['rate2'];?>",val3:"<?php echo
$row['rate3'];?>",val4:"<?php echo $row['rate4'];?>",val5:"<?php echo
$row['rate5'];?>",val6:"<?php echo $row['rate6'];?>",val7:"<?php echo
$row['rate7'];?>",val8:"<?php echo $row['rate8'];?>",val9:"<?php echo
$row['rate9'];?>",val10:"<?php echo $row['rate10'];?>",val11:"<?php echo
$row['rate11'];?>",val12:"<?php echo $row['rate12'];?>",key:"3"},
            {columnname:"fio2", columndisplayname:"FiO2", val1:"<?php echo
$row['fio21'];?>", val2:"<?php echo $row['fio22'];?>",val3:"<?php echo
$row['fio23'];?>",val4:"<?php echo $row['fio24'];?>",val5:"<?php echo
$row['fio25'];?>",val6:"<?php echo $row['fio26'];?>",val7:"<?php echo
$row['fio27'];?>",val8:"<?php echo $row['fio28'];?>",val9:"<?php echo
$row['fio29'];?>",val10:"<?php echo $row['fio210'];?>",val11:"<?php echo
$row['fio211'];?>",val12:"<?php echo $row['fio212'];?>",key:"4"},
            {columnname:"pip", columndisplayname:"PIP", val1:"<?php echo
$row['pip1'];?>", val2:"<?php echo $row['pip2'];?>",val3:"<?php echo
$row['pip3'];?>",val4:"<?php echo $row['pip4'];?>",val5:"<?php echo
$row['pip5'];?>",val6:"<?php echo $row['pip6'];?>",val7:"<?php echo
$row['pip7'];?>",val8:"<?php echo $row['pip8'];?>",val9:"<?php echo
$row['pip9'];?>",val10:"<?php echo $row['pip10'];?>",val11:"<?php echo
$row['pip11'];?>",val12:"<?php echo $row['pip12'];?>",key:"5"},
            {columnname:"peep", columndisplayname:"PEEP", val1:"<?php echo
$row['peep1'];?>", val2:"<?php echo $row['peep2'];?>",val3:"<?php echo
$row['peep3'];?>",val4:"<?php echo $row['peep4'];?>",val5:"<?php echo
```

```
$row['peep5'];?>",val6:"<?php echo $row['peep6'];?>",val7:"<?php echo
$row['peep7'];?>",val8:"<?php echo $row['peep8'];?>",val9:"<?php echo
$row['peep9'];?>",val10:"<?php echo $row['peep10'];?>",val11:"<?php echo
$row['peep11'];?>",val12:"<?php echo $row['peep12'];?>",key:"6"},
          {columnname:"itime", columndisplayname:"I Time", val1:"<?php
echo $row['itime1'];?>", val2:"<?php echo $row['itime2'];?>",val3:"<?php
echo $row['itime3'];?>",val4:"<?php echo $row['itime4'];?>",val5:"<?php
echo $row['itime5'];?>",val6:"<?php echo $row['itime6'];?>",val7:"<?php
echo $row['itime7'];?>",val8:"<?php echo $row['itime8'];?>",val9:"<?php
echo $row['itime9'];?>",val10:"<?php echo
$row['itime10'];?>",val11:"<?php echo $row['itime11'];?>",val12:"<?php
echo $row['itime12'];?>",key:"7"},
          {columnname:"mode", columndisplayname:"Mode", val1:"<?php echo
$row['mode1'];?>", val2:"<?php echo $row['mode2'];?>",val3:"<?php echo
$row['mode3'];?>",val4:"<?php echo $row['mode4'];?>",val5:"<?php echo
$row['mode5'];?>",val6:"<?php echo $row['mode6'];?>",val7:"<?php echo
$row['mode7'];?>",val8:"<?php echo $row['mode8'];?>",val9:"<?php echo
$row['mode9'];?>",val10:"<?php echo $row['mode10'];?>",val11:"<?php echo
$row['mode11'];?>",val12:"<?php echo $row['mode12'];?>",key:"8"},
          {columnname:"o2saturations", columndisplayname:"O2
Saturations", val1:"<?php echo $row['o2saturations1'];?>", val2:"<?php
echo $row['o2saturations2'];?>",val3:"<?php echo
$row['o2saturations3'];?>",val4:"<?php echo
$row['o2saturations4'];?>",val5:"<?php echo
$row['o2saturations5'];?>",val6:"<?php echo
$row['o2saturations6'];?>",val7:"<?php echo
$row['o2saturations7'];?>",val8:"<?php echo
$row['o2saturations8'];?>",val9:"<?php echo
$row['o2saturations9'];?>",val10:"<?php echo
$row['o2saturations10'];?>",val11:"<?php echo
$row['o2saturations11'];?>",val12:"<?php echo
$row['o2saturations12'];?>",key:"9"},
          {columnname:"etco2", columndisplayname:"ET CO2", val1:"<?php
echo $row['etco21'];?>", val2:"<?php echo $row['etco22'];?>",val3:"<?php
echo $row['etco23'];?>",val4:"<?php echo $row['etco24'];?>",val5:"<?php
echo $row['etco25'];?>",val6:"<?php echo $row['etco26'];?>",val7:"<?php
echo $row['etco27'];?>",val8:"<?php echo $row['etco28'];?>",val9:"<?php
echo $row['etco29'];?>",val10:"<?php echo
$row['etco210'];?>",val11:"<?php echo $row['etco211'];?>",val12:"<?php
echo $row['etco212'];?>",key:"10"},

    ],

<?php
$SQL="select  * from bloodgases where userId =$userId";
$result = mysql_query($SQL);
$row=mysql_fetch_assoc($result);
//var_dump($row);
?>

       bloodgases: [
      {columnname:"", columndisplayname:"Time", val1:"<?php echo
$row['Time1'];?>", val2:"<?php echo $row['Time2'];?>",val3:"<?php echo
$row['Time3'];?>",val4:"<?php echo $row['Time4'];?>",val5:"<?php echo
$row['Time5'];?>",val6:"<?php echo $row['Time6'];?>",val7:"<?php echo
$row['Time7'];?>",val8:"<?php echo $row['Time8'];?>",val9:"<?php echo
$row['Time9'];?>",val10:"<?php echo $row['Time10'];?>",val11:"<?php echo
$row['Time11'];?>",val12:"<?php echo $row['Time12'];?>",key:"1"},
          {columnname:"ph", columndisplayname:"PH", val1:"<?php echo
$row['ph1'];?>", val2:"<?php echo $row['ph2'];?>",val3:"<?php echo
$row['ph3'];?>",val4:"<?php echo $row['ph4'];?>",val5:"<?php echo
$row['ph5'];?>",val6:"<?php echo $row['ph6'];?>",val7:"<?php echo
$row['ph7'];?>",val8:"<?php echo $row['ph8'];?>",val9:"<?php echo
```

```
$row['ph9'];?>",val10:"<?php echo $row['ph10'];?>",val11:"<?php echo
$row['ph11'];?>",val12:"<?php echo $row['ph12'];?>",key:"2"},
          {columnname:"paco2", columndisplayname:"paCO2", val1:"<?php
echo $row['paco21'];?>", val2:"<?php echo $row['paco22'];?>",val3:"<?php
echo $row['paco23'];?>",val4:"<?php echo $row['paco24'];?>",val5:"<?php
echo $row['paco25'];?>",val6:"<?php echo $row['paco26'];?>",val7:"<?php
echo $row['paco27'];?>",val8:"<?php echo $row['paco28'];?>",val9:"<?php
echo $row['paco29'];?>",val10:"<?php echo
$row['paco210'];?>",val11:"<?php echo $row['paco211'];?>",val12:"<?php
echo $row['paco212'];?>",key:"3"},
          {columnname:"pao2", columndisplayname:"paO2", val1:"<?php echo
$row['pao21'];?>", val2:"<?php echo $row['pao22'];?>",val3:"<?php echo
$row['pao23'];?>",val4:"<?php echo $row['pao24'];?>",val5:"<?php echo
$row['pao25'];?>",val6:"<?php echo $row['pao26'];?>",val7:"<?php echo
$row['pao27'];?>",val8:"<?php echo $row['pao28'];?>",val9:"<?php echo
$row['pao29'];?>",val10:"<?php echo $row['pao210'];?>",val11:"<?php echo
$row['pao211'];?>",val12:"<?php echo $row['pao212'];?>",key:"4"},
          {columnname:"sbic", columndisplayname:"S.Bic", val1:"<?php echo
$row['sbic1'];?>", val2:"<?php echo $row['sbic2'];?>",val3:"<?php echo
$row['sbic3'];?>",val4:"<?php echo $row['sbic4'];?>",val5:"<?php echo
$row['sbic5'];?>",val6:"<?php echo $row['sbic6'];?>",val7:"<?php echo
$row['sbic7'];?>",val8:"<?php echo $row['sbic8'];?>",val9:"<?php echo
$row['sbic9'];?>",val10:"<?php echo $row['sbic10'];?>",val11:"<?php echo
$row['sbic11'];?>",val12:"<?php echo $row['sbic12'];?>",key:"5"},
          {columnname:"be", columndisplayname:"ME", val1:"<?php echo
$row['be1'];?>", val2:"<?php echo $row['be2'];?>",val3:"<?php echo
$row['be3'];?>",val4:"<?php echo $row['be4'];?>",val5:"<?php echo
$row['be5'];?>",val6:"<?php echo $row['be6'];?>",val7:"<?php echo
$row['be7'];?>",val8:"<?php echo $row['be8'];?>",val9:"<?php echo
$row['be9'];?>",val10:"<?php echo $row['be10'];?>",val11:"<?php echo
$row['be11'];?>",val12:"<?php echo $row['be12'];?>",key:"6"},
          {columnname:"lactate", columndisplayname:"Lactate", val1:"<?php
echo $row['lactate1'];?>", val2:"<?php echo
$row['lactate2'];?>",val3:"<?php echo $row['lactate3'];?>",val4:"<?php
echo $row['lactate4'];?>",val5:"<?php echo
$row['lactate5'];?>",val6:"<?php echo $row['lactate6'];?>",val7:"<?php
echo $row['lactate7'];?>",val8:"<?php echo
$row['lactate8'];?>",val9:"<?php echo $row['lactate9'];?>",val10:"<?php
echo $row['lactate10'];?>",val11:"<?php echo
$row['lactate11'];?>",val12:"<?php echo $row['lactate12'];?>",key:"7"},
          {columnname:"bloodsugar", columndisplayname:"Blood Sugar",
val1:"<?php echo $row['bloodsugar1'];?>", val2:"<?php echo
$row['bloodsugar2'];?>",val3:"<?php echo
$row['bloodsugar3'];?>",val4:"<?php echo
$row['bloodsugar4'];?>",val5:"<?php echo
$row['bloodsugar5'];?>",val6:"<?php echo
$row['bloodsugar6'];?>",val7:"<?php echo
$row['bloodsugar7'];?>",val8:"<?php echo
$row['bloodsugar8'];?>",val9:"<?php echo
$row['bloodsugar9'];?>",val10:"<?php echo
$row['bloodsugar10'];?>",val11:"<?php echo
$row['bloodsugar11'];?>",val12:"<?php echo
$row['bloodsugar12'];?>",key:"8"},
          {columnname:"na", columndisplayname:"Na+", val1:"<?php echo
$row['na1'];?>", val2:"<?php echo $row['na2'];?>",val3:"<?php echo
$row['na3'];?>",val4:"<?php echo $row['na4'];?>",val5:"<?php echo
$row['na5'];?>",val6:"<?php echo $row['na6'];?>",val7:"<?php echo
$row['na7'];?>",val8:"<?php echo $row['na8'];?>",val9:"<?php echo
$row['na9'];?>",val10:"<?php echo $row['na10'];?>",val11:"<?php echo
$row['na11'];?>",val12:"<?php echo $row['na12'];?>",key:"9"},
          {columnname:"k", columndisplayname:"K+", val1:"<?php echo
$row['k1'];?>", val2:"<?php echo $row['k2'];?>",val3:"<?php echo
$row['k3'];?>",val4:"<?php echo $row['k4'];?>",val5:"<?php echo
```

```
$row['k5'];?>",val6:"<?php echo $row['k6'];?>",val7:"<?php echo
$row['k7'];?>",val8:"<?php echo $row['k8'];?>",val9:"<?php echo
$row['k9'];?>",val10:"<?php echo $row['k10'];?>",val11:"<?php echo
$row['k11'];?>",val12:"<?php echo $row['k12'];?>",key:"10"},
          {columnname:"cai", columndisplayname:"Ca I", val1:"<?php echo
$row['cai1'];?>", val2:"<?php echo $row['cai2'];?>",val3:"<?php echo
$row['cai3'];?>",val4:"<?php echo $row['cai4'];?>",val5:"<?php echo
$row['cai5'];?>",val6:"<?php echo $row['cai6'];?>",val7:"<?php echo
$row['cai7'];?>",val8:"<?php echo $row['cai8'];?>",val9:"<?php echo
$row['cai9'];?>",val10:"<?php echo $row['cai10'];?>",val11:"<?php echo
$row['cai11'];?>",val12:"<?php echo $row['cai12'];?>",key:"11"},
          {columnname:"hb", columndisplayname:"Hb", val1:"<?php echo
$row['hb1'];?>", val2:"<?php echo $row['hb2'];?>",val3:"<?php echo
$row['hb3'];?>",val4:"<?php echo $row['hb4'];?>",val5:"<?php echo
$row['hb5'];?>",val6:"<?php echo $row['hb6'];?>",val7:"<?php echo
$row['hb7'];?>",val8:"<?php echo $row['hb8'];?>",val9:"<?php echo
$row['hb9'];?>",val10:"<?php echo $row['hb10'];?>",val11:"<?php echo
$row['hb11'];?>",val12:"<?php echo $row['hb12'];?>",key:"12"},

    ],

<?php
$SQL="select  * from neurological where userId =$userId";
$result = mysql_query($SQL);
$row=mysql_fetch_assoc($result);
//var_dump($row);
?>
      neurological: [
      {columnname:"", columndisplayname:"Time", val1:"<?php echo
$row['Time1'];?>", val2:"<?php echo $row['Time2'];?>",val3:"<?php echo
$row['Time3'];?>",val4:"<?php echo $row['Time4'];?>",val5:"<?php echo
$row['Time5'];?>",val6:"<?php echo $row['Time6'];?>",val7:"<?php echo
$row['Time7'];?>",val8:"<?php echo $row['Time8'];?>",val9:"<?php echo
$row['Time9'];?>",val10:"<?php echo $row['Time10'];?>",val11:"<?php echo
$row['Time11'];?>",val12:"<?php echo $row['Time12'];?>",key:"1"},
          {columnname:"gcsavpu", columndisplayname:"GCS/AVPU",
val1:"<?php echo $row['gcsavpu1'];?>", val2:"<?php echo
$row['gcsavpu2'];?>",val3:"<?php echo $row['gcsavpu3'];?>",val4:"<?php
echo $row['gcsavpu4'];?>",val5:"<?php echo
$row['gcsavpu5'];?>",val6:"<?php echo $row['gcsavpu6'];?>",val7:"<?php
echo $row['gcsavpu7'];?>",val8:"<?php echo
$row['gcsavpu8'];?>",val9:"<?php echo $row['gcsavpu9'];?>",val10:"<?php
echo $row['gcsavpu10'];?>",val11:"<?php echo
$row['gcsavpu11'];?>",val12:"<?php echo $row['gcsavpu12'];?>",key:"2"},
          {columnname:"rtpupil", columndisplayname:"RT Pupil",
val1:"<?php echo $row['rtpupil1'];?>", val2:"<?php echo
$row['rtpupil2'];?>",val3:"<?php echo $row['rtpupil3'];?>",val4:"<?php
echo $row['rtpupil4'];?>",val5:"<?php echo
$row['rtpupil5'];?>",val6:"<?php echo $row['rtpupil6'];?>",val7:"<?php
echo $row['rtpupil7'];?>",val8:"<?php echo
$row['rtpupil8'];?>",val9:"<?php echo $row['rtpupil9'];?>",val10:"<?php
echo $row['rtpupil10'];?>",val11:"<?php echo
$row['rtpupil11'];?>",val12:"<?php echo $row['rtpupil12'];?>",key:"3"},
          {columnname:"ltpupil", columndisplayname:"LT Pupil",
val1:"<?php echo $row['ltpupil1'];?>", val2:"<?php echo
$row['ltpupil2'];?>",val3:"<?php echo $row['ltpupil3'];?>",val4:"<?php
echo $row['ltpupil4'];?>",val5:"<?php echo
$row['ltpupil5'];?>",val6:"<?php echo $row['ltpupil6'];?>",val7:"<?php
echo $row['ltpupil7'];?>",val8:"<?php echo
$row['ltpupil8'];?>",val9:"<?php echo $row['ltpupil9'];?>",val10:"<?php
echo $row['ltpupil10'];?>",val11:"<?php echo
$row['ltpupil11'];?>",val12:"<?php echo $row['ltpupil12'];?>",key:"4"},
            ],
```

```
525
526     infusionDrugs: [
527         "",
528         "ADENOSINE",
529             "ADRENALINE",
530             "ALPROSTADIL",
531             "AMINOPHYLLINE",
532             "AMIODARONE",
533             "DINOPROSTONE",
534             "DOBUTAMINE",
535             "DOPAMINE",
536             "FENTANYL",
537             "GLYCERYL TRINITRATE",
538             "HEPARIN FLUSH",
539             "HYDRALAZINE",
540             "INSULIN (SOLUBLE)",
541             "ISOPRENALINE HYDROCHLORIDE",
542             "KETAMINE",
543             "MAINTENANCE FLUID",
544             "MIDAZOLAM",
545             "MILRINONE",
546             "MORPHINE",
547             "NITRIC OXIDE",
548             "NORADRENALINE",
549             "REMIFENTANIL",
550             "SALBUTAMOL",
551             "SODIUM NITROPRUSSIDE",
552             "THIOPENTAL",
553             "VASOPRESSIN (ARGIPRESSIN)",
554             "VECURONIUM"
555
556
557     ],
558
559     infusionUnits: [
560
561 "","mg/kg/hr","mg/kg/day","mcg/kg/hr","mcg/kg/min","nanogram/kg/min"
562     ],
563
564 };
565 <?PHP ?>
566
567
```

PATIENT.CSS

```
1  /*margin and padding on body element
2    can introduce errors in determining
3    element position and are not recommended;
4    we turn them off as a foundation for YUI
5    CSS treatments. */
6  body {
7        margin:0;
8        padding:0;
9  }
10 #doc3 {
11 margin:auto 00px;
12
13 }
14 .heading1{
15       font-size:160%;
16       width:300px;
17 }
18
```

```
.heading2{
	font-size:140%;
	width:300px;
	color:#333333;
	margin-bottom:5px;
}


#hd{
	background-color:#cdcdcd;
	border-bottom-style: solid ;
	border-bottom-color: black;
	border-bottom-width: 1px;
}


.myAccordion {
	float: right;
	margin-right: 15px;
	width:100%;
}

.myAccordion .yui-cms-accordion .yui-cms-item {

	width: 100%;
}

.myAccordion .yui-cms-accordion .yui-cms-item h3 {
	margin-bottom: 3px;
	margin-top:0px;

}

.accordionNav {
	float: left;
	width: 110px;
}

.myAccordion .yui-cms-accordion .yui-cms-item .accordionToggleItem {

	text-decoration: none;
	padding-left: 4px;
	display: block;
	background-color:#f05c5c;
}

.myAccordion .yui-cms-accordion .yui-cms-item.selected
.accordionToggleItem
	{

		background-color:#45b145;
}



h3{
 padding: 1px;
 color: #636363;
 background-color: #cdcdcd;
 background-position: top;
 background-repeat: repeat-x;
 font-weight: normal;
}
```

```
82
83  .yui-skin-sam .yui-dt table {
84        width: 100%;
85  }
86
87
88
89  .myAccordion .yui-cms-accordion .yui-cms-item .bd {
90        height: 0px;
91        overflow: hidden;
92        background-color: #fff;
93        float:left;
94  }
95
96  .myAccordion .yui-cms-accordion .yui-cms-item .bd .fixed {
97        overflow: hidden;
98        padding: 1px;
99        margin-top:0px;
100
101
102 }
103 .yui-t1 #yui-main .yui-b {
104     margin-left: 130px; /* plus any "gutter" */
105 }
106
107 .yui-t1 .yui-b {
108     width: 130px;
109 }
110 .fixed{
111       font-weight:bold;
112       }
113
114
115 /* custom styles for this example */
116 .yui-skin-sam .yui-dt-col-address pre { font-family:arial;font-size:100%;
117 } /* Use PRE in first col to preserve linebreaks*/
118
119 .calcButtonNumber{
120       background-color:#CCCCCC;
121       color:#0000CC;
122       width:35px;
123       height:27px;
124       font-size:12px;
125       font-weight:bold;
126 }
127 .widecalcButtonNumber{
128       background-color:#CCCCCC;
129       color:#0000CC;
130       width:70px;
131       height:27px;
132       font-size:12px;
133       font-weight:bold;
134
135 }
136 .calcButtonOperator{
137       background-color:#CCCCCC;
138       color:black;
139       width:70px;
140       height:27px;
141       font-size:12px;
142       font-weight:bold;
143
144 }
```

```
.calctable{
	border-style:inset;border-width:2px;background-color:#CCCCCC
}

#InterventionsNav.Nav A  {
	font-size:16px;
	color:white;
}
#InterventionsNav{
	background-color:#f05c5c;
	padding:10px;
	margin:2px;
}

#ChartNav.Nav A  {
	font-size:16px;
	color:white;
}
#ChartNav{
	background-color:#45B145;
	padding:10px;
	margin:2px;
}

#InfusionsNav.Nav A  {
	font-size:16px;
	color:white;
}
#InfusionsNav{
	background-color:#f05c5c;
	padding:10px;
	margin:2px;
}

#ObservationsNav.Nav A  {
	font-size:16px;
	color:white;
}
#ObservationsNav{
	background-color:#f05c5c;
	padding:10px;
	margin:2px;
}

#VentilationNav.Nav A  {
	font-size:16px;
	color:white;
}
#VentilationNav{
	background-color:#f05c5c;
	padding:10px;
	margin:2px;
}
#BloodgasesNav.Nav A  {
	font-size:16px;
	color:white;
}
#BloodgasesNav{
	background-color:#f05c5c;
	padding:10px;
	margin:2px;
}
#NeurologicalNav.Nav A  {
```

```
        font-size:16px;
        color:white;
}
#NeurologicalNav{
        background-color:#f05c5c;
        padding:10px;
        margin:2px;
}

#OpenAllNav.Nav A  {
        font-size:16px;
        color:white;
}
#OpenAllNav{
        background-color:#999999;
        padding:10px;
        margin:2px;
}

#CloseAllNav.Nav A  {
        font-size:16px;
        color:white;
}
#CloseAllNav{
        background-color:#999999;
        padding:10px;
        margin:2px;
}

#yui-rec19{
        height:24px;
}
#yui-rec20{
        height:24px;
}
#yui-rec21{
        height:24px;
}
#yui-rec22{
        height:24px;
}
#yui-rec23{
        height:24px;
}
#yui-rec24{
        height:24px;
}
#yui-rec25{
        height:24px;
}
#yui-rec26{
        height:24px;
}
#yui-rec27{
        height:24px;
}
#yui-rec36{
        background-color:#999999;
}
#yui-rec28{
        background-color:#999999;
}
#yui-rec18{
```

```
271         background-color:#999999;
272   }
273   #yui-rec46{
274         background-color:#999999;
275   }
276   #yui-rec58{
277         background-color:#999999;
278   }
279   #yuievtautoid-0{
280         width:100%;
281   }
282   #yuievtautoid-1{
283         width:100%;
284   }
285   #yuievtautoid-2{
286         width:100%;
287   }
288   #yuievtautoid-3{
289         width:100%;
290   }
291   #yuievtautoid-4{
292         width:100%;
293   }
294   #yuievtautoid-5{
295         width:100%;
296   }
297   #yuievtautoid-6{
298         width:100%;
299   }
300
301
302
```

MCA.CSS

```
1
2
3
4   tr.odd{
5         background-color:#cdcdcd;
6         border-bottom-style: solid ;
7         border-bottom-color: black;
8         border-bottom-width: 1px;
9   }
10
11  #patients{
12
13        border-left-style: solid ;
14        border-left-color: black;
15        border-left-width: 1px;
16        padding-left:20px;
17  }
18
19
20
21  table
22  {
23
24        width:95%;
25
26  }
27
28  thead
```

```
{
border-bottom:1px dotted #000000;
background-color:#5A7ACF;
color:white;
font-weight:bold;

}

thead th
{
	padding:1em 1em .5em;
	border-bottom:1px dotted #000000;
	font-size:100%;
	text-align:left;
}




td
{
	padding:.25em .25em;
}


#middle
{
	background-color:grey;
}

```

14 Appendix F – Screen Shots

See hard copy

15 Appendix G – Test Documentation

See hard copy

16 Appendix H – Test Transcripts

See hard copy

17 Appendix I – Correspondence

See Hard Copy

18 Appendix J – Database documentation

See Hard Copy

19 Appendix K – Installation Instructions

See CD

Appendix L – Test Results

Comparison of three data entry methods

Subjects	Character Recognition Keyboard									
	Task 1		Task 2		Task 3		Task 4			
	Time	No. Errors	Time	No. Errors	Time	No. Errors	Time	No. Errors	User Satisfaction	User Satisfaction %
Subject 1	170	9	87	4	202	11	200	17	13	18
Subject 2	222	8	164	7	112	4	201	9	19	26
Subject 3	147	15	188	18	80	8	188	13	25	35
Subject 4	232	12	147	14	198	14	130	11	31	43
Subject 5	187	10	202	18	214	13	118	4	14	19
Subject 6	192	19	188	22	208	8	99	4	33	46
Subject 7	240	5	145	7	117	4	78	6	25	35
Subject 8	219	12	255	25	95	17	145	19	14	19
Subject 9	198	16	178	11	113	15	113	5	13	18
Subject 10	167	22	147	17	102	14	96	9	64	89
Subject 11	180	26	129	5	96	2	70	0	42	58
Subject 12	200	20	220	25	210	17	119	7	22	31
Subject 13	199	17	197	21	199	16	189	11	21	29
Subject 14	155	21	173	17	156	18	201	8	12	17
Subject 15	185	19	205	6	111	9	166	5	8	11
Subject 16	250	25	191	18	216	11	113	6	21	29
Subject 17	238	22	99	29	208	16	102	12	6	8
Subject 18	222	11	132	24	145	14	99	18	31	43
Subject 19	200	7	211	11	199	7	114	5	14	19
Subject 20	201	8	202	12	198	10	121	4	23	32

Average	**200.2**	**15.2**	**173**	**15.55**	**158.95**	**11.4**	**133.1**	**8.65**	**22.55**	**31**
Average Time of all 4 tasks	166.3125									
Average Error Count of all 4 tasks	12.7									

QWERTY Keyboard									
Task 1		Task 2		Task 3		Task 4			
Time	No. Errors	Time	No. Errors	Time	No. Errors	Time	No. Errors	User Satisfaction	User Satisfaction %
72	0	62	0	64	0	58	0	32	44
89	0	61	0	70	0	52	0	49	68
75	0	73	1	89	0	55	0	47	65
68	2	88	2	56	0	70	1	35	49
55	1	75	0	61	0	55	1	41	57
45	1	66	0	55	0	45	0	42	58
72	2	59	1	65	0	59	1	31	43
60	0	50	0	59	0	65	0	55	76
75	1	85	1	45	1	64	0	61	85
60	0	90	2	60	0	55	0	61	85
74	1	78	1	59	0	61	0	58	81
90	6	80	0	77	0	60	0	39	54
65	1	65	0	78	0	55	0	64	89
78	1	55	0	45	1	62	0	58	81
85	2	85	2	69	0	68	0	39	54
60	0	49	1	72	2	58	2	45	62
65	1	66	0	62	2	68	0	32	44
55	2	50	0	58	1	66	0	45	62

65	1	89	1	59	1	64	1	50	69
64	0	88	1	61	0	66	1	51	71
68.6	**1.1**	**70.7**	**0.65**	**63.2**	**0.4**	**60.3**	**0.35**	**46.75**	65
65.7									
0.625									

Custom Javascript Keyboard									
Task 1		Task 2		Task 3		Task 4			
Time	No. Errors	Time	No. Errors	Time	No. Errors	Time	No. Errors	User Satisfaction	User Satisfaction %
57.5	1	55	1	37	0	31	0	72	100
60	2	56	0	80	1	40	0	72	100
61	2	55	1	58	0	41	0	66	92
68	1	55	0	45	0	50	0	64	89
55	0	68	1	38	1	35	0	71	99
49	1	45	0	35	0	30	1	61	85
56	2	61	1	32	0	28	0	68	94
49	2	55	0	41	0	35	0	72	100
55	1	59	1	40	0	42	1	71	99
50	1	43	1	46	1	52	2	71	99
48	1	44	0	41	0	36	0	71	99
96	0	75	1	88	1	68	0	58	81
61	0	55	0	44	0	50	0	71	99
48	1	45	1	45	0	44	0	75	104
63	1	61	0	38	1	35	0	68	94
55	0	51	1	45	0	42	0	62	86
57	2	55	0	50	0	52	1	61	85
48	1	49	1	44	0	44	0	62	86

66	0	50	1	50	1	48	0	65	90
58	1	60	2	59	0	41	0	70	97
58.025	**1**	**54.85**	**0.65**	**47.8**	**0.3**	**42.2**	**0.25**	**67.55**	94
50.71875									
0.55									

Keyboard Type	Time - Task 4 only		Error Count - Task 4 only	User Satisfaction
Character Recognition	133.1		8.65	31
QWERTY	60.3		0.35	47
Custom Javascript	42.2		0.25	94

Comparison of Pen and Paper

Task Times for each section of the form - Pen and Paper						
Test Subject	**Interventions**	**Infusions**	**Observations**	**Ventilation**	**Blood Gases**	**Neurological**
Subject 1	41	30	34	22	45	9
Subject 2	62	45	50	25	58	15
Subject 3	74	40	55	32	45	10
Subject 4	51	50	44	29	71	15
Subject 5	48	35	30	18	29	8
Subject 6	60	48	33	19	44	12
Subject 7	38	35	29	27	42	8
Subject 8	44	28	31	18	51	11
Averages	**52**	**39**	**38**	**24**	**48**	**11**

Combined Task Times for all sections of the form- Pen and Paper			
Total for All Sections	**Total excluding Interventions**	**Total excluding interventions and infusions**	**Observations only**
181	**140**	**110**	**34**
255	**193**	**148**	**50**
256	**182**	**142**	**55**
260	**209**	**159**	**44**
168	**120**	**85**	**30**
216	**156**	**108**	**33**
179	**141**	**106**	**29**
183	**139**	**111**	**31**
212	**160**	**121**	**38**

Task Times for each section of the form – Tablet PC						
Test Subject	**Interventions**	**Infusions**	**Observations**	**Ventilation**	**Blood Gases**	**Neurological**
Subject 1	223	72	58	45	66	35
Subject 2	240	65	66	60	62	25
Subject 3	180	80	45	42	67	30
Subject 4	225	52	37	34	45	34
Subject 5	190	67	29	29	39	28
Subject 6	220	78	42	35	50	31
Subject 7	197	65	30	30	47	25
Subject 8	210	77	45	20	39	37
Averages	**211**	**70**	**44**	**37**	**52**	**31**

Task times for each section of the form using pen and paper

Combined Task Times for all sections of the form- Tablet PC			
Total for All Sections	**Total excluding Interventions**	**Total excluding interventions and infusions**	**Observations only**
499	**276**	**204**	**58**
518	**278**	**213**	**66**
444	**264**	**184**	**45**
427	**202**	**150**	**37**
382	**192**	**125**	**29**
456	**236**	**158**	**42**
394	**197**	**132**	**30**
428	**218**	**141**	**45**
444	**233**	**163**	**44**

Task times for combined sections of the form – pen and paper

Task	Total for All Sections	Total excluding Interventions	Total excluding interventions and infusions	Observations only
Pen and Paper	212	160	121	38.25
Tablet PC	444	233	163	44

Comparison of task times using pen/paper and tablet PC