# Design, implementation and evaluation of a National NeoCare Transport prototype system

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## Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university.

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#### Summary

It is recognised that information technology is underutilised in healthcare. Although it is possible to perform a wide variety of tasks using computerised systems, numerous Irish hospitals continue to use paper-based records, and many clinicians have yet to experience the potential benefits that information technology can deliver (Department of Health and Children, 2004).

The aims of this project were to design and implement a user interface for the electronic capture of the nursing documentation used by the National Neonatal Transport Programme (NNTP), to evaluate if the NNTP nurse members viewed the prototype interfaces favourably and to consider a more efficient method of extracting the data from the nursing documentation to be both entered into the NNTP database, and used for clinical audit.

A user-centered design approach was followed to increase the likelihood of project success. The initial stage in the iterative design process was to interview both the NNTP nurses and the Transport Coordinator. The results of these interviews helped to generate a requirements list that was then incorporated into the prototype system design.

The interfaces were designed using Microsoft Visual Basic. Advice was sought from NNTP nurses during the design stage concerning content details. A Tablet PC was used to run the prototype program during the evaluative phase. Suggested design modifications were made to a number of forms and these would need to be evaluated during a second iteration of the user interface prototyping process. Any further progress in project development was outside the time scale for this project but details of the next stage in the design process were outlined in detail.

The NNTP nurses generally, viewed the NeoCare prototype system very favourably. Reservations were expressed about whether it would be more time consuming to complete the documentation than at present. It is hoped that in time this prototype system will be extended into practice. Only then will its potential benefit to the NNTP nurses be finally determined.

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# Abbreviations

ABG	Arterial Blood gas
BP	Blood pressure
CBG	Capillary Blood gas
CIS	Clinical Information System
CPAP	Continuous positive airway pressure
ETT	Endotracheal tube
Ex-utero	After birth
IBP	Invasive Blood pressure
ICU	Intensive Care Unit
In-utero	Before birth
IT	Information technology
MAP	Mean airway pressure
NEC	Necrotising enterocolitis
NIBP	Non-Invasive Blood pressure
NICU	Neonatal Intensive Care Unit
NNTP	National Neonatal Transport Programme
O2	Oxygen
PEEP	Positive End Expiratory Pressure
PIP	Peak Inspiratory Pressure
PO2	Partial Pressure of Oxygen
SAO2	Oxygen Saturation level
UAC	Umbilical Arterial Catheter
UVC	Umbilical Venous Catheter

### Chapter 1 – Introduction

Historically, the use of information technology in the healthcare arena has been underutilised. In the last number of decades significant investments have been made in many countries to implement a range of information systems (Song *et al.* 1997). In Ireland however, patient records remain largely paper-based. While the Department of Health and Children recognises the role that information technology could play in the collection and dissemination of health information, they also acknowledge that Irish health information systems as a whole remain fragmented, under-resourced and under-developed (Department of Health and Children, 2004).

The importance information technology plays at a clinical level varies from hospital to hospital, region to region, and from country to country. Although it is possible to perform a variety of tasks using computerised systems, many clinicians in Ireland have yet to experience the potential benefits that information technology can deliver (Department of Health and Children, 2004). Bedside computer systems, also known as point-of-care systems, release nurses from manual documentation activities. Research carried out in the last few years would appear to support the view that computerized documentation is quicker and more accurate, allowing more time for direct patient care (Simpson, 2001). It has been demonstrated that the introduction of a clinical information system can lead to a significant reduction in the amount of time spent on nursing documentation (Fraenkel *et al.* 2003).

This project attempted to harness the power of information technology for the benefit of a specialised group of nurses. The aims of the project were twofold:

- To design and implement a user interface prototype for an electronic version of specific nursing documentation used by the Irish National Neonatal Transport Programme (NNTP) that would capture, in a single data collection tool, the fragmented data currently being collected, and to then evaluate if it was viewed favourably by the users
- To consider how the use of the NeoCare prototype system could lend itself to a more efficient method of extracting data from the nursing documentation to be both entered into the NNTP database, and used for clinical audit.

The National Neonatal Transport Programme (NNTP), a nationwide service, is involved in providing neonatal intensive care services, both in the hospital setting and in transit between hospitals, to a vulnerable population. The NNTP team consists of an experienced neonatal nurse, a pediatric registrar and an ambulance person (Annual Report, 2003). A Transport Coordinator manages the day to day running of the service. Hospitals, for a variety of reasons, sometimes need to transfer a neonate to another hospital for specialised care. The NNTP travel from their base hospital to the referring hospital, stabilise the neonate as appropriate and transport them to the receiving hospital.

The NNTP service is available to any neonate under six weeks of age who requires the care of a Neonatal Intensive Care Unit (NICU). The term neonate refers to a newborn baby from birth to 28 days of life (Halliday *et al.* 1989) and, to avoid confusion, will be used here to describe any baby transported by the NNTP. Each of the three Dublin maternity hospitals does one week on-call for transport every three weeks. At the end of the relevant hospital's week on-call the transport Coordinator collects all data recorded during the on-call period.

Nursing documentation collected by the National Neonatal Transport Team (NNTP) during the course of a transfer is fragmented and consists of two separate data collection forms:

- 1. An initial record of demographic details, together with other relevant items such as; time call was logged, time transport was accepted, mobilisation time and transport completion time.
- 2. A complete record of all the physiological data, procedures performed, drugs given and any other relevant details pertaining to the baby from the time of arrival in the referring hospital to the time the baby is left in the receiving hospital.

Data relevant to clinical audit is then extracted from the above records manually by the Transport Coordinator and transferred into the NNTP database. A third form is also used, when appropriate, to record all babies who, for a variety of reasons, are not accepted for transport. These details are also entered into the database. However, at times this log is not completed as it is kept at the base hospital and does not accompany the NNTP when they are mobile, making it more difficult to remember to fill it in on return.

While the above list of data collection tools represents the necessary documentation that has to be completed by the nurse during a neonatal transport, the author has attempted to put forward a new electronic method of recording the required data and has suggested a more efficient way of entering the data into the NNTP database. This prototype system that has been built, is known as the NeoCare Transport system. Most studies, which have looked at the effects of computerized systems on the quality of nursing documentation, have described a positive relationship between automation and quality (Nahm and Poston, 2000).

Due to the nature of care delivered in the intensive care setting, the volume of paperwork generated during each patient's stay is considerable (Butler and Bender, 1999). This information is used to assess, treat and monitor patients and having the right information to hand at the appropriate time is vital in providing quality nursing care (Turner, 2002). NNTP nurses, delivering specialised nursing care outside the traditional hospital setting, face not only the problems associated with working in an information intensive environment but also the added strains of working in a very confined area where space is at a premium. It would be assumed that any system developed that has the potential to release them from detailed record keeping, difficult at the best of times in an unfamiliar hospital and in a moving vehicle, would be greeted with enthusiasm. However, healthcare projects have failed in the past when the needs and views of users, the tasks they need to perform and their ranges of technical abilities have been ignored (McManus, 2000). This project hopes to avoid these pitfalls by involving the users in the relevant phases of development and evaluation.

A literature review and analysis is presented in Chapter two. A number of topics relevant to the project are outlined. An introduction is given to the function and role of neonatal transport services together with the rationale behind the development of such specialised teams. The Irish situation is then examined, with specific reference to the development of the Irish National Neonatal Transport Programme (NNTP). According to many software vendors, the use of information technology has the potential to save time in documentation and retrieval of patient information, (Marasovic *et al.* 1997). Research relating to the benefits and problems associated with the electronic recording of patient data is analysed and critiqued. Research relating to user acceptance of computerised systems is highlighted. Special attention is given to research relating to the importance of user acceptance in any changes in work practices.

Many fundamental changes are taking place in the management of healthcare in Ireland. These are discussed with reference to their impact on the provision of the NNTP.

In chapter three the user centered design approach to this project is clearly explained. The methodology used to elicit user requirements is discussed in detail. The current paper system for nursing documentation is outlined, together with the design and implementation of the NeoCare prototype system.

Chapter four is concerned with evaluation of the NeoCare prototype system. The rationale behind the chosen method of evaluation is discussed. The findings from the evaluation are presented, together with implemented and suggested design modifications. The conclusions to the project, together with a reflection on the user interfacing design process and identified areas for future work are presented in Chapter five.

### Chapter 2 – Review and analysis of the literature

#### 2.1 Neonatal transport services

The constantly evolving treatments and technologies in the neonatal intensive care arena, have led to the survival of sicker newborn infants, together with smaller and more premature neonates (Stevens *et al.* 1999). However, in the initial stages, these babies require intensive medical and nursing care. Such care is only available in neonatal intensive care units (NICU's). Transferring babies within, and between, hospitals is an integral part of neonatal intensive care nursing. Neonatal intensive care facilities should be available to all critically ill neonates, together with a service trained to transfer them safely to these facilities (Boyd, 2000).

#### 2.1.1 Development of neonatal transport services

In an ideal world, all babies requiring treatment in NICU's would be transferred to such specialised centers in-utero. Research has shown that an antenatal transfer guarantees a better outcome for the neonate, with respect to severe neonatal morbidity, than a postnatal transfer (Hohlagschwandtner *et al.* 2001). Nevertheless, in many instances this situation does not occur as preterm delivery is often unexpected or illness in a full term baby is unanticipated, and therefore an ex-utero transfer becomes necessary.

Neonatal transport services have evolved over time. In some countries, such as the United Kingdom and Australia, these services were initially developed as local initiatives provided by larger neonatal units in the region, often without specific funding (Rashid *et al.* 1999, Field *et al.* 1997). However research has shown that transferring critically ill neonates without specially trained staff results in greater morbidity and mortality (Agostino *et al.* 1999).

In England, where the use of specialised neonatal transport teams is well established, an audit was undertaken in 1997 to assess the effectiveness of changes in transport practices from *ad hoc* transport teams to a dedicated neonatal transport team (Leslie and Stephenson, 1997). Data on neonates transported by both types of teams were collected over two 19-month periods. The data collected included demographic, logistical, equipment, and medical support details. The transport team contemporaneously also calculated a "transport score" using five

physiological variables. The same procedures and parameters were followed in both time periods. After the first audit in 1991-1993 a specialised transport team was formed and underwent formal training with associated continuing education. The audit findings demonstrated that overall mortality was significantly lower in the 1994-1995 group, compared to the 1991-1993 group. Time spent on pre-transport stabilisation had increased in the 1994-1995 group. Improved transport scores were also achieved in this time period. While the results of this audit certainly demonstrate the improvements a dedicated neonatal transport team can achieve there may have been other factors that also influenced the outcomes. The authors acknowledged that, while the mortality rates in the latter group were significantly lower than in the former group, ongoing developments in neonatal care in the intervening period could have contributed to this finding.

#### 2.1.2 The Irish situation

Historically, in Ireland, the transfer of neonates between hospitals was the responsibility of the referring hospital and was carried out on an *ad hoc* basis. However, the need for a specialised neonatal transport team was recognised by those involved in the provision of neonatal intensive care. In a study, carried out by Hussein *et al.* (2001) in the Republic of Ireland, consultant neonatologists and pediatricians caring for neonates identified the lack of a neonatal transport service as a major problem in Ireland and that priority should be given to rectifying the situation. This survey actually took place in November 1997. By the time the report was published in 2001 the Department of Health and Children had already decided to fund such a service.

#### 2.1.3 The National Neonatal Transport Programme

The National Neonatal Transport Programme (NNTP), a nationwide service, was established in March 2001 as a rapid response service for the stabilisation and transportation of premature and ill neonates. The eight Health Boards funded the service prior to their abolition. At present funding of the service has come under the umbrella of the Health Boards Executive (HeBE). The Health Service Executive and the National Hospitals' offices will be taking over this function in due course. The transport teams are drawn from the three Dublin maternity hospitals, together with the Eastern Regional Ambulance Service. The hospitals are on-call for NNTP transports on a rotational basis, for a week at a time, from 0900-1700hrs although a high number of transports are completed outside these scheduled hours. The transport team, consisting of an experienced neonatal nurse, a pediatric registrar and an ambulance person travels to the referring hospital, stabilises the neonate as appropriate and transports them to the receiving hospital (Annual Report, 2003).

The goals of this service are:

- 1. "To provide quality, standardised care for neonates up to the age of six weeks who require transport to regional neonatal/surgical intensive care units nationally.
- 2. To improve patient outcomes by providing transport teams skilled in the anticipation and delivery of emergency and intensive neonatal medicine."

(Annual Report, 2003:1).

The number of neonates transported annually has greatly exceeded expectations. It had initially been thought that the number requiring the expertise of the transport team would be approximately 150 annually. However, the number availing of the service has far surpassed this, with 233 transports carried out in 2003, an increase of 30% on the previous year. This figure decreased slightly in 2004. Given the demand for the service, the possibility of extending the hours of service availability is currently under review (Annual Report, 2003).

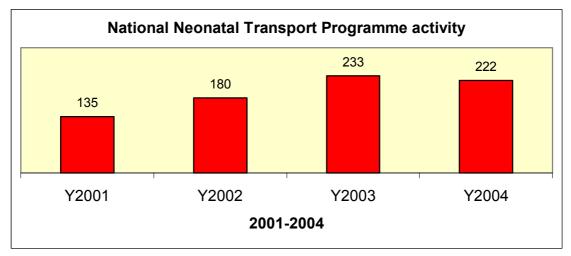


Figure 1 NNTP activity 2001-2003

A clinical audit was carried out by the NNTP in August 2003 to evaluate the effectiveness of the service provided. A retrospective chart audit was undertaken on all babies less than eight

days of age, transported to the three Dublin maternity hospitals since the start of the programme. These babies were divided into two groups, those transported by the NNTP and those transported by *ad-hoc* teams. The instances of hypothermia, hypoglycaemia, respiratory acidosis and respiratory disturbances were reduced in those babies transported by the neonatal transport team (Annual Report, 2003). While these results do support other research findings into the benefits of specialised transport teams (Leslie and Stephenson, 1997, Agostino *et al.* 1999), it would be beneficial to repeat this audit again after a reasonable length of time. This is because educational training concerning post resuscitation/pre-transport stabilisation procedures, run by the NNTP, is now available to personnel in peripheral units, and may have an influence on future study findings.

#### 2.1.4 The way forward

In neonatal intensive care, as in other areas of healthcare, record keeping is an essential part of clinical practice. It is vital that these documents accurately reflect the clinical details as this clinical information is used for a variety of purposes beyond the immediate patient-care documentation. Such purposes include quality review and improvement processes, risk management, productivity measurements, resource allocations, business planning and as a means to justify the services provided (Soe, 2005). The use of information technology can improve both the manner in which data is captured as well as improve the way in which that data is extracted for clinical audit (National Institute for Clinical Excellence, 2002). Patient care statistics are vital in assessing the quality of care given and in providing evidence-based clinical best nursing practice (Saba, 2001). Bakken (2001) argues that an informatics infrastructure is essential if evidence-based practice is to be implemented. Transport teams need to embrace these new technologies in order to continue to provide a high quality neonatal transport service (Cornette, 2004).

#### 2.2 Future healthcare direction

Fundamental changes are taking place in the way healthcare is delivered in Ireland in the 21<sup>st</sup> Century (O'Dwyer, 1998). The pressure is now on the need to justify the continued running of individual services. Clinical audit and benchmarking are two obvious way to do this. Clinical audit collects and analyses data obtained during patient care to produce measures that can be

used to evaluate care against a pre-set standard (Georgiou and Pearson, 2002). Internal benchmarking facilitates the observation of trends within the local population while external benchmarking is important for quality assurance (Soe, 2005). It is recognised that international benchmarking increasingly influences critical health service decisions by national governments, emphasising the need for better, more accessible and more comparable international health data (Department of Health and Children, 2004).

The Department of Health and Children itself identified the need to expand the development of clinical audit, through local and national data collection and sharing of outcomes information, if standards were to be safeguarded and improvements made in ensuring value for money (Deloitte and Touche, 2001). A report by Deloitte and Touche (2001), carried out on behalf of the Department of Health and Children, highlighted the need to develop consistent and comparable sets of performance indicators, and to standardise the collection, monitoring and evaluation of data. Clinicians in neonatal settings are confronted with the challenge of finding ways to meet these needs. The use of a database to capture this valuable information is an obvious choice. The choice of selecting the data elements to populate the database would be decided by identifying what data outputs needed to be calculated (Soe, 2005).

The NNTP maintains a database of all neonatal transfers. This database is used to produce clinical audit outcomes and to serve as a repository for data used for clinical benchmarking. At present, because all the transport documentation is paper-based, the data must be extracted manually from the records before being entered into the database. This is a time consuming process and is contrary to the idea that data should only be entered once, and as close to the point of patient contact as possible (Department of Health and Children, 2004). Given that the number of transports has greatly exceeded expectations, new and more efficient methods of collecting and auditing the data must be explored. Advances in information and computer technology offer an ideal method of increasing the capacity to produce, assess and disseminate information (Department of Health and Children, 2004).

To date investment in information technology (IT) infrastructure and systems in the Irish healthcare sector has been inadequate (Deloitte and Touche, 2001). In areas where health

information systems have been introduced, they appear to work well and compare favourably with those in other countries. However, as a whole the IT infrastructure within the Irish healthcare system remains fragmented, under-resourced and under-utilised (Department of Health and Children, 2004). This situation mirrors that of the National Health Service in England (Humber, 2004). The National Health Information Strategy (2004), published by the Department of Health and Children, sets out their vision of how information technology can transform the healthcare domain. A central theme of the strategy is the importance of converting raw data into useful information that can then be used to guide decision-making, service planning and evaluation. The end result of implementing any health information system is to create a situation whereby improved data quality leads to benefits for users and positive feedback for data providers. The usefulness of the system to the users and their involvement in its development and improvement is the key factor in achieving and maintaining data quality.

In healthcare the move from paper-based methods of documentation to electronic formats presents a significant cultural challenge. To optimise the benefits of such a change in service delivery it is essential that the new technologies be designed around the users, in other words the people that will be using them (Department of Health and Children, 2004).

#### 2.3 User acceptance

While there are many users of any IT system, from the multidisciplinary clinical team to the IT support team, for the purposes of this literature review and analysis the term users refer to the nurses and/or doctors who interact with healthcare systems at the clinical level.

User acceptance is an estimate of the user's degree of motivation to interact with the system. The more the users feels that use of the system is essential for improved job performance, the more they will want to interact with the system (Lun, 1995). Systems should complement current workflow practices, which should be determined through user participation and observation (Kirkley and Rewick, 2003). Disturbances in nursing workflow have been linked to difficulties in user acceptance when introducing a computer-based system (Ammenwerth *et al.* 2003). When the flow between screens matches the user's workflow practices it makes sense to the user, making it easier to learn (Ambler, 2000). Much of the literature related to

user acceptance is concerned with acceptance after the implementation of new systems (Vassar *et al.* 1999, Ammenwerth *et al.* 2003). As this project is concerned with designing and implementing a prototype system, attention is focused in this section on issues related to maximizing project success prior to, and during a system's implementation.

The literature supports the view that taking a user-centered design approach to system development increases the chances of developing a successful product. This is especially true in the healthcare sector when the systems are directly involved in the delivery of patient care (Fitch, 2004). It has been shown that failure to obtain clinician input in information technology projects has been responsible for project failures in the healthcare domain (Heathfield and Wyatt, 1993). Within the Irish healthcare setting there is a concern that, in some cases, system development and implementation does not involve user input and that changes in work practice demanded by a new system, are not necessarily considered (Deloitte and Touche, 2001).

#### 2.4 User-centered design approach

With a user-centered design process all developments are carried out with the user as the center focus. The system's goals, objectives, context and environment can all be attributed to the user's viewpoint, together with all aspects of the tasks that the product supports (Rubin, 1994). The purpose of choosing a user-centered design approach is to design a product so that "the users can perform required use, operation, service and supportive tasks with a minimum of stress and a maximum of efficiency" (Woodson, 1981) as cited in (Rubin, 1994:10).

While some system development projects appear to support a user-centered design approach, paying lip service to such a process has been proven to be an expensive mistake. In one particular project for a National Health Service (NHS) Trust in England the failure to incorporate elicited user requirements into the design of a simple data collection system for a community healthcare provider, resulted in the development of a very unusable piece of software. The initial plan was that clinicians would enter, review and update patient information on Personal Digital Assistants (PDA's) rather than using paper-based records. An outside company was hired to examine the feasibility of introducing electronic data capture to replace the paper-based system. However, the Trust ignored many aspects of their submitted

report, which had included user input and consultation and instead focused in on what they considered valuable. This lead to the development of a minimal system to computerise the Finance Information Package (FIP), a paper-based recording system, concerned with client details and contacts with those clients. The contract to build the system was awarded to a software house that submitted a much lower price for development than any of its competitors. After the contract was awarded, user input was not obtained until testing of the software began. The testing highlighted usability problem areas and, although these were brought to the attention of the IT manager, they were not passed on to the software house. Some changes were made to the software, but as the usability issues were ignored, hardly any of these changes improved the usability of the system (McManus, 2000).

While this above case is testimony to the failures of a single organisation to follow through on the principles of user-centered design principles it underlines the importance of such a process. This is demonstrated by the success an American healthcare organisation had in implementing an integrated clinical information system, when genuine commitment to user involvement was followed. From the start users were involved in all stages from design and selection, through to implementation and training (Kirkley and Rewick, 2003).

#### 2.4.1 Factors contributing to project success

Many factors contribute to the overall success of any project. The initial step to success is to involve users early in the process. A participatory meeting between users and system designers is necessary to create a meaningful dialogue. In order to understand and specify user requirements, focus group interviews and usability testing are potential options. A combination of focus group interviews and usability testing have been shown to be more effective for specifying user requirements, than basing the requirements solely on what is elicited from the interviews (Garmer *et al.* 2004).

The next step is to ensure that the user requirement are translated appropriately into the system requirements and incorporated into the design and development to the user's satisfaction (Fitch, 2004). The most appropriate way of achieving this goal may be to follow an iterative user interfacing process. With this process users are initially interviewed to get their opinions about the system feasibility. A user interface prototype is then built which

incorporates their ideas. The users subsequently evaluate the interface. There are two types of evaluation, both formative and summative. Summative evaluation occurs towards, or at the end of the design process. Conversely, formative evaluation should occur at early and intermediate stages of the design process on both paper-based prototypes and on partially completed software prototypes. Informal, often qualitative indications of usability are revealed at this stage, which help determine whether the design needs radical revision or simply minor amendments. Formative evaluation does not usually involve a high cost outlay and the evaluation results can be reasonably quickly analysed with the results fed back into the design activity (Le Peuple and Scane, 2003). Informal evaluation techniques, implemented throughout the iterative design process, help to ensure that problems are discovered before significant effort and resources have been spent on the implementation itself. It is much simpler and cost effective to discard or change a design in the earlier prototype development stages than it is in the latter stages (Dix et al. 1998). If necessary, changes and modifications are then made to the design. This cycle continues until no further alterations are needed (Ambler, 2004). Many system development projects follow this iterative process (Rubin, 1994).

The requirements of the users should drive any project development as they have an in-depth understanding of the objectives the system must support. A basic reality of software development is that the user interface represents the system to the users. What users want is for the software developers to build applications that serve their needs and are easy to use. Therefore, getting the interface design right is important on several levels. Firstly, simplicity is the key to successful interface design. The simpler the application is to use, the easier it is to learn, resulting in reduced training costs. Secondly, the better the interface is, the more satisfied the users become (Ambler, 2000). It has been said that clarity, navigability and ease of use of computer screens is a universal requirement of any user-friendly systems (Darbyshire, 2000). As user satisfaction is one of the key factors to information system success (Al-Khaldi and Wallace, 1999) it is worth following these design principles.

The use of information technology in the clinical setting is more likely to be successfully implemented if it results in more efficient and effective work practices. Simply changing from a paper-based system to an electronic one, with no beneficial results for the clinician, will

achieve few goals (Kirkley and Rewick, 2003). The following section looks at the advantages of capturing data via electronic means.

#### 2.5 Data capture and mobile technology

Nursing is an information-intensive environment (Marren and Murnane, 2003). Due to the nature of care delivered in intensive care units, large amounts of data are amassed during each individual's stay (Butler and Bender, 1999). Bedside computer systems, also known as point-of-care systems, release nurses from manual documentation activities. It is said that computerized documentation is quicker and more accurate, increasing time for direct patient care (Simpson, 2001).

#### 2.5.1 Reduced documentation time

Fraenke *et al.* (2003) reported that nurses spent significantly less time documenting routine information, nursing notes and hourly observations in an intensive care unit (ICU) following the implementation of a Clinical Information System (CIS). These systems are usually constructed on a client-server architecture with bedside workstations, and offer electronic charting of physiologic variables, together with a variety of interfaces to other bedside devices. Patient demographics and laboratory results may be imported by interfacing with other hospital systems.

In another study Pabst *et al.* (1996) found that staff on medical-surgical units reduced the time spent on documentation activities from 13.7% to 9.1% post CIS introduction. However, in this instance, nurses were only able to capture 39% of their entries using the automated system. If a more extensive system had been introduced it is possible that the reduction in documentation time would have been more impressive.

It must be said that nurses are not unanimous in their belief that computerised documentation leads to reduced charting time. Dennis *et al.* (1993) found that, while the introduction of a bedside computer system had a positive impact on the efficiency, effectiveness and satisfaction of nursing staff, nurses were divided in their opinion on whether the system saved or took them more time in the documentation process. This may be partly accounted for by the fact that while the speed and ease of recording data was increased, it was counterbalanced

by a significant increase in the number of narrative entries by the nursing staff. One positive outcome was the clear legibility of the computerised records, making it markedly easier to find and read relevant information.

#### 2.5.2 Quality of documentation

Nahm and Poston (2000) reported a significant increase in the quality of nursing documentation after the introduction of a computerised nursing system. Quality of nursing documentation was measured by the percentage compliance to a modified 35-item medical record review tool developed by the Joint Commission on Accreditation of Healthcare Organisation (JCAHO), an external regulatory agency. Combining the results from the four nursing units involved in the study there was a 13% increase in compliance with JCAHO standards, from a mean pre-score of 85% to an 18 month post-implementation score mean of 98%. These findings support those of Dennis *et al.* (1993). Using a combination of external standards from JCAHO and internal standards devised by the hospital's nursing department they reported a 34% increase in compliance with 11 standards. They also found a 10% decline in compliance with 3 other standards for which the computer software was not tailored to provide word cues.

By comparison, Marasovic *et al.* (1997) were unable to demonstrate that the use of automated documentation in an Australian ICU was statistically more beneficial than the traditional manual documentation. In this study the CIS in question was only a basic system. There were no interfaces with ventilators, infusion pumps, pathology, radiology or the hospital CIS which may have impacted on the activities and efficiency of the study.

#### 2.5.3 Hand-held computers

Ideally, clinicians need to be able to have access to relevant information whenever and wherever they need it within the clinical setting. Mobile computing is emerging as an ideal solution to this challenge (Choi *et al.* 2004). Much of the research on mobile computing in healthcare is concerned with the use of PDA's and the majority of this work is concerned with their use by medical staff (Carroll *et al.* 2004, Lapinsky *et al.* 2001, McAlearney *et al.* 2004). The optimal role of hand-held computers in nursing is still unclear because of the lack of a

unified nursing language, combined with individual and organisational factors such as characteristics of the nurse, unit, managerial support and workload issues (Choi *et al.* 2004).

In some instances the use of mobile computing has not demonstrated beneficial results when compared to traditional paper-based charting. Medical residents, in an American NICU, used PDA's as a computer-based patient record and charting system to ascertain if their use could reduce the number of documentation discrepancies (Carroll *et al.* 2004). For four months pre and post PDA introduction, documentation discrepancies in relation to three variables, patient weights, vascular lines and medications were studied. The findings showed that there were improvements in the accuracy of weight recorded but no clear improvement in the other two variables. The study's conclusion was that the use of the PDA failed to demonstrate a clear benefit. However, a limitation of this study was that, with regard to the medication variable, the only item investigated was that the medication had to have the same name as that on the paper-based drug sheet. The drug's dose and frequency was not included in the analysis. This is despite the fact that research has shown that the two most frequent medication errors are dosing errors and incorrect frequency (Bates, 1999, Kozer *et al.* 2002). Fraenke *et al.* (2003) conversely reported a significant reduction in the number of medication incidents following the introduction of a CIS.

In another study by Lapinsky *et al.* (2001) the medical team in an ICU used PDA's to store and retrieve reference information, schedules, and contact numbers. Patient data entered included demographic details, medical history, current diagnoses, treatments performed and management plans. Of interest was the finding that the more senior doctors, who were not usually responsible for entering patient data, gave the PDA's the most favourable response. This group of senior doctors used the PDA's primarily to view stored information and had minimal need to enter data. They also had been in the study longer and had more time to familiarize themselves with the PDA platform. The remainder of the doctors, while acknowledging benefits associated with the PDA use, highlighted areas for improvement in relation to creating a user-friendly system. Many of the suggested improvements related to ease of data entry through the use of shortcuts and lists, limiting the range of data stored to that essential to patient management, and the ability to transmit data easily between staff. The need to develop easy-to-use user interfaces was also emphasised by nurses, who used a PDA- based point-of-care system in a clinical trial in a Korean hospital. In evaluating the system one of the critical drawbacks to using the PDA was felt to be the small screen size, making it difficult to view an adequate amount of data at once (Choi *et al.* 2004).

The above systems all have one thing in common. They are used in the hospital environment. The system proposed by this author would be used by the NNTP both in the referring hospitals and while traveling between hospitals. This is not a new concept but such a system does not presently exist in Ireland for the NNTP. Information can be found on electronic systems used by personnel involved in patient transports. In Norfolk, Virginia, the Critical Care Transport Team from the Children's Hospital of the King's Daughters use PDA's to record patient care details during transport. The software used was developed by Health Informatics Norfolk, Virginia, in collaboration with the Neonatal/Pediatric Transport Team. Data entered for each transport episode includes times, personnel, patient demographics, diagnoses and other patient information. The Transport team members synchronize the handheld data with the hospital system either remotely or onsite. Once the data is synchronized, a web application supplies data management and report generation (Palm.com URL, 2001).

The American military have developed a "trauma pod" called the Life Support for Trauma and Transport (LSTAT<sup>TM</sup>) patient care transport care platform. This trauma pod is used for stabilizing and managing injured personnel en-route to medical facilities (Hudson, 2003). This is a very advanced system that incorporates the most up-to-date medical monitoring and therapeutic capabilities with computer processing capacity. All monitoring devices are integrated into the system, which allows patient and device data to be entered in a simultaneous, time-synchronized, continuous format, together with electronic transmission, storage and documentation. While this system was initially developed for military use, its use in civilian situations is growing. However, from a financial and technological viewpoint, such a system would be beyond the needs and requirements of many healthcare providers. The challenge is to work within the available resources, to optimise the beneficial effects that the introduction of ICT can provide.

#### 2.6 Conclusion

One goal of nursing is to develop IT systems that support clinical nursing practice as well as enhancing the quality of patient care (Saba, 2001). Due to the volume of babies transported annually by the NNTP large amounts of data are being amassed. With the possibility of extending the hours of NNTP cover, an even greater volume of data could soon be collected. Therefore, owing to the demands on the service, it is important to explore ways of improving the effectiveness and efficiency of service delivery and audit. Developing a new way to collect, store and audit the nursing documentation would seem a logical place to start. This is an area where the introduction of information technology could have great potential. It is hoped that this research project will be the initial step in realising this potential change to the current method of recording nursing documentation.

The Department of Health and Children (2004) has placed particular emphasis on the need to expand the development of clinical audit, through local and national data collection and sharing of outcomes information. The National Health Information Strategy's central theme is the importance of converting raw data into useful information that can then be used to guide decision-making, service planning and evaluation. In order to compare services across different areas, transport teams need to agree on what would constitute a standard minimum dataset for transport – for example, demographic data, type of transfers, refused transfers, together with a clear method of data analysis. This uniform approach to data collection would aid quality improvement strategies by highlighting regional differences in outcome, shortfalls in standards, comparisons with other services and time trends - in other words the basis of benchmarking (Cornette, 2004). The advantage of the service in the Republic of Ireland is that, because it is a nationwide service, all data collected relating to neonatal transport in Ireland is of a standard nature. This, however, does not preclude the possibility of improvements in the type of data collected. If the NNTP wishes to benchmark its service against those in other countries it must not act in isolation but must instead develop a recognised standard minimum dataset for transport in collaboration with other similar organisations. From an Irish perspective a starting point for such a collaboration would be to decide what essential data needs to be collected on a nationwide scale, in terms of clinical audit, service justification and service planning. It would then be possible to investigate if this data would be sufficient to allow benchmarking and comparison with other similar services in other countries.

The implementation of the author's suggested system, if extended into practice, would have a number of potential benefits. The incidence of duplication of data would be reduced, the ease of capturing the data at source would be improved and improved methods of extracting the relevant data for clinical audit would be implemented. Another potential benefit would be in relation to manpower issues. Recruitment and retention of nurses is increasingly difficult (Dwyer and Taaffe, 1998). In Fraenkel *et al.*'s (2003) study they found that nursing retention and recruitment increased after the CIS implementation. It is possible that such a benefit might also be seen in nurse retention within the NNTP with the implementation into practice of this project.

Although the NNTP is a stand-alone service, contrary to some previous information technology endeavors in the Irish healthcare setting, the developed system must not be created in isolation but must instead be able to communicate with other patient related IT systems. This would ensure that in the future, when the electronic healthcare record is implemented nationwide, data that will presently have to be entered manually into the prototype system could instead be transferred electronically. New modes of service delivery, such as mobile communication technologies have the potential to enhance the manner in which the NNTP is run. The Government has identified that these technologies may be especially beneficial to healthcare staff working outside traditional hospital boundaries. Where presently communication is conducted with the referring hospital by phone it is possible that in the future, as suggested by Cornette (2004), advice may be given by video link, both from the base hospital and en-route to the referring hospital.

Opinion remains divided on whether the use of electronic methods of documentation reduces the time spent recording patient data. The more recent research findings are more favourable than earlier studies. With regard to the quality of documentation, again the findings are divided. Some researchers have demonstrated a positive link between an increase in documentation quality following the introduction of CIS's. Other researchers have been unable to support these findings. However, it is difficult to accurately compare research findings in these areas as the CIS's in hospitals do not all have the same functionality. In some instances only a basic system is in operation whilst in others all paperwork has been eliminated and interfaces have been developed with the medical devices and hospital information systems. It is impossible at present to say what effects a system, such as that suggested by the author, would have on NNTP service delivery.

The development of mobile computing via hand-held devices is still in its infancy. Much of the research relates to the use of PDA's. The problems encountered when using such devices are mainly concerned with ease of data entry and limitations due to small screen size. The use of Tablet PC's, as envisioned by the author as the medium to run the prototype system, as opposed to PDA's, may overcome the issues related to screen size while the use of menudriven input rather than text-based input may speed up data entry. If neonatal transport services are to continue to provide excellent patient care, new developments in the way in which work can be carried out are to be welcomed. Any system that has the potential to reduce documentation time, increase the quality of data collected and to improve the capture of that data for clinical audit should be developed and assessed. Only then will it be possible to confirm or deny its promise.

In the following chapter the steps taken to design and implement the NeoCare prototype system will be outlined in detail. The needs and aspirations for system's development, together with the methods used to realise them, are presented in the table below.

Needs	Methods
Involvement of users	<ul> <li>Focus group interview</li> </ul>
	<ul> <li>Interview with Transport Coordinator</li> </ul>
	<ul> <li>Development of requirements list</li> </ul>
	• User input elicited during development stage re
	interface design
	<ul> <li>Usability testing</li> </ul>
Improve the data entry	<ul> <li>Elimination of data duplication</li> </ul>
	<ul> <li>Use of drop-down menus and lists</li> </ul>
	<ul> <li>Automatic calculation of fluid intakes</li> </ul>
Improve the method of	<ul> <li>Data automatically communicated to the Transport</li> </ul>
collecting and reusing the data	Coordinator

### Chapter 3 – User centered design

When designing any IT system there is ample evidence to suggest that taking a user-centered approach, increases the probability of gaining user acceptance (Fitch, 2004). Clinician input at stages during the development lifecycle is vital as they have an in-depth knowledge of the objectives the system must support. Research has shown that failure to elicit clinician input has a detrimental effect on a project's success (McManus, 2000). The use of a combination of focus group interviews, and usability testing is an ideal way to determine these user requirements (Garmer *et al.* 2004). The resulting requirements list drawn up following focus group interviews can then be incorporated into the system design and built into a prototype for evaluation and enhancement. Before a detailed description is given on the steps taken to develop and implement the NeoCare prototype system, an overview of the current system will be outlined.

#### 3.1 Overview of current system

Four separate data collection records are used by the NNTP. One of them is a medical record of the patient's condition and treatment and, as this project is concerned with the nursing documentation, will not be discussed here. The nursing records completed by the nurses during the course of a neonatal transport consist of two separate data collection items, the booking form (the Neonatal Transport Data Log) and the flow sheet. The third paper record is the Refusal log that is used to record details of babies that, for a variety of reasons, the team was unable to transport. A diagram of the flow of nursing data during a neonatal transport can be found in Appendix 1. The nurse is responsible for completing these three forms. The Transport Coordinator then collects the completed forms, reviews them and manually enters selected data into the NNTP database. This process is displayed in the following UML diagram.

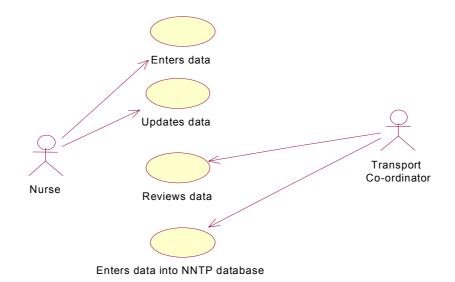


Figure 2 Use Case Diagram of NNTP members' roles

The booking form (Appendix 2) is started when a call comes in to the NNTP requesting a neonatal transfer. This form contains an initial record of demographic details together with other relevant items, including the time the call was received, time transport was accepted, mobilisation time and, when the transport is completed, time the team returned to base (Appendix 3 – Data labels D1, D2, D5).

The flow sheet contains the majority of nursing data collected during a neonatal transport. It is composed of two sheets, an original top sheet and a carbon copy bottom sheet. The original copy is left in the baby's notes at the accepting hospital, while the carbon copy is collected, analysed and stored by the NNTP Coordinator. This flow sheet is a complete record of all the physiological data, procedures performed, intravenous fluids and drugs given and other relevant details pertaining to the baby, from the time the team arrives in the referring hospital to the time the baby's care is handed over in the accepting hospital (Appendix 3 – Data labels D3 and D4).

Physically, the flow sheet is an unwieldy and cumbersome data collection tool. It is a nonstandard size; the size of three A4 pages joined together side-by-side, but is contained within an A4 size folder. This means that it is folded into three when in-transit and frequently, when new data are added, is not opened out to its full size, resulting in script being transferred through to both the right and wrong areas on the carbon copy. Given that the carbon copy is the only source of data used by the NNTP Coordinator to extract the majority of nursing data for the NNTP database, it is often extremely difficult to decipher what has been written. An example of one of these carbon copy forms can be seen in Appendix 4. As this is an actual transport form, for reasons of confidentiality, any identifying information has been removed.

The third paper record completed by the NNTP nurses is the refusal log. This log is used to record the details of babies who, for a variety of reasons, are not accepted for transport (Appendix 3 - D at label D7). However, at times this log is not filled in as it is kept at the base hospital and does not accompany the NNTP when mobile, making it more difficult to remember to complete it in on return.

Each of the three Dublin maternity hospitals does one week on-call for transport every three weeks. At the end of the relevant hospital's week on-call the transport Coordinator collects all data amassed during the on-call period in person. She then manually extracts data relevant to clinical audit from the above paper records (Appendix 3 – Data label D6) and transfers it into the NNTP database. This is a time consuming process as the clarity of entered data is dependant on a number of factors, including the individual's handwriting, the quality of data on the flow sheet's carbon copy and the influence the road surface has on the ability to keep recorded elements within their allocated space on the form. The fact that not all babies refused transport are entered into the refusal log also alters the validity of that statistical data maintained on the database. This has the potential to underestimate the real figures from the point of justifying any need to extend the service, a situation that is currently under discussion.

#### 3.2 NeoCare Transport system

With this prototype system the nurse would again enter and update the data as before. The first UML (Unified modeling language) diagram below illustrates the sequence of events during a transport.

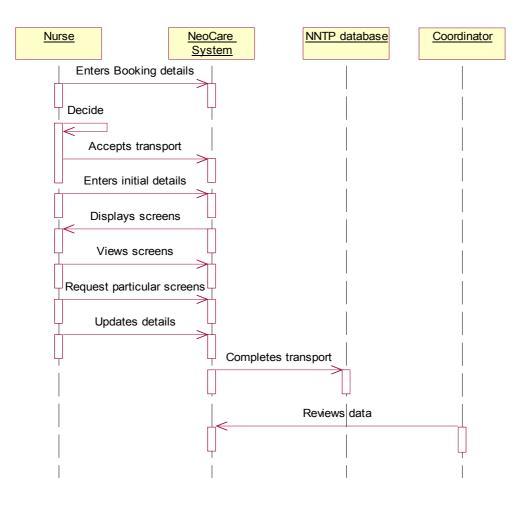


Figure 3 Diagram of sequence of events during a transport

On completion of the transport, when the team returns to base, the collected data would automatically be entered into the Neocare database. An XML representation of the data would then be sent to the remote NNTP server. The Transport Coordinator would review the received data and then update the NNTP database. This sequence of events is illustrated in the diagram below.

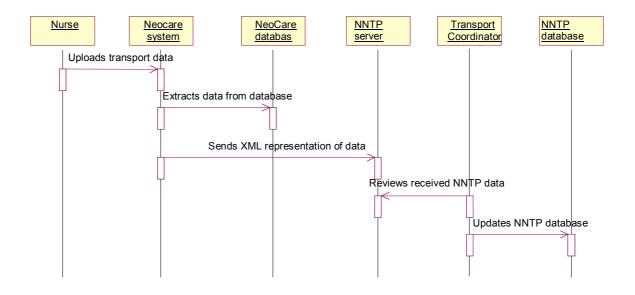


Figure 4 Diagram of sequence of events on return to base

When a transport is refused the booking details are still entered into the NeoCare prototype system by the nurse. Once the decision is taken to decline the transport the reason for this decision is entered and, if at the base hospital, the data is automatically sent to the NNTP server. If the team is mobile when the transport is refused the data is saved and uploaded on return to the base hospital. This sequence of events is presented in the sequence diagram below.

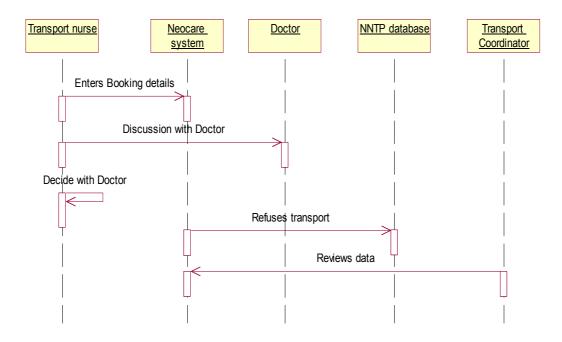
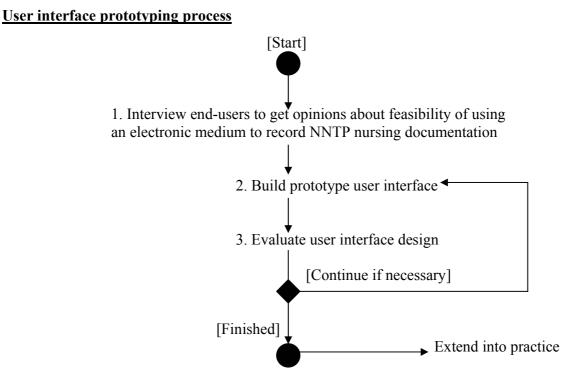


Figure 5 Diagram of sequence of events during a refused transport

As a user centered design approach was taken in designing and implementing the NeoCare prototype system, the author followed the user interface prototyping process presented below, where user involvement was elicited from the start.

# 3.3 Outline of user interface prototyping process



Source adapted from Ambler, S.W. (2004) <u>The Object Primer: Agile Model Driven Development With UML 2.</u> 3<sup>rd</sup> Ed. Cambridge:University Press.

Many system development projects follow this iterative process whereby the product is designed, modified, tested and evaluated repeatedly by the end-users (Rubin, 1994). The scope of such a project would extend beyond this author's time-scale. Rather, this is the initial stage of the iterative process in what will hopefully be, a longer development process. The first step in the design process was to elicit user opinions about the proposed system feasibility. It was felt that the most appropriate data collection method was the use of focus group interviews and an individual interview with the Transport Coordinator.

### 3.4 Focus group interview

A focus group can be defined as a detailed, open-ended group discussion, within a limited length of time, that explores a specific set of issues on a predefined and limited topic (Robinson, 1999). The major advantage of this type of interview is that valuable data can be obtained quickly and cheaply. Some people are more comfortable in voicing their opinions in a group setting, in the company of friends and colleagues, rather than being interviewed individually. However, it is essential that dominant personalities in the group are not allowed monopolise the discussion at the expense of others (Parahoo, 1997).

### 3.5 Selecting the participants

Purposive sampling was used to recruit participants for the interviews. With purposive sampling the researcher deliberately selects whom to include in the interviews on the basis that those selected are most suitable people to provide data on the issues under discussion (Parahoo, 1997). It had initially been hoped to carry out focus group interviews with the NNTP members in each of the three maternity hospitals. However, obtaining ethical approval proved to be more lengthy than had initially been anticipated and therefore, it was decided to limit the interviews to the researcher's own hospital, the first hospital where ethical approval had been sought and obtained.

# 3.6 Group organisation

The focus group interview was conducted in February 2005. Of the nine Neonatal Transport nurses invited to attend five participants took part in the interview. This was considered to be an acceptable number as such groups often consist of between five to eight participants (Robinson, 1999). Following an introduction to the research topic participants were each given a copy of the diagram used to capture the current workflow and sequence of data collection (Appendix 1). UML diagrams were not used as it was felt they would not be readily understood by those with limited computer experience. The participants easily understood the diagram used, and all agreed that the workflow sequence was captured appropriately.

On the subject of the refusal log, one participant acknowledged that she was unaware that it existed and therefore was not entering relevant data when appropriate. While this omission

would have no consequence for the transported neonates, it would affect statistical data stored in the transport database relating to the number of transports refused. A description of how the new proposed system would work was then outlined through means of a story (Appendix 5). Three questions were then put to the participants:

- **1.** Do you think that an electronic version of the nursing documentation would be workable for you and the transport programme?
- 2. What barriers do you see that would impede or overwhelm an electronic version of the nursing documentation?
- **3.** Taking into consideration what we presently record what data elements do you feel should be included or omitted from the proposed system?

The interview was tape-recorded, transcribed and then analysed to identify the most important themes. The author acted as the facilitator for the interview.

# 3.7 Data collection and analysis

In the data presented below P# is the respective focus group participant. The participants' own comments are in italics. For the purposes of confidentiality names of participants and any other identified people or places have been omitted.

# **Question 1:**

Do you think that an electronic version of the nursing documentation would be workable for you and the transport programme?

All the participants viewed the proposed system favourably. Three areas where benefits were identified related to the elimination of data duplication, the positive effects of automatic capture of vital signs and the ability to generate a paper printout of relevant information for the receiving hospital.

P1 – It would save you a lot of time because you have a lot of writing to do. If you accept a transport and take down the details then, more often than not, you end up writing them in loads of different places. And going from one page and back again, trying to find the place to

put it (data) down. When you'd get to the hospital you'd have everything printed out. I think it has great potential. I suppose once you get used to the thing it would be less work.

**P2** – *I* think it's a good idea – vital signs automatically captured.

**P3** – The things that you think "O, I must write that down", and the child is really sick, and you do forget about them, whereas, if they were monitored all the time, and you could go back and highlight "Yes, this is important" and you could add to it as well.

**P4** – *The beauty is we'll have more time for the baby.* (At present) *you're so conscious of litigation you're just writing and writing and writing. You'd go through it fairly quickly because there's none of this writing down.* 

**P5** – *It would make things an awful lot easier.* 

**P1** – *It would save a lot of time. Sometimes filling out those sheets can be very stressful, especially if the child is really sick.* 

One participant had worked in a hospital in the Middle East, which had introduced a paperless hospital information system, and found it easy to use, even though she was initially a novice computer user.

**P4** – It was so simple to do. It was like a book, that was the way I looked at it, and there were 5 pages in the book, and you went through the 5 pages and it covered everything. We just did a little bit of typing on it, just to say if there was any change or what kind of day the baby had. What I liked about it was that it would record an event, say you need to do a big resuscitation, it will record everything and you just say "Ok, we gave adrenaline when the heart beat was that time" so you know exactly. You're not under pressure to do the paperwork as well (during the resuscitation).

Current difficulties related to the legibility of the data entered into the flow sheet, while traveling in a moving vehicle, were identified. As this sheet holds the bulk of the data that the Transport Coordinator needs to enter into the Transport Database it is important that the writing is readable

**P3** – You usually start off on one line and end up on anther line, depending on the bumps. And 36 could end up looking like 38.

P1 – How (the Transport Coordinator) interprets them I really don't know.

# **Question 2:**

What barriers do you see that would impede or overwhelm an electronic version of the nursing documentation?

No major barriers were identified. Concerns were raised primarily about how easy it would be to learn how to use the proposed system and suggestions were made to overcome those difficulties.

**P3** – *Getting used to it I suppose* (would be a problem). *The two weeks that we're not on call you could take it and* (get used to it).

**P1** – You could even use it here looking after a child first of all, just to get used to it and iron out problems. I'd say that could help. I think that would be a great idea.

**P2** – *I think the idea of looking after a baby inside* (at own hospital) *and use it is a good idea.* 

It was felt that it was difficult to know if entering data on screen, rather than the present method of paper entry, would take more or less time than it does presently. One concern, identified by two participants, was related to the size of the text on the screen.

**P5** – Will the screens be big enough for our eyes to see?

#### **Question 3:**

Taking into consideration what we presently record, what data elements do you feel should be included or omitted from the proposed system?

Much of the discussion raised by this question, among the participants, revolved around what data elements, currently collected, should be omitted or redesigned in the proposed system. In general, many elements in the flow sheet were viewed positively.

P4 - I must say the obs sheet (flow sheet) is good, in that there's a lot of detail, so I think that that should be transferred into the program. It covers everything.

P1 - I think the Neonatal Arousal Scale (a scoring system used to assess neurological responses) could be redesigned, as what are you doing but checking the child's pupils. Obviously you're going to record that but you're not going to need the detail that's on those sheets.

**P2** – *The only thing we ever do is look at their pupils.* 

On the flow sheet there is an assessment area where a number of items have to be filled in relating to the baby's neurological, cardiovascular, respiratory, gastrointestinal and genitourinary status.

P1 – Really, a lot of that isn't relevant (data items).

**P2** – *I just put in what I, as a nurse, know but then I, generally, go to the Doctor* (Transport Doctor accompanying the nurse) *and say "Here, will you fill in the rest of that please?" A lot of that should be on the Doctor's bit* (the Doctor fills in his/her own separate notes as well). *If the Doctor's examining the baby that shouldn't be on our bit.* 

By running through items on the assessment area of the flow sheet, a list was made of items for inclusion and omission in the proposed system. Further discussion centered on the level of detail in the transfer letter. A transfer letter from the referring hospital accompanies the baby to the receiving hospital. It includes details relating to the mother's history, pregnancy and

birth details, the baby's history and treatment received so far. This letter's composition differs from hospital to hospital, and some contain more detail than others.

**P1** – *They don't all have a transfer letter and they look at you with ten heads if you go looking for one.* 

**P2** – *The last time I did a transfer was the first time I did not have to write a ream. It was brilliant.* 

The participants wanted to be able to enter more demographic data and the maternal history that is currently required.

**P1** – *If you just had, say the front page of our transfer letter* (from own hospital), *where you'd have all the relevant details, like contact numbers, all that sort of thing, and then just a brief history.* 

**P2** – Include mothers' and fathers' names.

# 3.8 Summary of focus group interview

The participants were unanimous in the endorsement of the proposed system with no one expressing feelings of misgiving. This may have been because critical care nurses are accepting of new technology and, particularly, the role of information technology in the provision of patient care (Fraenkel *et al.* 2003). While they felt the proposed system would lead to a reduction in time spent inputting data, some of the additional data elements they wished to add to the flow sheet would, in fact, result in an increase in captured items. This might have the effect of negating the time saving possibilities.

One area of concern expressed by the participants was in relation to the current situation where, because each hospital has their own transfer letter, the level of detail in each letter varied, and at the other extreme, some hospitals do not have one at all. The group as a whole felt that, by capturing more data elements on the prototype system, the need for a comprehensive transfer letter was less important. However, during the author's interview with the Transport Coordinator, it emerged that she is investigating the possibility of designing a transfer letter that would be sent to all the hospitals using the service to complete when a baby

is availing of the service. This would have the effect of ensuring the relevant data was available without the need to add more captured elements to the prototype system. For this reason extra data elements, that would be contained in the planned transfer letter, were not added to the prototype system.

# 3.9 Interview with National Neonatal Transport Coordinator

The interview took place in the Transport Coordinator's office in the Rotunda Hospital. She expressed her enthusiasm for the possibility of collecting the nursing data by electronic means. She was asked what elements she would like to see included in the prototype system. There were three items that she felt should be included:

- Transport score
- Pre-departure checklist
- Incident log

### **Transport score**

At present the Transport Coordinator calculates the transport score by giving a numerical score to 5 physiological variables that are collected during transport and enters this score into the NNTP database. However, not all the variables needed to calculate the transport score are always recorded and, in those instances, she enters an estimated score. She would like to see a method in place to collect the data needed to arrive at a transport score included in the proposed system. The score would be collected on arrival at the referring hospital, when departing from the referring hospital and on arrival at the accepting hospital.

#### **Pre-departure checklist**

The pre-departure checklist would be used to ensure that all relevant items were available to accompany the baby to the accepting hospital, such as x-rays, maternal bloods and consent form for transport. Items also on the checklist would include the mother's planned method of feeding, whether the baby had received religious rites and that the baby's identity bands had been checked and verified. At present this data is collected but not all in one specified place on the flow sheet.

### **Incident** log

This would be filled in if any untoward incidents occurred during the course of a neonatal transport. This would include incidents concerning the baby, such as the need to reintubate the baby en-route, as well as equipment malfunctions. Currently, there is an equipment log that is used to report any equipment problems, which are then communicated to the Transport Coordinator for resolution. The Transport Coordinator would like to see in place a mechanism for reporting incidents, relating to both the baby and equipment, within the prototype system rather than using the stand-alone system presently in use that only covers equipment problems.

# 3.10 Design of the NeoCare Transport prototype

Following the focus group interview and discussions with the Transport Coordinator a requirements list of desired elements to omit or redesign for the prototype system was drawn up and is included in Appendix 6.

The second step in the design process was to incorporate the user requirements into a prototype user interface. Prototyping is the activity of creating partial designs, speedily and cheaply, with the purpose of allowing designers to get feedback from users at an early stage in the design process. Prototypes can be categorised as either low-fidelity, medium-fidelity or high-fidelity, depending on the extent to which the prototype design accurately reflects the appearance and behaviour of the application. Medium-fidelity prototypes can be designed using a software prototyping tool, which allows partial or fully functional prototypes to be fairly quickly and easily created. During user interface evaluation the users can interact more naturally with computer-based prototypes than with low-fidelity, paper-based prototypes (Le Peuple and Scane, 2003).

Microsoft Visual Basic, a software prototyping tool, was used to design and implement the user interfaces for the NNTP nursing documentation. As crowded screens are difficult to understand and use (Ambler, 2000), it was felt necessary to divide the collectable data items into a number of smaller forms, therefore, excluding the login form, 15 electronic forms replaced the three current paper-based records.

To maintain a degree of consistency within the interface design in all the forms, barring the login form, the Menu Bar follows the accepted Microsoft convention of:

- File
- Edit
- View
- Help

For the purposes of this project the Help function is non-functional but, if extended into practice, it would offer help facilities for every data element. Consistency and simplicity were two user-centered design principles that were adhered to during this development phase. Consistency of design should make the system easier for the end-users to learn. This would include such items as having the navigation bars in the same place on all screens and labeling buttons and menus with easily recognised nursing terminology (Kirkley and Rewick, 2003). These factors reinforce the findings of a qualitative study carried out by Darbyshire (2000). He found that users regarded clarity, navigability and ease of use of computer screens as vital elements of a user-friendly system (Darbyshire, 2000).

The initial form is the Login form. The system will only be accessible to members of the NNTP. All valid users will be issued with a user name and password in order to log onto the system.

🖏 Login		×
User Name:	sbrown	1
Password:		
	OK Cancel	

Figure 6 Login

The user enters a user name and password and clicks on the **OK** command button to access the system. If an incorrect entry is made the user is allowed to reenter and click **OK**. A second command option **Cancel** is available to the user if she decides not to access the system.

The order of the forms follows the previously mentioned workflow diagram. They have been designed to complement the current data collection processes. Screen shots of the forms are presented in this section. Where appropriate, a table outlines the data elements contained within the form, together with the type of data collected, the method of capture and any applicable comments. The following diagram illustrates the workflow dynamics of the forms of the NeoCare prototype system that will be explained in this section. The forms are colour coded as outlined below:

- These forms contain initial data entry elements and are completed prior to leaving the base hospital. The only exception to this is if the team received a request for a new transport once mobile.
  - These forms are started once the team arrives at the referring hospital.
- The yellow box beside two of the rows of forms denotes that initial data is entered into these forms.
  - The black boxes connected with some forms indicate ongoing activity associated with those forms once initial data has been entered.

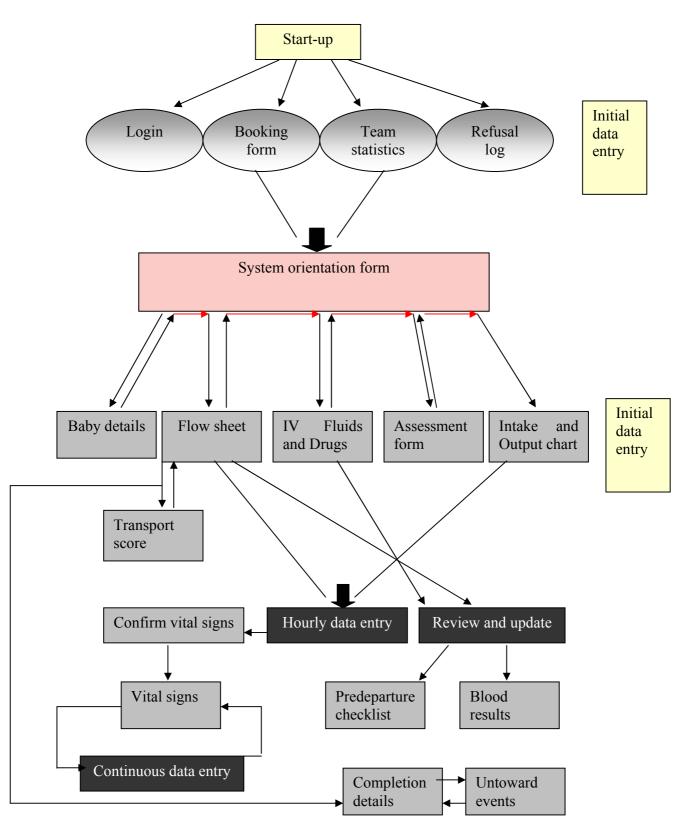


Figure 7 NeoCare prototype system diagram

The initial nursing documentation is the Booking form.

🖷 Booking details	
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp	
Baby Details	
Name: Baby Smith	Date: 01/05/2005
Date of Birth: 25/04/2005	Time: 14.00
Time of Birth: 12.36	<u> </u>
Gestational age: 33,5	Gender Female: •
ID#: 1256-2005	Male: C
Reason for transport: PDA ligation	
Name: Portlaoise Regional Hos	pital 💌
Unit: SCBU	
Phone No: 145/456237	
Consultant: Dr Green	_
Time decision made to transport: 13:30	
Was there a delay in contacting team? Yes 🔿 🛛 No 💿	
Reasons for delay in contacting team:	V
Accepting Hospital	T
Name: Dublin - OLHSC	Transport Refused
Unit: Main ICU	
Consultant: Dr Grey	Transport Accepted:

Figure 8 Booking form

It is divided into three separate sections, the baby's details, the referring hospital's details and the accepting hospital's details.

Booking details				
Data elements:	Туре:	Method of	Comments:	
		Capture:		
Baby details:				
Date and time		Automatic		
Name	Text	Manual entry		
Date of birth	Numerical	Manual entry		
Time of birth	Numerical	Manual entry		
Gestational age	Numerical	Manual entry		
Gender	Boolean	Manual entry	Choice of Yes or No Option buttons	
ID Number	Numerical	Manual entry		
Reason for transport	Text	Manual entry		
Referring hospital details:				
Name	Text	Manual entry	User picks from choice of 27 options in Combo box or manually enters other name	
Unit	Text	Manual entry		
Phone number	Text	Manual entry		
Consultant	Text	Manual entry		
Time decision made to	Numerical	Manual entry		
Delay in contacting the team?	Boolean	Manual entry	Choice of Yes or No Option buttons	
Reason for delay (if any)?	Text	Manual entry	User picks from Combo box choice or enter other text manually. Deselected if the answer to the previous question is No.	
Accepting hospital details:				
Name	Text	Manual entry	User picks from choice of 27 options in Combo box or manually enters other name	
Unit	Text	Manual entry		
Consultant	Text	Manual entry		

Figure 9 Booking details table

Two data items that have not previously been recorded but are easily elicited at this stage have been added to this form.

- 1. Was there a delay in contacting the team?
- 2. What was the reason for the delay?

A decision then has to be taken as to whether the transport is accepted or refused. If the transport is refused the user clicks on the **Transport Refused** command button which opens the Refusal log.

<b>≋, Refusal log</b> <u>File E</u> dit <u>V</u> iew <u>H</u> r	
Date call received:	01/05/2005 Time call received: 14.00
Referring hospital:	Portlaoise Regional Hospital
Name:	Baby Smith
ID#:	1256-2005
Gestational age:	33.5
Reason for transport:	PDA ligation
Accepting hospital:	Dublin - OLHSC
Reason for refusal:	Current call will not be finished before five
	Save

Figure 10 Refusal log

Refusal log					
Data elements:	Туре:	Method of Capture:	Comments:		
Date and time		Automatic	From Booking form		
Name of referring hospital	Text	Automatic	From Booking form		
Baby's name	Text	Automatic	From Booking form		
ID number	Numerical	Automatic	From Booking form		
Gestational age	Numerical	Automatic	From Booking form		
Reason for transport	Text	Automatic	From Booking form		
Name of accepting hospital	Text	Automatic	From Booking form		
Reason for refusal	Text	Manual entry	User picks from choice of 3 common options in Combo box or manually enters another		

Figure 11 Refusal log table

The only item to be completed on the form is the reason why the transport was refused. The command button **Save** then closes the file. If, on the other hand, the transport is accepted the user clicks on the **Transport Accepted** command button on the Booking form which opens the Team statistics form.

🛋 Team statistics	
<u>F</u> ile <u>E</u> dit ⊻iew <u>H</u> elp	
- Team members	
Nurse: S	heila Breen
Doctor: J	ohn Dunne
Ambulance Personnel: J	ohn 🛨
On-call hospital: 🛛	coombe Hospital 🚍
Mode of Transp	ort: Ground: 💿 Air:C
Times Time transport accept	ed: 1600
Initiation dela	ays: None
Time team leaves ba	ise: 1635
Mobilisation ti	me: 35.00
Reason for mobilisation dela (If a	
	Leaving base hospital

Figure 12 Team statistics

The Team statistics form contains data relating to team's composition and mode of transport, together with items relating to mobilisation times.

Team statistics								
Data elements:	Туре:	Method of Capture:	Comments:					
Team composition:	Team composition:							
Nurse's name	Text	Manual entry						
Doctor's name	Text	Manual entry						
Ambulance personnel's name	Text	Manual entry	Choice selected from list box					
Name of on-call hospital	Text	Manual entry	Choice selected from list box					
Mode of transport	Boolean	Manual entry	Choice of Ground or Air option buttons Option buttons					
Times:								
Time transport accepted	Numerical	Manual entry						
Initiation delays	Text	Manual entry	Choice of 4 options from Combo box or user can enter reason manually					
Time team leaves base	Numerical	Manual entry						
Mobilisation time	Numerical	Automatic	Computerised item					
Reason for mobilisation delays	Text	Manual entry	User enters data into free text box					

Figure 13 Team statistics table

The user then clicks on the command button Leaving base hospital to open the next form.

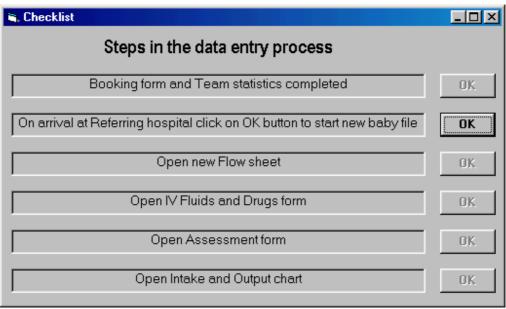


Figure 14 Checklist

The Checklist form has been developed to orientate the user within the system. Although the forms have been developed to follow the workflow practices, it was felt that providing the user with a point of origin for the next number of forms would increase the learnability of the system. Command buttons to forms the users should not yet access have been deselected. On arrival at the Referring hospital the user clicks on the only command button available to open the next form in the workflow process, the Baby details form.

<b>≊. Baby details</b> File Edit View Help	
Patient details	
Name: Baby Smith Birth w	eight: 740 Grams
DOB: 25/04/2005 Current w	eight: 700 Grams
ID#: 1256-2005 Pku t	aken: Yes: 💿 No:O
Airway Self ventilating: O Ambient 02: O CPAP: O Nasal prongs: O Ventilated: O	ETT Size: 2.5 💼 Type: Nasal 🚍 Length: 8cms Taped at: 6.5cms
Konakion given: Yes: 🕤 No: 🔿	Next

Figure 15 Baby details

This form contains details relating to the support the baby is receiving to maintain an adequate airway, together with other relevant patient details.

Baby details						
Data elements:	Туре:	Method of Capture:	Comments:			
Patient details:						
Name	Text	Automatic	From Booking form			
Date of birth	Numerical	Automatic	From Booking form			
ID Number	Numerical	Automatic	From Booking form			
Birth weight	Numerical	Manual entry				
Current weight	Numerical	Manual entry				
Pku taken?	Boolean	Manual entry	Choice of Yes or No Option buttons			
Konakion given?	Boolean	Manual entry	Choice of Yes or No Option buttons			
Airway:						
Maintaining airway	Boolean	Manual entry	User selects from choice of 5 option buttons			
ETT details:						
Size	Numerical	Manual entry	User selects choice from list box			
Туре	Text	Manual entry	User selects choice from list box			
Length	Numerical	Manual entry				
Taped at	Numerical	Manual entry				

Figure 16 Baby details table

When completed the user clicks on the **Next** command button. This reopens the Checklist form.

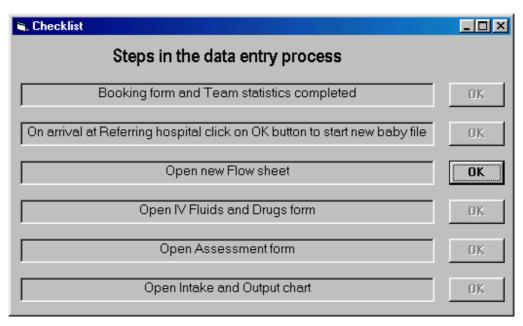


Figure 17 Checklist

At this stage the command button linked to the third item on the Checklist (Open new Flow sheet) is the only command button available to the user as the others have been deselected. The user clicks on this button to open the Flow sheet.

📽 Flow sheet		
<u>File E</u> dit <u>V</u> iew <u>H</u> elp  01/05/2005 Name: Baby Smith	ID#: 1256-2005	Times Arrival time: 17.00

Figure 18 Section of Flow sheet

The date and baby's name and ID number are automatically entered into the Flow sheet. The first item to be entered is the time of arrival. When the arrival time is entered the **Enter** command button beside the data item is activated. When the user clicks **Enter** the Transport score form is opened.

🐂 Transport score				
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp	)			
Baby details		1		Physiological variables:
Date: 01/05/2005				<ul> <li>Glucose</li> </ul>
Name: Baby Smith				<ul> <li>Mean BP</li> </ul>
1236-2003				<ul> <li>Blood PH</li> </ul>
Glucose:	On arrival	On departure	- Accepting hosp	• PO2
Mean BP:	33			<ul> <li>Temperature</li> </ul>
PH:	7.32			
PO2: Blood gas/SAO2:	91%			
Temp:	36.7			
			Enter	

Figure 19 Transport score

The Transport score is collected at three time intervals during the transport process, on arrival at the referring hospital, on departure from the hospital and on arrival at the accepting hospital. The five physiological variables collected serve to illustrate the baby's stability at a given time. Once entered the user clicks on the **Enter** command button which reopens the Flow sheet.

C	, Flow sheet					
Ī	<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp					
Ī	Time	17.15	18.00			
	Axilla/Rectal Temp	36.7	36.5			
	Skin Temp	36.2	36.0			
	Incubator Temp	35	35			
	Colour	Pink	Pink			
	Heart Rate	166	150			
	Resp Rate	60	60			
	SAO2 %	95	92			
	NBP: Sys/Dia	54/36	50/35			
	BP: Sys/Dia	50/30	48/32			
	Mean: NIBP/IBP	41/33	40/38			
	Cerebral signs	0	0			
	Ventilation					
	Mode	IM∨	IMV			
	Rate	60	60			
	FIO2 %	75	65			
	PIP	20	20			
	PEEP	5	5			
	MAP	9	9			
	tE Ratio	1:1	1:1			
	Insp Time	0.4	0.4			
	Air entry R/L	Equal	Equal			
	Suction	ETT	No			

The Flow sheet contains a record of all the baby's vital signs and ventilation setting during the transport episode. An initial set of readings is now manually entered. A cerebral sign scoring system, outlined on the top of the Flow sheet and displayed below, is used to grade this variable. The author has designed it with input from an NNTP member to eliminate the need to enter free text, thereby speeding up the entry process.

<b>N</b> .		_		<
Cerebr	al signs sec	bre		1
	Nor	ne:	Ο	
	Fistir	ng:	1	
	Mouthir	ng:	2	
	Toe curlin	ng:	3	
	Starir	ng:	4	
	Hiccupir	ng:	5	
Archin	ng/hypertor	nic:	6	
Jerk	y movemer	nts:	7	
	Seizir	ng:	8	

-

Figure 20 Sections of the Flow sheet

Once readings are entered the user clicks on the Next command button, which reopens the Checklist.

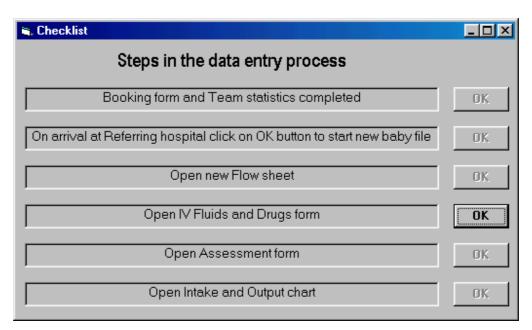


Figure 21 Checklist

At this point the command button linked to the fourth item on the Checklist (Open IV Fluids and Drugs form) is the only command button available to the user. The user clicks on the **OK** command button to open this form.

IV Fluids:	Site:		Solutio	n:	_	Rat	e:	Dose:	Baby details
1: UVC		Dex	trose 10%		•	2	mls/hr		Baby Smith
UVC		= Dop	amine in 5% [	)ex	•	0.17	mls/hr	5mcg/kg/min	ID#:
UVC		Mor	phine in 5% D	ex	•	0.13	mls/hr	10mcg/kg/hr	1256-2005
k JUVC		= Dob	utamine in 5%	Dex	•	0.15	mls/hr	2.5mcg/kg/min	Total mls/kg:
i Perip	heral	Pac	ked cells		•	3	mls/hr	12mls over 4hrs	100
UAC		Нер	Saline 0.9%	1	-	0.5	mls/hr	2units/ml	1
									1
							0.		1
Time:			Dose:	Rout				inature:	
Time: 18.00	Phenobarbitone	•	7.4mgs	IV	=	SBreer	n / JDor	ine	
Time: 18.00		-		IV IV		SBreer SBreer	n / JDor	ine	Flow sheel
Time: 18.00	Phenobarbitone	-	7.4mgs	IV IV Sc		SBreer SBreer	n / JDor	ine	Flow shee
<b>Time:</b> 18.00	Phenobarbitone	-	7.4mgs	IV IV Sc Sc		SBreer SBreer	n / JDor	ine	
<b>Time:</b> 18.00	Phenobarbitone	•	7.4mgs	IV IV Sc Sc ETT		SBreer SBreer	n / JDor	ine	Flow sheet Intake and Output
Time: 18.00	Phenobarbitone	*	7.4mgs	IV IV Sc Sc ETT		SBreer SBreer SBreer	n / JDor	ine	Intake and
Drugs Time: 18.00 18.10	Phenobarbitone	•	7.4mgs	IV IV Sc Sc ETT		SBreer SBreer SBreer	n / JDor	ine	Intake ar
Time: 18.00	Phenobarbitone	•	7.4mgs	IV IV Sc Sc ETT		SBreer SBreer	n / JDor	ine	Intake and

Figure 22 IV Fluids and Drugs form

This form contains a record of all the fluids and drugs that the baby receives during the transport.

IV Fluids and drugs								
Data elements:	Туре:	Method of Capture:	Comments:					
Patient details:								
Name	Text	Automatic	From Booking form					
ID Number	Numerical	Automatic	From Booking form					
Total mls/kg	Numerical	Manual entry						
Each IV Fluid:								
Site	Text	Manual entry	User selects from 5 in list box					
Solution	Text	Manual entry	User selects from 13 in Combo box or enters other manually					
Rate	Numerical	Manual entry						
Dose	Numerical + Text	Manual entry						
Each Drug:								
Time drug given	Numerical	Manual entry						
Name of drug	Text	Manual entry	User selects choice of 6 common drugs from list box or enters other drug manually					
Dose	Numerical + Text	Manual entry						
Route	Text	Manual entry	User selects from choice of 6 from list box					
Signature	Text	Manual entry						

Figure 23 IV Fluids and Drugs table

When finished the user clicks the Next command button, reopening the Checklist.

🐃 Checklist	
Steps in the data entry process	
Booking form and Team statistics completed	OK
On arrival at Referring hospital click on OK button to start new baby file	0K.
Open new Flow sheet	0K.
Open IV Fluids and Drugs form	0K.
Open Assessment form	OK
Open Intake and Output chart	0K.

Figure 24 Checklist

At this point the command button linked to the fifth item on the Checklist (Open Assessment form) is the only command button available to the user. The user clicks on the **OK** command button to open this form.

🛋 Assessment form	and nursing notes		١×
<u>Eile E</u> dit <u>V</u> iew <u>H</u> el	p		
Assessment		Baby details Date: 01/05/2005	
Consciousness level:	Sedated	Name: Baby Smith	
Muscle tone:	Hypotonic	ID#: 1256-2005	
Cry:	Ventilated	Exceptions to assessment findings	
CV: Precordial activity:	Normal	Q Q	
Perfusion:	Cap refill <4secs	A. A. A. A	
Resps: Breath sounds:	Equal		
Secretions:	Loose		_
GI:			-
Abdomen:	Soft and non-tender		
Bowel sounds:	Present		
Gastric tubes:	NGT		
		Nex	ĸt

Figure 25 Assessment form

This form is used to record the assessment of the baby under a number of headings:

- Neurological
- Cardiovascular
- Respiratory
- Gastrointestinal

The user enters the findings in the appropriate text boxes. The date, baby's name and ID number are entered automatically. The section titled "Exceptions to assessment finding" is where the user can use free text to enter any relevant details not covered under the previous headings. The graphic image of the baby has been taken from the present paper Flow sheet.

Currently, on the paper-based Flow sheet, the nurse marks with an "x" where the exceptions are, such as any areas of bruising, any breaks in the skin's integrity or surgical incisions, to name but a few. It is not possible to highlight these identified areas with the prototype system. The picture has been included to help the user instantly recognise what input is required in this section.

When finished the user clicks on the Next command button, reopening the Checklist.

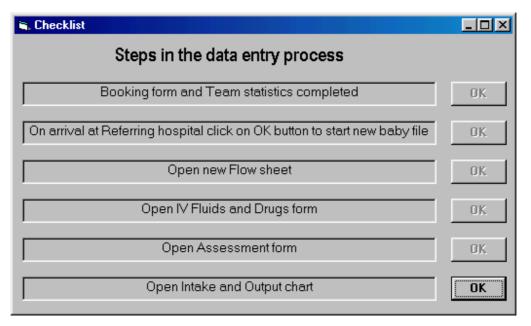


Figure 26 Checklist

At this point the command button linked to the sixth item on the Checklist (Open Intake and Output chart) is the only command button available to the user. The user clicks on the **OK** command button to open this form.

Time:		trose D%	Dopa in 5%			nine in Dex	Dobut in 5%	tamine & Dex		ked Ils		Saline .9%	Totals:
8.00	50	2	10	0.17	15	0.13	10	0.15	12	3.00	30	0.50	5.95
9.00	48	2.00	9.83	0.17	14.87	0.13	9.85	0.15	9	3.00	29.5	0.50	11.90
20.00	46		9.66		14.74		9.7		6		29		
	<u> </u>		<u> </u>		<u> </u>							_	
	<u> </u>												
				<u> </u>	<u> </u>				<u> </u>		<u> </u>	_	<u> </u>
	-			<u> </u>	·					-			<b></b>
				 						- 			·
)utput-										} 1 [	Baby c		
)utput	Pu:	Bo:	N/G as	p Glu	cose:	Abd gi	irth: [ (	Chest t	ube:	}	Name:	:	·
Time:				-		_	irth: C	Chest t	ube:	}	-	:	·
Time: 18.00	Pu:		N/G as	-		Abd gi 21 cms	irth: C	Chest t	ube:		Name:	:	
Time: 18.00 19.00				e		_	irth: C	Chest t	ube:		Name: Baby 9 ID#:	: Smith	
Time: 18.00 19.00				-		_	irth: C	Chest t	ube:		Name: Baby 9 ID#: 1256-2	: Smith	·
				e		_	irth: C	Chest t	ube:		Name: Baby 9 ID#: 1256-2 Date:	: Smith 2005	
Time: 18.00 19.00				e		_		Chest t	ube:		Name: Baby 9 ID#: 1256-2	: Smith 2005	

Figure 27 Intake and Output chart

The Intake and Output chart is where the hourly IV fluid readings and output readings are recorded. Again, the baby's name and ID number are entered automatically. The names of any fluids entered on the IV Fluids and Drugs form are automatically entered into the column headings. On an hourly basis the user enters the infusion readings into the first column of the corresponding solution. In the following hour, when the user enters the new reading, the total infused for that hour is automatically calculated and entered into the second column on the first line. The last column "Totals" is where the accumulated total of all the infusions is automatically entered. This running total is automatically updated hourly when the readings are entered. The user also enters any output details on the appropriate time line.

When the initial hourly readings are recorded the user clicks on the command button to return to the Flow sheet.

	17 15			J1296-	2005	Times     Cerebral signs score     Arrival time:     None:
Axilla/Rectal Temp	17.10	18.00				1700 Enter Fisting:
	36.7	36.5				Departure time: Mouthing: Toe curling:
Skin Temp	36.2	36.0				Enter Staring:
Incubator Temp	35	35				Time at accepting Hosp Hiccuping:
Colour	Pink	Pink				Enter Arching/hypertonic: Jerky movements:
Heart Rate	166	150				Time of return to base Seizing
Resp Rate	60	60				Enter
SA02 %	95	92				-Nursing notes
NIBP: Sys/Dia 5	54/36	50/35				1720 CXR
IBP: Sys/Dia 5	50/30	48/32				1725 Needle aspiration of Rt pneumothorax
Mean: NIBP/IBP 4	41/33	40/38				
Cerebral signs	0	0				
Ventilation						
Mode	IM∨	IMV				
Rate	60	60				
FIO2 %	75	65				
PIP	20	20				
PEEP	5	5				
MAP	9	9				
I:E Ratio	1:1	1:1				Confirm vital Disadamate IV Fluids a
Insp Time	0.4	0.4				signs Blood results Drugs
Airentry R/L B	Equal	Equal	T			Intake and Predeparture

Figure 28 Flow sheet

At this stage all the initial data have been entered. The command buttons at the bottom of the Flow sheet, which, until now have been deselected, are now used to navigate between forms. As IV fluids or drugs are given their form is updated. The input and output chart is updated as necessary. Any nursing details can be entered into the Text box. The vital signs are updated on the Flow sheet. In the NeoCare prototype system, when vital signs are entered, the user clicks on the command button **Confirm vital signs.** This opens the Vital signs form where selected vital signs are graphically represented.

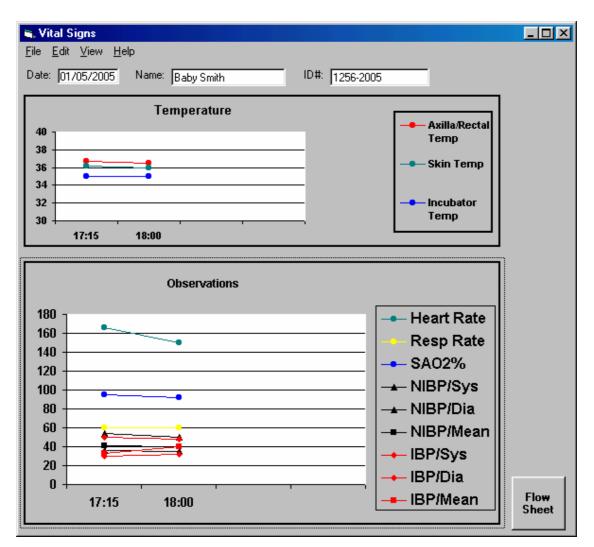


Figure 29 Vital signs

The selected vital signs are those captured by the NNTP cardiorespiratory monitor. It is envisioned that, at a later stage in the proposed system development, these data elements would be captured automatically, by interfacing with the monitor, and that the user would just click **Confirm vital signs** to enter the data into the appropriate areas on the flow sheet and graphic form. This would reduce the manual entering of vital signs. At present this facility is not operational. A graphic representation of the selected vital signs on the Flow sheet has been made to show the user what this form would look like. It is this graphical image that the user will see when the **Confirm vital signs** command button is clicked. To return to the Flow sheet the user clicks the **Flow sheet** command button. The Blood results form, accessed by clicking on the **Blood results** command button on the Flow sheet, is used to record the results of any blood tests.

🛋 Blood re	esults							
<u>F</u> ile <u>E</u> dit	<u>V</u> iew <u>H</u> elp							
Blood gase: Source:		Acc Hosp 芸	Mobile 📃	Acc Hosp	🚍 🗛 Acc Ho	isp 📑	Baby details	
Type: 🔀	ABG 🚍	ABG 🚍	CBG 🚍	ABG	🚍 🗛 🖂		Baby Smith	_
Time:	18.00						ID#: 1256-2005	
Ph:	7.32						·	
PC02:	5.4						- Other results	
BE:	-2.6						ľ	
St Bic:	21.7							
P02:	7.9							
FBC			rea and electro	lytes				
Hb:	10.2		Na+ 132					
PCV:	.35		K+ 4.5					<b>*</b> 1
WCC:	11.2		Ca++ 1.89					
Platelets:	108	S S	3R: T/D 120,	/12			FI	ow Sheet

Figure 30 Blood results form

The baby's name and ID number is entered automatically. One section of the form is used to record blood gases. This test would be the most commonly performed one during transport. The transport ambulance is equipped with a portable blood gas analyser so that it is possible to take and analyse blood gases while mobile. For this reason the user must enter the source of the test, from a choice of three in the list box. The user must also select whether it is an arterial or capillary blood gas from the second list box.

The other two most commonly taken blood tests in the referring hospital would be a full blood count, and urea and electrolytes. With any of the three mentioned tests the user only has to enter the appropriate values. A free text box is also available to record other relevant tests. Once values are entered the user clicks the **Flow sheet** command button to return to the Flow sheet.

Prior to departure from the referring hospital the user clicks on the **Pre-departure checklist** command button at the bottom of the Flow sheet, opening the Pre-departure checklist form.

Image: system with the system       Predeparture checklist         File       Edit       View       Help         Baby details       ID#:       1256-2005		
Procedures performed		
IV insertion: 🔽	Other:	
Umbilical line insertion: 🗖		
Arterial line insertion: 🔽	4	
N/G insertion: 🔽		
Intubation: 🗖		
Chest aspiration: 🗖		
Chest tube insertion: 🗖	1 1	
Checked	Mother has	
Name bands: 🔽	Expressed wish to B/F: 🔽	
Maternal bloods: 🗖	Received NNU info: 🔽	
X-rays: 🔽	Photo of baby: 🔽	
Consent form: 🔽	Seen baby: 🔽	
Received Yes ⊙ religious rites: No C	Touched baby: 🔽	Enter

Figure 31 Pre-departure checklist

This form is used to record all procedures carried out by the NNTP in the referring hospital. In the first section, "Procedures performed", the user ticks any relevant boxes and, if a procedure has been carried out that is not on the list, this data can be enter in the free text box. The second section, "Checked", serves as a reminder to the user to check a number of items prior to departure. The user ticks the boxes if appropriate. The user is given a Yes or No option button to select regarding whether or not the baby has received religious rites. A further section is given to maternal details regarding the baby. The **Enter** command button returns the user to the Flow sheet. When leaving the referring hospital the user enters the departure time and clicks the **Enter** command button.



As with the arrival time entry, when the user clicks **Enter** the Transport score form is opened. The five physiological variables are again recorded, this time in the departure column (see Figure 19). Once again the user clicks the **Enter** command button to return to the Flow sheet. This process is repeated again once the team arrives at the accepting hospital.

Figure 32 Section of Flow sheet

Once back at the base hospital, having left the baby at the accepting hospital, the user enters the time into the relevant place on the Flow sheet and clicks Enter. This opens the Completion details form.

🛋 Completion det	ails 📃 🗆 🗙
<u>F</u> ile <u>E</u> dit ⊻iew <u>H</u>	lelp
Untoward events -	Incident form
No: 🔿	Completed:
Yes: 🔿	Yes: 🗖
<u> </u> ]	
	Finish
	Finish

Figure 33 Completion details

If no untoward event occurred during the transport episode the user selects the No option button. The incident form completed frame remains deselected and the user clicks **Finish** to complete the transport documentation. If, however, an untoward event did occur the user selects the Yes option button. This action opens the Untoward events form.

🐃 Untoward events	
<u>File E</u> dit <u>V</u> iew <u>H</u> elp	
Date: 01/05/2005 Name: Baby Smi	th ID#: 1256-2005
Baby	Equipment
Desaturation requiring stimulation: 🗖	Ventilator failure: 🔲 Monitor failure: 🔲
Rise in CO2 (if ABG done): 🦵	Inf. pump failure: 🔽 🛛 Ambulance prob: 🗖
Accidential extubation: 🦵	Loss of IV: 📁 🛛 Failed gas supply: 📩
ETT blocked: 🔽	Bag not equiped: 🧮
Pupil changes: 🗖	Communication issues: 🥅
Other:	
Action taken	
Reintubated with Size 3.0 ETT. Tolerated p	rocedure well.
Used infusion pump in ambulance. Broken p	oump out for repair.
	Enter

Figure 34 Untoward events

The date, baby's name and ID number are automatically entered. The user selects any appropriate check boxes or, if none address the problem, manually enters data in the "Other" text box. Details of any actions taken are entered into the relevant text box. The user then clicks **Enter** to return to the Completion details form.

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This action also enters a tick in the check box Incident form completed.

Figure 35 Completion details

Finally the user clicks the Finish command button to end the transport episode and the NeoCare prototype program. These last two forms contain data that are not currently collected. They have been included at the Transport Coordinator's request. It was felt appropriate to include them in the NeoCare prototype system, for evaluation by the NNTP nurses.

Having designed a working prototype the next stage in the user interface design process is evaluation.

# Chapter 4 – Evaluation

Usability evaluation, the third step in the user interface prototyping process, is a critical part of user interface design. The three main goals of evaluation are to assess the extent of the system's functionality, to assess the effect of the interface on the user and to identify any specific problems with the prototype system (Dix *et al.* 1998). There are a variety of evaluation strategies that can be employed at this stage of the design process. The method chosen depends on whether the design exists as a runnable system or as a paper prototype, whether it is to be designed by the design team or by the users, and whether the findings are to be of a quantitative or qualitative nature (Dix *et al.* 1998).

The author intended to gather subjective, qualitative data from the users. This non-numerical data and findings, such as lists of problems users had when using the interface, would then be used to generate suggestions for modifications to improve the interaction design. This kind of data is helpful in identifying which design features are associated with measured usability problems during the iterative developmental cycle (Hix and Hartson, 1993).

At this stage the goals of the evaluation were:

- To determine whether the design met and satisfied the specified user requirements
- To determine whether any usability problems existed
- To determine whether the users felt the prototype system would be usable in practice
- To generate more user requirements based on the evaluation findings.

The evaluation strategy chosen here was scenario-based, script-driven testing. The author had developed written step-by-step instructions, designed to follow the NNTP workflow process, to be presented to the participants. Two scenarios were presented to the users; a refused neonatal transport (Appendix 7) and an accepted neonatal transport (Appendix 8). The users were then observed interacting with the system and their actions recorded. The script used by the evaluator had tick boxes beside every data entry element, and also room for comments. The original plan was that a tick would be use to record every correct entry and a cross would record every incorrect entry. As each form was completed it would also be photographed, using a digital camera, to act as a means of verifying the script findings. This was to ensure

that, if the evaluator was writing particular comments and missed a data element entry, it would have been possible to review the photographic evidence afterwards.

However, this alone would have been insufficient to determine how well the system meets the users' requirements, as it would not always have given an insight into the users' decision processes or attitudes. To overcome this participants were to "think aloud"; describing what they thought was happening, why they took a certain action, what they were trying to do. The advantage of "thinking aloud" is its' simplicity. It needs little skill to perform and can offer useful insight into problems with an interface.

As well as asking the participants to think aloud during the evaluation process the evaluator asked them questions if their behaviour was uncertain and, conversely, the user was able to ask the evaluator questions if a problem occurred. This type of evaluation, known as cooperative evaluation, is where the users are encouraged to see themselves as collaborators in the process rather than just experimental subjects. The advantages of this approach were threefold. It was a less formal process. The users were encouraged to criticize the system, thereby helping to generate further user requirements for the next design iteration. The evaluator was able to clarify points of confusion as they occured, in order to maximize the ability to identify problem areas (Dix *et al.* 1998). As well as recording the users actions on paper for the script-driven testing, an audiotape was used to record the verbal interactions from the session.

## 4.1 Participants and setting

Four of the five NNTP members who took part in the focus group interview evaluated the system. The evaluation took place in Neonatal Centre in the Coombe Women's Hospital. While this could have been viewed as field-testing, in reality it was not, as the majority of NNTP nursing documentation is completed outside the base hospital. However, since all the participants work in the Neonatal Centre there it was felt that the setting would be more conducive to putting them at their ease. The testing took place in an office in the Neonatal Centre as interruptions would have been inevitable if carried out in the in the NICU.

#### 4.2 Choice of hardware to run program

Given that during a neonatal transport situation the transport team operates both in the hospital environment and in the specially equipped neonatal intensive care ambulance or, occasionally in a helicopter, portability is vital to the success of such a system. Due to the restricted mobile environment in which the team operates, the size of the computer hardware, its weight, durability and battery life would be major concerns when considering what platform to use. The author decided that a Tablet PC was the most appropriate computer to use given its weight and screen size. It was therefore decided to evaluate the prototype system on a Tablet PC to give the NNTP nurses a realistic impression of how the prototype system would function. However, choosing to use a Tablet PC lead to unexpected problems during the design evaluation. Although the interfaces were an acceptable size when viewed on the desktop computer, on the Tablet PC they were smaller. One of the issues identified by two participants in the initial focus group interview had been related to the size of the text on the screen. Due to the size of the interfaces the digital camera was not used, as it was impossible to focus the lens to the point that the forms were clearly visible.

It had been hoped that the users would enter the neonate's vital signs and ventilation settings into the Flow sheet manually. However, the chart designed for this process, while in appearance, is what would be used in a live situation, would not allow data entry when the program was running. The users had to evaluate the appearance of this part of the Flow sheet from a static screen.

Two methods were used to enter the data, either by using natural handwriting with a stylus, which was then converted into typed text, or by tapping a screen keyboard with the stylus. It took time for the participants to become accustomed to writing to the screen, as the converted text did not always reflect the inputted letters. Abbreviations that are commonly used in the NNTP documentation were difficult to input, as the Tablet tried to convert these to recognised words. In order to enter words such as "NEC" it was necessary to input each letter and convert it to text individually. There are no systems currently in use that are good at general cursive script recognition (Dix *et al.* 1998).

Where numerical data had to be entered that contained decimal points, using the natural handwriting method, it was essential to position the decimal point correctly, in a low position, or else the number would be entered as, for example 6-5, rather than 6.5. This caused problems, especially in the intake and output form, where data were automatically calculated based on inputted entries. In those instances the program would not allow the participant to progress any further without debugging and, as there was no problem with the relevant code, the user then had to go back to the start of the program again. However, even given the problems encountered above, there were also many valuable findings during the design testing.

## 4.3 Design testing

Testing took place in two sessions, with two participants at a time. This was because the screen orientation on the Tablet PC made it impossible for more than three people to view the screen at the same time. The scenarios (Appendix 7 and 8) were generally followed but deviations did occur when, due to errors in entry, the users had to go back to the beginning and start again. In those instances the evaluator entered the relevant information into the initial forms, until the form where the errors caused the program to stop was reached.

The participants, generally, were happy with the content of the interfaces. In places where were no constraints placed on the accepted way to enter some data elements a few variations were inputted. For example where the evaluator had thought that the correct entry would have been "Baby Smith" one participant entered "Smith" while another entered "B Smith". Where the date of birth was to be entered as "25/04/2005" it became apparent that, because of difficulties converting "/" from natural handwriting to text, it was necessary to enter it as "25-04-2005". When entering numbers containing decimals, with the difficulties mentioned previously, the participants found it more helpful to input that data using the screen keyboard and stylus.

Three elements that the participants would like to see included in the next iteration were:

Blood results form – Date and time for all the blood tests. At present only the Blood gases have a time and none of the blood tests include the date.

- IV Fluids and Drugs form Strength of drug solutions in the IV Fluids. At present the dose of the drugs is included but not the strength.
- **Navigation** The ability to navigate between more forms than presently possible.

The one item they all felt strongly about was the Transport Score. This form was included at the request of the Transport Coordinator. However, all the participants felt that is was not appropriate to add it to the documentation, as it would mean that it would have to be completed initially before any other care was given to the baby, and it is not currently recorded. This highlights the conflict that can arise when the current workflow practices are altered. Research has shown that systems should complement current workflow practices (Kirkley and Rewick, 2003). Disturbances in nursing workflow have been linked to difficulties in user acceptance when introducing a computer-based system (Ammenwerth *et al.* 2003).

One suggestion made to overcome this issue was:

# **P1** – *Could you bring the Transport score up at the end of the transport?*

However, as the score has to be filled in three times, both on arrival at, and departure from the referring hospital, and at the accepting hospital, that is not considered a viable option.

The following advantages were voiced about the prototype system:

- **P2** *All the information is on a screen. You don't have to go from one sheet to another sheet.*
- **P3** *There is unlimited space to write extra things if you had to write extra things.*
- P2 You've only got 4 lines to write IV Fluids (current paper version) and you've got 6 on that (Prototype).
- P1 *I* think it would be much easier to use than to Obs sheets as they are (current flow sheets).
- **P2** *It's going in the exact same way* (mirroring current workflow practices).

- **P3** *I* think it's definitely the way we're going (computerization).
- P1 and P4 Both thought that it would be much quicker to use than the current paper system.

The following disadvantages were voiced about the prototype system:

- P3 You'd need to get used to using it. I wouldn't like it to take more time doing that than writing (on paper). At the moment I think it would until you'd get used to it. Because it's a bit bitty and if you go wrong it takes longer to go back.
- P3 *I* think going from page to page (form to form) you can't see everything at a glance. You have to open the computer (open relevant form).

Other issues related to technological queries about a fully working system, rather than to the NeoCare prototype system itself. These included:

- How a printout would be obtained for the hospitals?
- How the Transport Coordinator would get a copy of the documentation?
- Would the data be saved automatically or would the user have to remember to save the data as she goes along?
- Could the vital signs be automatically sent to the Transport score when they are entered?
- Whether the ability to interface with the baby's cardiac monitor to automatically capture select data would be included in a working system?

Overall the general opinion about the NeoCare prototype system was positive. Modifications were suggested that will be incorporated into the next iteration. While advantages were identified about using the prototype system, there still existed some reservations about whether it would take the user more time to complete the documentation than at present. With the prototype system 7 forms replace the single paper-based Flow sheet. The loss of the ability to see all the data currently recorded on the Flow sheet at a glance was seen as a disadvantage. Given that this was the first time the participants had viewed the prototype

system their reactions were, in the main, encouraging. The next step in the development process is to make modifications to the interfaces, based on the above findings.

# 4.4 Design modifications

The following design modifications, which have been incorporated into the interfaces, include those suggested during the evaluation. The users felt that they might need to amend details in some forms, for example if an incorrect weight was initially given or if some added observation was made. Navigation between forms, once the initial forms were completed, had been restricted to the following six forms:

- Flow sheet
- Blood results
- IV Fluids and drugs
- Intake and output
- Pre-departure checklist
- Vital signs

Therefore, it is proposed to enable the users to navigate between the forms already mentioned as well as adding the Assessment form, the Baby Details form and the Transport score to that list, once all initial details have been entered. This would give the user greater freedom in deciding the order in which she would like to complete the data entry. This may vary from baby to baby, as each baby's condition dictates the sequence of events that occur once the NNTP arrive at the referring hospital. The manner in which the user navigates between the forms has also been changed.

The Checklist form has been discarded. Instead, the Command button at the bottom of the Team statistics form, which would be clicked on arriving at the referring hospital, opens the Flow sheet.



Figure 36 Modified section of Team statistics

From the Flow sheet, rather than using command buttons to move between screens, tab keys at the top of the screen will be used in their place.

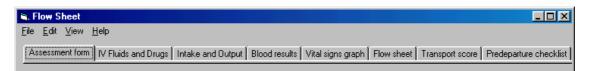


Figure 37 Modified section of Flow sheet

The tab keys conceptually represents folders within a filing cabinet. Clicking on the relevant tab key will open the form. This may be more appealing to the users as a navigation tool between forms. While they cannot see the details on all the forms simultaneously, they can see at a glance all the tab keys for the forms they will use on a regular basis during a neonatal transport. These tab keys will be seen in all the forms listed above. The tab key on the form that is accessed will be depressed, as a means of orientating the user to where they are within the system. These tab keys will be in the same place on all the relevant forms. The forms where data are entered once, and once only, will still not be accessible once completed.

On the Blood results form both the date and time have been added to the full blood count and urea and electrolytes results.

🖷, Blood results	_ D ×
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp	
Assessment form VV Fluids and Drugs Intake and Output Blood results Vital signs graph Flow sheet Transport score Predepa	arture checklist
Name: Baby Smith ID#: 1256-2005	
Name: Baby Smith ID#: 1256-2005	
Source: Ref Hosp = Acc Hosp =	
Type: ABG 🚍 ABG 🚍 ABG 🚍 ABG	
Date: 12/05/2005	
Time: 1800	
Ph: 7.32	
PC02: 5.4	
BE: 2.6	
St Bic: 21.7	
P02: 7.9	<b>•</b> 1
Urea and electrolytes FBC	
Date: 12/05/2005	
Time: 1710 Time: 1240	
Na+: 132 Hb: 10.7	
K+: 4.5	
Ca++: 1.94 WCC: 9.2	
SBR: T/D: 120/12 Platelets: 108	
	Flow Sheet

Figure 38 Modified Blood results form

On the IV Fluids and Drugs form a column has been added to the IV fluid section for entering the strength of the IV solutions.

<b>≊, IV Fluid</b> s <u>F</u> ile <u>E</u> dit ∖	<mark>s and drugs</mark> √iew <u>H</u> elp							
Assessment	form IV Fluids and Drug	s [Intake ar	nd Output   Blo	od results   Vi	tal signs	graph   F	low sheet   Transpo	it score Predeparture checklis
IV Fluids	Site:		Solution	n.	Ra	te:	Dose:	Strength:
1:	JUVC	🚍 Dextros			2.0	mls/hr		
2:	JUVC	Dopam	ine in 5% Dex	•	0.17	mls/hr	5mcg/kg/min	1000mcg/ml
3:			ne in 5% Dex		0.13		10mcg/kg/hr	80mcg/ml
4: 5:			mine in 5% Dex		0.15		2.5mcg/kg/min	1000mcg/ml
o: 6:	Peripheral UAC				3.0 0.5	mis/hr mis/hr	12mls over 4hrs	2units/ml
Drugs Time:	Drug:	Dose:	Route:		nature	:	Baby details	Baby Smith
	• •						ID#:	1256-2005
	• •						Total mls/kg:	100
	• •							Next
	<b>_</b>							

Figure 39 Modified IV Fluids and Drugs form

The Assessment form and the Baby details form have been combined to form a new Assessment form.

🛎 Assessment form		sing notes								
<u>F</u> ile <u>E</u> dit ⊻iew <u>H</u> el	ιP									
Assessment form IV F	Fluids and	Drugs   Intake and	l Output	Blood results	Vital signs graph	Flow s	heet   Trar	nsport score	e   Predepar	ture checklist
Patient details Name: Baby Smith		Birth weight:	740gms		Konakion given	– Airwaj Self v	entilating:	0	Size: 2.	5 =
DOB: 12/05/2005	5	Current weight:	700gms		Yes: 💿	v	CPAP: /entilated:		Type: N.	
ID#: 1256-2005	_	Pku taken:	Yes: 🖲	No:C	No: O		bient 02:		Length: 80	:ms
Date: 22/06/2005	ō	Date Pku taken:	17/05/2	2005			al prongs:	Т	aped at: 6.	5cms
Assessment										
Consciousness level:	Sedated	Neuro:			Precordial a	activity:	Normal	CV:		_
Muscle tone:	Hypoton	ic			Pe	rfusion:	Cap refill	<4secs		-
Cry:	Ventilate	;d			46	J		GI:		_
		Resps:					Soft and r	non-tender		_
Breath sounds:							Absent			
Secretions:	Loose				Gastric	: tubes:	Nasogast	ric tube		
Exceptions to assessm	ent finding	]5							1	
	R	3								Next

Figure 40 Modified Assessment form

The issue of entering data into the Transport score caused most discord during the evaluation process. The participants were apposed to having to input the data for this score system, as it is not currently recorded. However, transport scores have been shown to be of positive value in the area of clinical audit in neonatal transport services (Leslie and Stephenson, 1997, Shoo *et al.* 2001). With any change in workflow practices it is essential to gain the co-operation of the people concerned through discussion, dialogue and education (Kirkley and Rewick, 2003).

Another means of collecting the Transport score data is proposed here. This could be evaluated during the second iteration of the prototype system. On arrival at the referring hospital, when the initial baseline observations are entered in the Flow sheet, the temperature, oxygen saturation and mean blood pressure readings would be automatically entered into the initial Transport score. If a glucose or blood pH level was taken the result would have to be entered by the user. On departure from the referring hospital and on arrival at the accepting hospital the observations are currently filled in on the paper Flow sheet. It is proposed that, when the user enters the time of departure from the referring hospital, the observations would already have been entered into the Flow sheet. Clicking enter on the time element would automatically enter the temperature, oxygen saturation and mean blood pressure readings into the Transport score. Again, if a glucose or blood pH level was taken, the result would have to be entered manually by the user. This process would be repeated at the accepting hospital. As previously stated, the outcome of the discussions between the Transport Coordinator and the users may influence this element of the design modifications and further changes may need to be made before the second evaluation.

Another design modification, which would be incorporated into the second iteration, concerns the placing of constraints on the users when inputting some data elements. Elements, such as Baby Name or ID Number, would have to be entered in the same manner by all users. This would ensure the standardization of certain data elements. When inputting numerical data, such as date of birth, when the two digit day of the month was entered the computer would automatically insert "/" and this would be repeated following the two digit month entry. This would also negate the necessity of converting "/" from natural handwriting to text, an issue that caused difficulties for the users during the evaluation. It would also be necessary to resize the forms so that they occupy the full Tablet PC screen, making them more discernible.

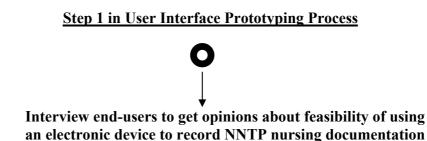
The first cycle in the User interface prototyping process has now been completed. The following section reviews this iterative design process, acknowledging where limitations occurred and makes recommendations for future progress in the quest to extend the NeoCare prototype system into practice.

# Chapter 5 – Conclusion

The aims of this project were to design a user interface prototype for a computerised system to record the NNTP nursing documentation, to evaluate if the users viewed it favourably and to contemplate a more efficient method of extracting that data to be both entered into the NNTP database, and used for clinical audit. User-centered design principles were followed as taking a user-centered design approach to system development increases the chances of developing a successful product, especially in the healthcare setting (Fitch, 2004). A review of the iterative design process that was followed is presented below.

#### 5.1 Review of the iterative design process

The starting point for this whole project was to design a prototype system that would benefit nurse members of the NNTP. The author was in an excellent position in that she was not only a member of the NNTP and had worked extensively with the paper-based records, but also had an insight into the challenges involved in designing computerised systems for users with a wide disparity in computer knowledge.



The focus group interview was the initial step in the user centered design process. A limitation of the project may be that only one focus group interview was carried out, and that it was in the hospital where the author herself worked. Conversely, the NNTP members in the three hospitals use the same documentation, and follow the same workflow practices, so it could be argued that the participants in the focus group were a representative group.

All participants made valuable contributions to the discussions. Two of the three questions put to the participants were concerned with their views on the potential benefits of using an electronic medium to collect the data for transport, while the final question related to identifying specific data elements to include or omit for the NeoCare prototype. The author had to restrain herself from leading the interview too much as, given her familiarity with the transport process, she had her own views on what should be contained in the prototype system. The author acknowledges that conducting focus group interviews is a skill that can only be improved on over time.

#### Step 2 in User Interface Prototyping Process

**Build prototype user interface** 

Building the prototype system in Visual Basic was a slow process. Initially the author thought that she would only need four to five forms to replace the paper-based system. However, as the design progressed it became apparent that any idea of replicating the paper-based system in an electronic format was not going to work. The whole sequence in which data was collected had to be reengineered to fit into the prototype system. Fifteen forms were eventually designed for data collection during each transport episode. The rationale behind the development of that number of forms was that it was essential not to crowd too much data onto each screen; to avoid overloading the user with tightly packed screens. During this development stage input was sought from NNTP members concerning the data elements included on the forms and, following advice, changes were made to some elements and others that had not been thought of were added. This was a valuable lesson for the author, as it highlighted the argument that, collaboration is needed at all steps in the design process, rather that designing a prototype system in isolation.

#### Step 3 in User Interface Prototyping Process

#### Evaluate user interface design

The evaluation was a success in that the participants highlighted some concrete changes they would like to have seen made to the prototype system. They identified elements that they would like to see added to certain screens and issues that they would like to see included on the next iteration. One of these issues related to navigating between screens. The author had designed it so that each user had to follow a set course through the screens, and that once some forms were filled in it was impossible to return to them. The rationale behind this was to make the prototype system as easy to master as possible. The participants, however, felt that they wanted to have more control over the sequence of their data entry.

Another valuable lesson from the evaluation is that, prior to introducing any changes to workflow practices, they should be first discussed and ironed out with the users. This applies to the introduction of the Transport score, which the Transport Coordinator had wanted the users to complete during each transport episode. The author's role in this project was to remain impartial to the internal workings within the NNTP. In this regard the transport score had been incorporated into the prototype system as requested by the NNTP Transport Coordinator. In hindsight, it might have been more beneficial to enable the NNTP team discuss this issue and to come to a consensus prior to designing the interfaces. However, this may not have been attainable in the time scale for the project.

Choosing to run the prototype on a Tablet PC lead to its own problems. These problems were mainly grouped around the difficulties of entering data using natural handwriting with a stylus, which was then converted into typed text. One way to have avoided this pitfall was to have used a paper prototype for the evaluation stage. However, this may not have given the participants a realistic vision of how to proposed system would work in practice.

# Step 4 in User Interface Prototyping Process

#### Make design modification

Design modifications were identified during the evaluation. Some of these changes were concerned with physical changes to the user interfaces, while some related to changes to be made in the system's programming. The biggest change was in the way in which the users will navigate around the system. With the changes made, the users will have much more control in the order of inputting data. While the author had thought that the initial navigation process, where to user could not deviate from the order of data input until all the initial forms had been completed, would make the prototype system easier for the user to learn, she now accepts that users need to feel in control of the NeoCare prototype system and not the other way around. While the users may be novices in using the system, they are experienced in the workings of the NNTP, and have developed their knowledge of the paper system over time. Allowing them the control to move around and input data into the prototype system in an individual manner rather than constraining their movements should exploit this knowledge. Therefore the new navigating method may probably be viewed more favourably in the next evaluation cycle.

Viewed as a whole, the user centered design process has been a success in that the users have been involved from the initial stages. They helped to draw up a requirements list for the NeoCare prototype system and made valuable suggestions during the development and evaluation stages, which have in turn led to design modifications for a second iteration.

#### 5.2 Future work

The initial vision for this project was to develop a prototype system to augment the work carried out by the nurses of the NNTP and to contemplate a more efficient method of extracting the data from the nursing documentation for entry into the NNTP database. Due to new job commitments, having led the process to this point this author must now relinquish her involvement in any future work. It is therefore time to adopt a team-based approach to strengthen the project's chances for a successfully implementation into practice. Ownership of

the project will now pass to the Transport Coordinator and all the nurses within the NNTP. A plan for the future development of the NeoCare Transport system is outlined below:

- 1. Discussions should firstly take place with the Transport Coordinator and the users regarding the need to collect the Transport score. Once a decision is reached regarding this change to current data collection practices, the resultant outcome should be factored into any new design modifications.
- 2. The second iteration of the prototype system would include the design modifications identified during the first evaluation that have already been incorporated into the interfaces. The number of participants involved in the evaluation should be expanded to include NNTP members in the other two maternity hospitals. This would lead to more extensive testing of the NeoCare prototype system as the number of participants involved would greatly exceed the initial group. Having participants evaluating the prototype system who have already been introduced to it together with novice users would bring a fresh perspective to the proceedings and might identify new issues. If the need for further modifications are discovered or suggested during this second evaluation a further iteration would need to take place.
- 3. When the stage is reached that no further modifications are necessary it will then be necessary to enlist the services of a computer programmer to write a robust code for the NeoCare prototype system. This would ensure that issues already identified, such as putting constraints on inputting data elements or automatically saving entered data, would be in place. Both the NeoCare database and the NNTP database will also need to be developed.

It is hoped that, following the extensive evaluation, testing and modifying cycles outlined above, and with the combined support of the NNTP nurses and Transport Coordinator, the NeoCare prototype system may finally be extended into practice.

## 5.3 Conclusion

In Ireland the use of information technology in the healthcare setting has been underdeveloped to date. Staff have, in the main, yet to benefit substantially from its adoption at a clinical level. In Ireland, the paper-based record remains the medium of choice. However changes are occurring which will hopefully place suitable emphasis on clinicians being supported by technology rather than the reverse (Department of Health and Children, 2004).

Over the past number of years, the area of neonatal transport has not seen an explosion of scientific information (Cornette, 2004). In this climate of financial constraint there is obviously a strong need to justify continued service support, both financially and clinically. There are areas where improvements can be made. By establishing a minimum dataset for collection, improving data capture and extraction for clinical audit, it is hoped that this evidence would be readily available.

The use of mobile computing in healthcare is gaining momentum. PDA's seem to be the device of choice for a number of clinicians (Carroll *et al.* 2004, Lapinsky *et al.* 2001, McAlearney *et al.* 2004). However, their role in nursing still remains uncertain. Where they have been evaluated their screen size has been cited as a critical drawback to their use (Choi *et al.* 2004). The Tablet PC may overcome this problem. To date their use in healthcare is limited but they may yet find their niche market. It is felt they would be the most appropriate choice for the NNTP in terms of portability, weight and battery life.

Due to the nature of care delivered in Intensive Care Units, large volumes of data are generated. Recent research has found that the amount of time spent documenting routine information, nursing notes and hourly observations in this setting can be reduced with the introduction of a Clinical Information System (Simpson, 2001, Fraenke *et al.* 2003). It could then be postulated that developing an electronic system to support the nurses working in the NNTP would have similar benefits.

To increase the likelihood of project success it is essential to adopt a user-centered design approach. This is particularly important in the healthcare setting when systems are directly involved in the delivery of patient care (Fitch, 2004). Systems should be designed around the users and should complement current workflow practices. Users should be involved in system design from an early stage. Failure to give due recognition to user input can have a detrimental effect in project success (McManus, 2000). Research has shown that combining focus group interviews and usability testing is an effective means of eliciting user requirements (Garment *et al.* 2004).

Conducting focus group interviews is an acquired skill. It can be a challenge to obtain the desired data to draw up a requirements list while it is easier to uncover more abstract data. The participants in the focus group were on the whole enthusiastic about the prospect of using the NeoCare prototype system. Their attitude supports the finding that critical care nurses are more accepting of new technology, especially where it is directly involved in the provision of patient care (Fraenke *et al.* 2003). From the data gathered from the interviews, together with the author's own input the prototype system was designed.

Microsoft Visual Basic was the software prototyping tool used to design and implement the user interfaces for the electronic documentation. The order of the forms was designed to complement the current data collection processes. At stages during the design phase feedback was sought from NNTP members familiar with the paper documentation and based on their recommendations alterations were made to certain forms. The users evaluated the NeoCare prototype system once the design stage was completed. Difficulties were encountered with the practicalities of using a Tablet PC to run the prototype program. Clearly some handwriting was more easily converted to text than others but this difficulty should hopefully be overcome through greater use of the Tablet PC. One striking finding was that, unless prior agreement has been reached, any change in workflow practices causes great dissent. The inclusion of the Transport score bears this point out. Discussion now needs to take place between the Transport Coordinator and the NNTP members to resolve this issue.

Modifications were suggested during the evaluation. Some have already been made to selected forms, while others still need to be incorporated into the next iteration. Further testing of the NeoCare prototype system would be extended to include those NNTP nurse members in the other two hospitals. This new group of nurses would view the prototype system with a fresh eye, while the original participants would also be available to critique the design modifications.

It is hoped that following further redesigning and testing the NeoCare prototype system will finally be extended into practice. Ownership of the system, due to their participation and commitment, will deservedly rest with the nurse members of the NNTP. The extension of such a system into practice would lead the way in transforming the way care is documented during transport episodes, and the way that collected data is used for further purposes, helping the Irish NNTP join the drive towards creativity and innovation within the neonatal transport community.

# References

Agostino, R., Fenton, A.C., Kollee, L.A.A., Chabernaud, J.L., Carrapato, M.R., Peitersen, B. (1999) Organisation of neonatal transport in Europe. <u>Prenatal Neonatal Medicine.</u> 4(Supp 1): 20-34.

Al-Khaldi, M.A., Wallace, R.S.O. (1999) The influence of attitudes on personal computer utilization among knowledge workers: the case of Saudi Arabia. <u>Information and Management.</u> 36: 185-204.

Ambler, S.W. (2000) User Interface Design: Tips and Techniques (on line). Available: <u>http://www.ambysoft.com/userInterfaceDesign.pdf</u> (04/12/2004).

Ambler, S.W. (2004) <u>The Object Primer: Agile Model Driven Development With UML 2.</u> 3<sup>rd</sup> Ed. Cambridge:University Press.

Ammenwerth, E., Mansmann, U., Iller, C., Eichstadter, R. (2003) Factors Affecting and Affected by User Acceptance of Computer-based Nursing Documentation: Results of a Twoyear Study. Journal of the American Medical Informatics Association. 10(1): 69-84.

Annual Report (2003) <u>National Neonatal Transport Programme (Unpublished)</u>. Dublin: Neonatal Transport Coordinator. Rotunda Hospital.

Bakken, S. (2001) An Informatics Infrastructure Is Essential for Evidence-based Practice. Journal of the American Medical Informatics Association. 8(3): 199-201.

Bates, D.W. (1999) Frequency, consequences and prevention of adverse drug events. Journal of Quality in Clinical Practice. 19(1): 13.

Boyd, S. (2000) Neonatal transport In: Boxwell, G. (ed) <u>Neonatal Intensive Care Nursing.</u> London: Routledge.

Butler, M.A., Bender, A.D. (1999) Intensive Care Bedside Documentation Systems: Realizing Cost Saving and Quality Improvements. <u>Computers in Nursing.</u> 17(1): 32-38.

Carroll, A.E., Tarczy-Hornoch, P., O'Reilly, E., Christakis, D.A. (2004) The Effect of Pointof-Care Personal Digital Assistant Use on Resident Documentation Discrepancies. <u>Pediatrics.</u> 113(3): 450-454.

Choi, J., Chun, J., Lee, K., Lee, S., Shin, D., Hyun, S., Kim, D., Kim, D. (2004) MobileNurse: hand-held information system for point of nursing care. <u>Computer Methods and Programs in Biomedicine</u>. 74: 245-254.

Cornette, L. (2004) Contemporary neonatal transport: problems and solutions. <u>Archives of Disease in Childhood: Fetal and Neonatal Edition.</u> 89: F212-F214.

Darbyshire (2000) User-Friendliness of Computerized Information Systems. <u>Computers in Nursing</u>. 18(2): 93-99.

Deloitte and Touche (2001) <u>Audit of the Irish Health System for Value for Money</u>. Dublin: Department of Health and Children.

Dennis, K.E., Sweeney, P.M., Macdonald, L.P., Morse, N.A. (1993) Point of Care Technology: Impact on People and Paperwork. <u>Nursing Economics.</u> 11(4): 229-237.

Department of Health and Children (2004) <u>Health Information: A National Strategy.</u> Dublin: Stationery Office.

Dix, A., Finlay, J., Abowd, G., Beale, R. (1998) <u>Human-Computer Interaction</u>. 2<sup>nd</sup> Edition. Essex: Prentice-Hall Europe.

Dwyer, M., Taaffe, P. (1998) Nursing in 21<sup>st</sup> Century Ireland: Opportunities for Transformation. In: Leahy, A.L., Wiley, M.M. (eds) <u>the Irish Health System in the 21<sup>st</sup> Century.</u> Dublin: Oak Tree Press.

Field, D., Milligan, D., Skeoch, C., Stephenson, T. (1997) Neonatal Transport: time to change? <u>Archives of Disease in Childhood.</u> 76: F1-F2.

Fitch, C.J. (2004) Information Systems in Healthcare: Mind the Gap. In Sprague Jr, R.H. (ed) <u>Proceedings of the 37<sup>th</sup> Hawaii International Conference on System Sciences.</u> IEEE Computer Society, January 2004. [ISBN 0-769-52056-1].

Fraenkel, D.J. Cowie, M., Daley, P. (2003) Quality benefits of an intensive care clinical information system. <u>Critical Care Medicine</u>. 31(1): 120-125.

Garmer, K., Ylven, J., Karlsson, I.C.M. (2004) User participation in requirements elicitation comparing focus group interviews and usability test for elicting usability requirements for medical equipment: a case study. Journal of Industrial Ergonomics. 33(2): 85-98.

Georgiou, A., Pearson, M. (2002) The role of health informatics in clinical audit: part of the problem or key to the solution? Journal of Evaluation in Clinical Practice. 8(2): 183-188.

Halliday, H.L., McClure, G., Reid, M. (1989) <u>Handbook of Neonatal Intensive Care.</u> 3<sup>rd</sup> Edition. London:Bailliere Tindall

Heathfield, H.A., Wyatt, J. (1993) Philosophies for the design and development of clinical decision-support systems.

Hix, D., Hartson, H.R. (1993) <u>Developing User Interfaces: Ensuring Usability Through</u> <u>Product & Process.</u> Canada: John Wiley & Sons, Inc.

Hohlagschwandtner, M., Husslien, P., Klebermass, K., Weninger, M., Nardi, A., Langer, M. (2001) Perinatal mortality and morbidity: Comparison between maternal transport, neonatal

transport and inpatient antenatal treatment. <u>Archives of Gynecology and Obstetrics</u>. 265: 113-118.

Hudson, T. L. (2003) Maximizing a Transport Platform Through Computer Technology. <u>Computers, Informatics, Nursing.</u> 21(2): 72-79.

Humber, M. (2004) National programme for information technology. <u>British Medical Journal.</u> 328: 1145-1146.

Hussein, T., Clarke, T.A., Al Girim, H., Matthews, T.G. (2001) Questionnaire on the practices and priorities in neonatal care in Ireland. <u>Irish Medical Journal.</u> 94(3): 74-78.

Kirkley, D., Rewick, D. (2003) Evaluating Clinical Information Systems. Journal of Nursing Administration. 33(12): 643-651.

Kozer, E., Scolnik, D., Macpherson, A., Keays, T., Shi, K., Luk, T., Koren, G. (2002) Variables Associated With Medication Errors in Pediatric Emergency Medicine. <u>Pediatrics</u>. 110(4): 737-742.

Le Peuple, J., Scane, R. (2003) User Interface Design. Exeter: Crucial.

Lapinsky, S.E., Weshler, J., Mehta, S., Varkul, M., Hallett, D., Stewart, T.E. (2001) Handheld computers in critical care. <u>Critical Care.</u> 5: 227-231.

Leslie, A.J., Stephenson, T.J. (1997) Audit of neonatal intensive care transport – closing the loop. <u>Acta Paediatrica</u>. 86: 1253-1256.

Lun, K.C. (1995) New user interfaces. <u>International Journal of Bio-Medical Computing</u>. 39: 147-150.

McAlearney, A.S., Schweikhart, S.B., Medow, M.A. (2004) Doctors' experience with handheld computers in clinical practice: qualitative study. <u>British Medical Journal</u>. 328:1162-1166.

McManus, B. (2000) A Move to Electronic Patient Records in the Community: A Qualitative Case Study of a Clinical Data Collection System, Problems Caused by Inattention to Users and Human Error. <u>Topics in Health Information Management.</u> 20(4): 23-37.

Marasovic, C., Kenny, C., Elliott, D., Sindhusake, D. (1997) A Comparison of Nursing Activities Associated with Manual and Automated Documentation in an Australian Intensive Care Unit. <u>Computers in Nursing</u>. 15(4): 205-211.

Marren, U., Murnane, R. (2003) Empowering Nurses – Improving Care With I.T. <u>The All</u> <u>Ireland Journal of Nursing & Midwifery.</u> 2(8): 16-17. Nahm, R., Poston, I. (2000) Measurement of the Effects of an Integrated, Point-of Care Computer System on Quality of Nursing Documentation and Patient Satisfaction. <u>Computers in Nursing.</u> 18(5): 220-229.

National Institute for Clinical Excellence (2002) <u>Principles for Best Practice in Clinical Audit.</u> Oxon: Radcliffe Medical Press Ltd.

O'Dwyer, J. (1998) Reflections On Future Structures In The Health Services In: Leahy, A.L., Wiley, M.M. (eds) <u>the Irish Health System in the 21<sup>st</sup> Century</u>. Dublin: Oak Tree Press.

Pabst, M.K., Scherubel, J.C., Minnick, A.F. (1996) The Impact of Computerized Documentation on Nurses' Use of Time. <u>Computers in Nursing.</u> 14(1): 25-30.

Palm.com (2001) Palm Powered Handhelds Improve Emergency Medical Response (on line). Available: <u>http://www.palm.com/us/company/pr/2001/112601.html</u> (05/08/2005).

Parahoo, K. (1997) Nursing Research: Principles, Processes and Issues. Hampshire: Palgrave.

Rashid, A., Bhuta, T., Berry, A. (1999) A regionalised transport service, the way ahead? <u>Archives of Disease in Childhood.</u> 80: 488-492.

Robinson, N. (1999) The use of focus group methodology – with selected examples from sexual health research. Journal of Advanced Nursing. 29(4): 905-913.

Rubin, J. (1994) <u>Handbook Of Usability Testing: How To Plan, Design And Conduct Effective Tests.</u> Canada: John Wiley & Sons, Inc.

Saba, V.K. (2001) Nursing informatics: yesterday, today and tomorrow. <u>International Nursing</u> <u>Review.</u> 48: 177-187.

Shoo, K.L., Zupancic, J.A.F., Pendray, M., Thiessen, P., Schmidt, B., Whyte, R., Shorten, D., Stewart, S. (2001) Transport risk index of physiologic stability: A practical system for assessing infant transport care. Journal of Pediatrics. 139(2): 220-226.

Simpson, R.L. (2001) Compassion meets the computer age. <u>Nursing Management.</u> 32(1): 13-14.

Soe, A. (2005) Managing information. Seminars in Fetal & Neonatal Medicine. 10: 105-112.

Song, L., Ho, J., Ho, S. (1997) The Integrated Patient Information System. <u>Computers in</u> <u>Nursing.</u> 15(2): S14-S22 Supplement.

Stevens, B., Johnston, C., Franck, L., Petryshen, P., Jack, A., Foster, G. (1999) The Efficacy of Developmentally Sensitive Interventions and Sucrose for Relieving Procedural Pain in Very Low Birth Weight Neonates. <u>Nursing Research.</u> 48(1): 35-43.

Turner, D-M. (2002) Defining Nurses' Role in Health Informatics. <u>Canadian nurse</u>. 98(7): 8-10.

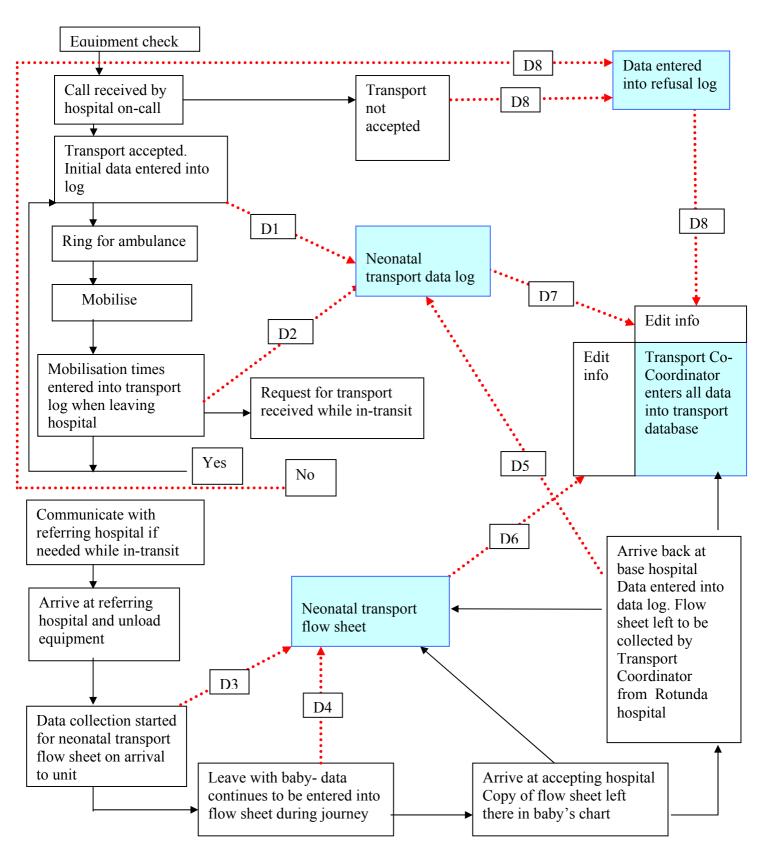
Vasser, J.A., Lin, B., Planchock, N. (1999) Nursing Information Systems: A Survey of Current Practices. <u>Topics in Health Information Management.</u> 19(4): 58-65.

# **Appendices**

 Appendix 1 – Flow of collected nursing data during transport

 Flow of operation:

 Data flow:



Date:	Data Col	llected by	Booked for next day:
Time:	Ground	Air 🗋	Time Booked for:
Name	DOB:	Reasor	n for transport
Referred By:			
Hospital Referring Paediatrici	an F	Phone:	Fax:
document all that take lon	reasons for dela ger than 60 min	ays. Documentation shou nutes.	dard for all transports. Please ald be present for all transports
Transport initiated a	t: Sault	Team r	notified by:
Tean	1	Arrival Time	Delays
Nurse:			
(In-house: Yes  Ambulance Controller	I No 🗅)		
ERHA Team			
Time Team left NICU		Departure Mobilisation time	Phone call to referrin hospital with ETA
		Return Data	
Time team return to	base:		ime of transport (departure to returr

# Appendix 2 – Booking form

Data	Data items
label D1	General data:
	Date, time, data collected by, ground/air transport, booked for next day, time
	booked, name, DOB, reason for transport, name of referring hospital and
	pediatrician, phone/fax number, transport initiated at, team notified at, name of
	nurse and doctor, doctor in-house – yes/no, ambulance controller, ERHA team.
D2	Departure data:
	Time team left NICU, mobilisation time, phone referring hospital with ETA.
D3	General info: Name, DOB, date, weight, ETT size, length, type, taped at.
	Vital signs: Time, axilla/rectal, skin and incubator temperatures, heart rate,
	IBP/NIBP readings, mean BP, respiratory rate, colour, oxygen saturation.
	Ventilation: Mode, rate, oxygen requirements, PIP/PEEP, MAP, I:E ratio, Hz,
	inspiratory time, AMP, air entry – R/L, suctioned orally, suctioned ETT.
	Items to tick if appropriate: Name band, maternal blood, x rays, baptised, PKU,
	Mother has: photo of infant, seen infant, touched infant, received NNU
	information, expressed wish to breast feed.
	Procedures performed (tick if appropriate): IV insertion, UVC insertion, UAC
	insertion, N/G insertion, intubation, chest aspiration, chest tube insertion, other.
	Neurological assessment (if appropriate): Time, R eye – size and reaction, L eye
	- size and reaction, neonatal arousal scale score, comments.
	Fluid management: IV fluids (for each line): Site, solution, rate.
	Intake: Volume at time of reading for each line
	Output: Urine, stools, N/G aspirate, chest tube, abdominal girth, glucose reading.
	Drug prescription (for each drug given): Time, drug, dose, route, signature.

# Appendix 3 – Data description

Data label	Data items
D3	Assessment:
	Neuro: State of consciousness/neonatal arousal scale, muscle tone, reflexes, cry,
	fontanels, sutures, head circumference
	Cardiovascular: Pulses, ECG rhythm, perfusion, central lines.
	Respiratory: Colour, character, breath sounds, secretions.
	Gastrointestinal: Abdomen, bowel sounds, gastric tubes, abdominal girth.
	Genitourinary: Other.
	Skin: Colour, abnormalities, other.
	Signature:
	Exceptions to assessment findings: Drawing of baby from front and back – to
	put x-marks at any places where exceptions are located, free text then given to
	describe these items.
	Nursing notes: Free text area to write any relevant notes.
	Blood gases (for each one recorded): Source, time, Ph, PO2, PCO2, St Bic,
	BE.
	Nurse's name and signature:

Data label	Data items
D4	At timed intervals:
	Vital signs: Time, axilla/rectal temperature, incubator temperature, skin
	temperature, heart rate, invasive BP or non-invasive BP reading, mean BP,
	respiratory rate, colour, oxygen saturation.
	Ventilation: Mode, rate, oxygen requirements, PIP/PEEP, MAP, I:E ratio, Hz,
	inspiratory time, AMP, air entry – R/L, suctioned orally, suctioned ETT.
	Fluid management:
	IV fluids (for each line): Site, solution, rate.
	Intake: Volume at time of reading for each line
	Output: N/G aspirate, glucose reading.
	Drug prescription (if given): Time, drug, dose, route, signature.
	Neurological assessment (if appropriate): Time, R eye – size and reaction, L
	eye – size and reaction, neonatal arousal scale score, comments.
	Blood gases (if done): Source, time, Ph, PO2, PCO2, St Bic, BE.
	Nursing notes (if necessary): Free text area to write any pertinent notes.
D5	Return data:
	Time team returned to base, total time of transport (departure to return), patient
	destination – tick either Coombe, Crumlin, NMH, Rotunda, Temple Street.

Data label	Data items
D6	From neonatal transport flow sheet:
	DOB, present weight, adverse events recorded, procedures done, resuscitation drugs
	given, other drugs given, IV fluids given, any unusual events recorded.
	Only one value for each of the following items is recorded in database: Vital signs
	- Temperature, heart rate, respiratory rate, BP,
	Ventilation settings – Rate, IE ratio, PIP, PEEP, O2 requirements.
	Items to be ticked if performed or applicable:
	O2, intubated, blood gas, x-rays, sedated, muscle relaxants, seizures, alert/oriented.
	Transport score:
	Score given to the following data – glucose, PH, O2 requirements, systolic BP.
	From neonatal transport data log:
	Referring hospital, referring pediatrician, destination hospital, provisional diagnosis,
	date of transport, transport initiated at, team nurse in-hospital – yes or no, team nurse
	arrival time if not in-hospital, team doctor in-hospital, team doctor arrival time if not
	in-hospital, team doctor delays, time leaving NNU, ETA phone call – yes or no, time
	return to base.
D7	Refusal data:
	Date, time call received, destination, name, reason for transport, gestation, age, was
	NNTP requested? Would NNTP have been requested if available?

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# Appendix 4 – Carbon copy section of Flow sheet

# Appendix 5 – Story from Focus group interview

Call received by hospital on-call

New file opened on Tablet PC and initial data entered.

Call either accepted or refused by highlighting option.

- Call accepted
  - o Any data elements already entered automatically entered into flow sheet
- Call refused
  - Automatically opens refusal screen where data elements already entered will be automatically entered and reason for refusal will be added. This saved data will then be either emailed to Ann Bowden or saved to floppy disc for collection.

While in-transit any call received for transport is entered into system and either refused or accepted.

At referring hospital flow sheet is started. Vital signs data (apex beat, resp rate, blood pressure and oxygen saturation) can be entered by two means – either by attaching baby to propac or by entering data via pen technology.

Short cuts will be used as much as possible but, where necessary, free text will be entered using screen keyboard.

In ambulance/helicopter on the way back the tablet will be hooked up to the monitor and all recorded vital signs will be automatically entered. Other elements, such as temp or hemacue would have to be entered by nurse.

At the accepting hospital the tablet would be connected to a printer and a printout of the recorded data would be generated.

Back at base final details, such as time of transport, are added and the complete file is either emailed to the Transport Coordinator or saved onto disc for collection.

# Appendix 6 – Requirements list

## 1.1 User interface requirements

The system shall provide user interfaces for each of the following features:

UI\_1 Login

- UI\_2 Booking details
- UI\_3 Refusal log
- UI\_4 Team statistics
- UI\_5 Checklist
- UI\_6 Baby details
- UI\_7 Flow sheet
- UI\_8 Transport score
- UI\_9 IV Fluids and drugs form
- UI\_10 Assessment form
- UI\_11 Intake and Output chart
- UI\_12 Vital signs
- UI\_13 Blood results
- UI\_14 Predeparture checklist
- UI\_15 Completion details
- UI\_16 Untoward events

## UI\_1 Login

Requi	ired fields
1.	User Name
2.	Password

Two command button options will then be available, OK and Cancel. The user clicks on the command button OK if appropriate. If a wrong user name or password has been entered the user will have the option to click the cancel button and reenter correctly. If someone tries to enter the system who is not a recognised user a message box will appear with the words "Unauthorised user".

# 1.1.2 UI\_2 Booking details

This interface contains the initial details recorded when requesting a neonatal transfer.

#### Automatic entries

Date and time call received

#### **Baby's details**

- 1. Baby's name
- 2. Date of birth
- 3. Time of birth
- 4. Gestational age
- 5. Gender option buttons allow a choice of either male or female.
- 6. ID number
- 7. Reason for transport

# **Referring hospital**

- Name of hospital a combo box will list the 27 hospitals commonly availing of the service alphabetically, or it will also be possible to input a hospital's name manually.
- 2. Name of hospital ward
- 3. Phone number of hospital ward
- 4. Referring consultant
- 5. Time decision was made to transfer baby
- 6. Any delay in contacting the team choice of Yes or No option buttons
- 7. Reasons for delay in contacting the team if applicable.

## **Accepting hospital**

- 1. Name of hospital an identical combo box to the referring hospital's name will be used here
- 2. Name of hospital ward
- 3. Accepting consultant

Two command buttons will then offer the user a choice of either accepting or refusing the transport.

# 1.1.3 UI\_3 Refusal log

The refusal log interface will be displayed if the appropriate command button in UI\_2 is clicked.

# Automatic entries

- 1. Date and time call received
- 2. Referring hospital
- 3. Baby's name
- 4. ID number
- 5. Gestational age
- 6. Reason for transport
- 7. Accepting hospital

# Manual entry

 Reason for refusal – a combo box will offer the user a number of choices or, if they do not correspond to the situation, a new one may be entered manually.

# 1.1.4 UI\_4 Team statistics

If the choice is made on the booking form to accept the transport this interface will open instead of the refusal log.

# Team members

- 1. Name of nurse
- 2. Name of Doctor
- 3. Name of ambulance personnel a choice will be made from options in a listBox
- 4. Name of on-call hospital a choice will be made from the three options in a listBox
- 5. Mode of transport two option buttons offer a choice of ground or air transport

# 1.1.4 UI\_4 Team statistics (continued)

## Times

- 1 Time transport accepted
- 2 Initiation delays a combo box will offer a choice of three options or, if none are appropriate, the data will be entered manually.
- 3 Time team leaves base
- Mobilisation time this will be automatically calculated by subtracting the "Time transport accepted" from the "Time team leaves base".
- 5. Reason for mobilisation delays the NNTP required the transport team to mobilise within 45 minutes of accepting a transport. It will be compulsory to fill in this field if this time is exceeded.

When leaving the base hospital the user will click on the command button "Leaving base hospital. This opens the Checklist interface.

#### 1.1.5 UI\_5 Checklist

The checklist interface will serve as a map to guide the user through the next number of interfaces. It consists of the names of a number of forms, with each form having a corresponding command button titled OK. In turn all the command buttons will be deselected save for the one that the user will click on next. There will be six command buttons in this interface linked to the following text boxes:

#### **Steps in the data entry process**

- 1. Booking form and Team statistics completed
- 2. On arrival at Referring hospital click on the OK button to start new baby file
- 3. Open new flow sheet
- 4. Open IV Fluids and Drugs form
- 5. Open Assessment form
- 6. Open Intake and Output chart

On arrival at the Referring hospital the user will click on the OK command button linked to the second item on the Checklist to open the baby details form.

## 1.1.6 UI\_6 Baby details

# <u>Patient details</u>

# Automatic fields

- 1 Baby's name
- 2 Date of birth
- 3 ID number

### **Required fields**

- 1. Birth weight
- 2. Current weight
- 3. PKU taken? choice of Yes or No option buttons
- 4. Konakion given? choice of Yes or No option buttons

# <u>Airway</u>

The user selects an option from the following selection by clicking on the appropriate option button:

Self-ventilating

CPAP

Ventilated

Ambient O2

Nasal prongs

# ETT

ETT size – a listbox will offer a choice of five options

ETT type – a listbox offers two choices

ETT length

ETT length at lips/nose

The user will then click on the Next command button that will reopen UI\_5 (Checklist). At this stage the only option available to the user will be to click on the OK command button to open the Flow sheet interface.

## 1.1.7 UI\_7 Flow sheet

#### Automatic entries

- 1. Date
- 2. Baby's name
- 3. ID number

#### **Manual entries**

#### **Times**

- 1. Arrival time at referring hospital
- 2. Departure time
- 3. Time of arrival at accepting hospital
- 4. Time of return to the base hospital

<u>Vital signs</u> - the following data are entered into vertical columns (One column for each time interval)

- 1. Time
- 2. Axilla/rectal temperature
- 3. Skin temperature
- 4. Incubator temperature
- 5. Colour
- 6. Heart rate \*
- 7. Respiratory rate \*
- 8. SAO2 \*
- 9. NIBP systolic and diastolic readings \*
- 10. IBP systolic and diastolic readings \*
- 11. Mean BP -NIBP and IBP readings \*

The vital signs that are starred (\*) are the ones that will be automatically captured once the baby is attached to the cardiorespiratory monitor. This monitor will interface with the Tablet PC.

## 1.1.7 UI\_7 Flow sheet (continued)

12. Cerebral signs - a number is entered here based on the following devised score which will be displayed in the Flow sheet

#### Cerebral signs score:

- 6	Arching/hypertonic =	Toe curling $= 3$	None = 0
- 7	Jerky movements =	Staring = 4	Fisting = 1
- 8	Seizing =	Hiccupping = 5	Mouthing $= 2$

## Ventilation settings

- 1 Ventilation mode
- 2 Ventilation rate
- 3 FIO2%
- 4 PIP
- 5 PEEP
- 6 MAP
- 7 I:E Ratio
- 8 Inspiratory Time
- 9 Air entry R/L

#### 10 Suction

A text box will also be available to input nursing notes as required.

5 command buttons at the bottom of the interface will allow the user navigate between forms. They will be deselected until all the forms on the Checklist have had initial data entered.

#### **Command buttons**

- 1. Confirm vital signs
- 2. Blood results
- 3. IV Fluids and Drugs
- 4. Intake and Output
- 5. Predeparture checklist

Initially the only command button available to the user will be Next (returns user to

UI\_5 – Checklist)

## 1.1.8 UI\_8 Transport score

This is calculated by giving a score to five physiological parameters, and is completed on arrival at the referring hospital, on departure from the referring hospital and on arrival at the accepting hospital. The interface will be accessed from the Flow sheet. When the user enters the arrival time at referring hospital, the departure time and the time of arrival at the accepting hospital she will click on a command button "Enter" beside each time text box. This will open the Transport score.

#### Automatic entries

- 1. Date
- 2. Baby's name
- 3. ID number

#### **Manual entries**

- 1. Glucose level
- 2. Mean Blood Pressure
- 3. Blood pH
- 4. PO2 (Blood gas reading or SAO2 reading)
- 5. Temperature

Clicking on the command button next will return the user to the Flow sheet.

# 1.1.9 UI\_9 IV Fluids and drugs form

Clicking on the command button "OK" on the Checklist form will initially open this form. Once all initial forms are completed clicking the appropriate command button on the Flow sheet will open it.

## Automatic entries

- 1. Baby's name
- 2. ID number

# **Manual entries**

- 1. Total mls/Kg
- 2. IV Fluids It will be possible to enter six IV infusions. For each infusion the following data will be entered:
  - Site a choice of 5 in a listbox.
  - Solution a choice of 13 in a combo box or solution may be entered manually.
  - Rate
  - Dose Optional entry if appropriate
- Drugs There will be space to enter 9 drugs. For each drug the following data will be entered:
  - Time
  - Drug a choice of 6 from list box or manual data entry
  - Dose
  - Route a choice of 6 from list box
  - Signature the name of nurse and doctor checking drug

Clicking on the Next command button will return the user to the Checklist. Two deselected command buttons, which open the Flow sheet and the Intake and Output form, will be used to navigate between these forms once all initial data has been entered into the forms on the Checklist.

# 1.1.10 UI\_10 Assessment form

This form is accessed from the Checklist form. Once completed it will be impossible to return to it.

# **Automatic entries**

- 1. Date
- 2. Baby's name
- 3. ID number

# **Manual entries**

The user will input data into the following text boxes:

- 1. Neurological assessment
  - Consciousness level
  - Muscle tone
  - Cry
- 2. Cardiovascular assessment
  - Precordial activity
  - Perfusion
- 3. Respiratory assessment
  - Breath sounds
  - Secretions
- 4. Gastrointestinal assessment
  - Abdomen
  - Bowel sounds
  - Gastric tubes

The user will also be able to enter free text into a text box entitled "Exceptions to assessment findings".

Clicking on the Next command button will return the user to the Checklist.

### 1.1.11 UI\_11 Intake and Output chart

This form will be accessed from UI\_5 (Checklist). The user will also be able to access it by clicking command buttons on UI\_7 (Flow sheet) and UI\_9 (IV Fluids and Drugs) once initial data has been entered into all forms on UI\_5.

#### **Automatic entries**

- 1. Baby's name
- 2. ID number
- 3. Date

## **Manual entries**

- 1. Intake A table consisting of 8 columns. The time will be entered into the 1<sup>st</sup> column. The name of each IV fluid entered into UI \_9 (IV Fluids and drugs) will be automatically entered into the subsequent 6 column headings. Each of these columns is subdivided into two columns; the first one will be used to enter the hourly infusion readings while the second one will be used to enter the calculated hourly volume infused. This will be an automatic calculation that will first be calculated when the 2<sup>nd</sup> hourly reading is entered. A final column (Totals) will automatically calculate the total volume of fluids infused hourly and this accumulated total will be automatically updated hourly when the readings are entered.
- 2. Output this table will consist of 7 columns as follows:
  - 1) Time
  - 2) Pu (passed urine)
  - 3) BO (bowels opened)
  - 4) N/G aspirate (nasogastric aspirate)
  - 5) Glucose
  - 6) Abd girth (abdominal girth)
  - 7) Chest tube

The times are automatically entered when the time is entered into the intake table. Data is entered into the relevant columns when appropriate.

The command button Next will return the user to the Flow sheet.

#### 1.1.12 UI\_12 Vital signs

The Vital signs form will display selected vital signs in graphical form. When the vital signs monitor, that records heart rate, respiratory rate, oxygen saturation levels, invasive and non-invasive blood pressure, is attached to the baby the monitor will interface with the Tablet PC and will automatically capture that data. The temperature readings, which the nurse will enter manually, will also be displayed in graphic form. The nurse will have to confirm the hourly reading on the Flow sheet by clicking on the Confirm vital signs command button that will then automatically enter the data into the graphs.

#### **Automatic entries**

- 1. Date
- 2. Baby's name
- 3. ID number

## **Graph 1 – Temperature**

- 1. Axilla/rectal temperature
- 2. Skin temperature
- 3. Incubator temperature

#### **Graph 2 – Observations**

- 1. Heart rate
- 2. Respiratory rate
- 3. SAO2
- 4. NIBP systolic reading
- 5. NIBP diastolic reading
- 6. NIBP mean
- 7. IBP systolic reading
- 8. IBP diastolic reading
- 9. IBP mean

The command button Flow sheet will return the user to the Flow sheet.

### 1.1.13 UI\_13 Blood results

#### **Automatic entries**

- 1. Baby's name
- 2. ID number

Blood gases – each blood gas will have the following elements inputted:

- 1. Source a choice of 3 from a list box
- 2. Type -a choice of 2 from a list box
- 3. Time
- 4. pH
- 5. PCO2
- 6. BE
- 7. St Bic
- 8. PO2

FBC

- 1. Hb
- 2. PCV
- 3. WCC
- 4. Platelets

## Urea and electrolytes

- 1. Na+
- 2. K+
- 3. Ca++
- 4. SBR: T/D

A text box will also be available to record any other results.

A command button will return the user to the Flow sheet (UI\_7).

# 1.1.14 UI\_14 Predeparture checklist

#### Automatic entries

1. ID number

**Procedures performed -** Check boxes for the following items will be selected if appropriate:

- 1. IV insertion
- 2. Umbilical line insertion
- 3. Arterial line insertion
- 4. Nasogastric tube insertion
- 5. Intubation
- 6. Chest aspiration
- 7. Chest tube insertion

A free text box will also offer the user space to record any procedures performed that are not listed above.

Checked items – Check boxes are selected for the following items if applicable:

- 1. Name bands on baby
- 2. Maternal bloods taken
- 3. Xrays to accompany baby
- 4. Consent form signed
- 5. Received religious rites a choice of Yes or No option buttons

Mother has – Check boxes are selected for the following items if applicable:

- 1. Expressed wish to breastfeed
- 2. Received NNU information
- 3. Photo of baby
- 4. Seen baby
- 5. Touched baby

A command button Enter will return the user to the Flow sheet (UI\_7).

# 1.1.15 UI\_15 Completion details

This form will be opened by clicking on the command button Enter linked to the element Time of return to base on UI 7.

Untoward events - a choice of Yes or No option buttons

If No is selected the transport episode will be finished and the checkbox Incident form

completed will be deselected. The Finish command button will close the program.

If Yes is selected this action will open the Untoward events form.

# 1.1.16 UI\_16 Untoward events

### Automatic entries

- 1. Date
- 2. Baby's name
- 3. ID number

**Baby** – Check boxes are selected for the following items if applicable:

- 1. Desaturation requiring stimulation
- 2. Rise in CO2
- 3. Accidental extubation
- 4. ETT blocked
- 5. Pupil changes

**Equipment** – Check boxes are selected for the following items if applicable:

- 1. Ventilator failure
- 2. Infusion pump failure
- 3. Loss of IV
- 4. Bag not equipped
- 5. Communication issues
- 6. Monitor failure
- 7. Ambulance problem
- 8. Failed gas supply

## 1.1.16 UI\_16 Untoward events (continued)

A text box Other will be available to the user to enter an unlisted event.

A further text box Action taken will be where the user will enter data manually.

The command button Enter will return the user to the Completion details form where this action will also enter a tick in the check box Incident form completed. Clicking the Finish command button will close the program.

### **1.2 Performance requirements**

PERF\_1 *Mandatory* The program shall be capable of running on a Tablet PC, which runs Windows XP OS and has memory and processor speed capabilities identical to that of a desktop computer.

PERF\_2 Mandatory The program shall respond to all requests within 500 milliseconds.

PERF\_3 Mandatory The system shall be unaffected by unsteady road conditions.

PERF\_4 Mandatory The system shall have wireless connectivity capabilities.

PERF\_5 *Mandatory* The battery supply must be capable of running the system for a minimum of five hours continuous use.

### **1.3 Software System Attributes**

#### 1.3.1 Reliability

REL\_1 Mandatory The system shall run for a minimum of eight hours without failure.

#### 1.3.2 Ease of use

US\_1 *Mandatory* All inputs shall be capable of being entered within 10 seconds by a nurse with two hours training on the system and minimal previous IT experience.

US\_2 *Mandatory* When mobile data shall be entered by either using the tablet pen or by writing directly to the screen.

US\_3 *Mandatory* When stored in the docking system at the base hospital it shall be possible to enter data using a keyboard.

US\_4 Mandatory A help feature shall be available for each input screen.

US\_5 Mandatory Data shall be automatically saved.

US\_6 *Mandatory* Screens should be capable of being read by those with less than perfect eyesight.

US\_7 *Mandatory* Screens that use colour, should be capable of being read by a colourblind user.

## 1.3.3 Portability

P\_1 Mandatory The Tablet PC shall weigh a maximum of three pounds.

P\_2 *Mandatory* The Tablet shall be easily removed from the docking station without having to disconnect any peripheral devices.

P\_3 *Mandatory* The Tablet shall be durable enough to withstand occasional rough handling.

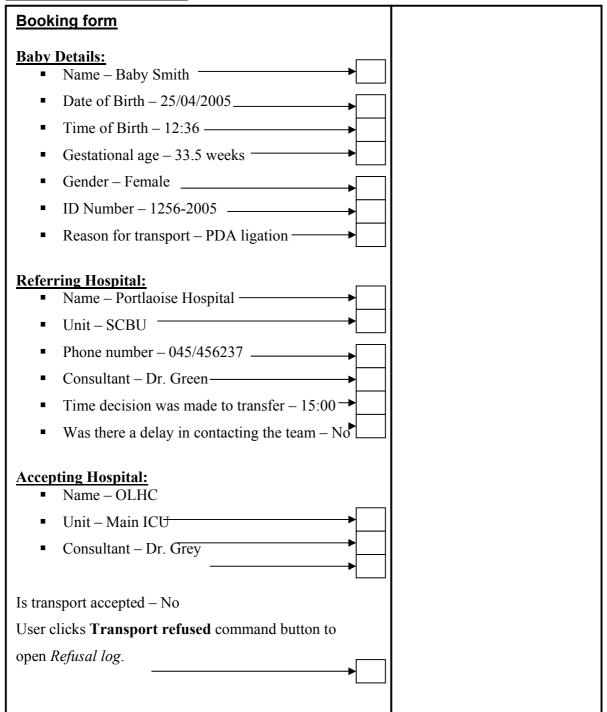
### 1.3.4 Security

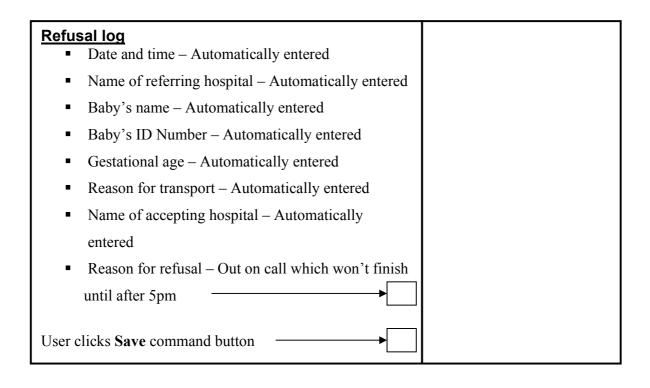
S\_1 Mandatory Access to the system shall be restricted to those with password clearance.

S\_2 *Mandatory* If the system is idle for more than 30 minutes it shall be necessary for the user to re-enter her password.

# Appendix 7 – Refused neonatal transport

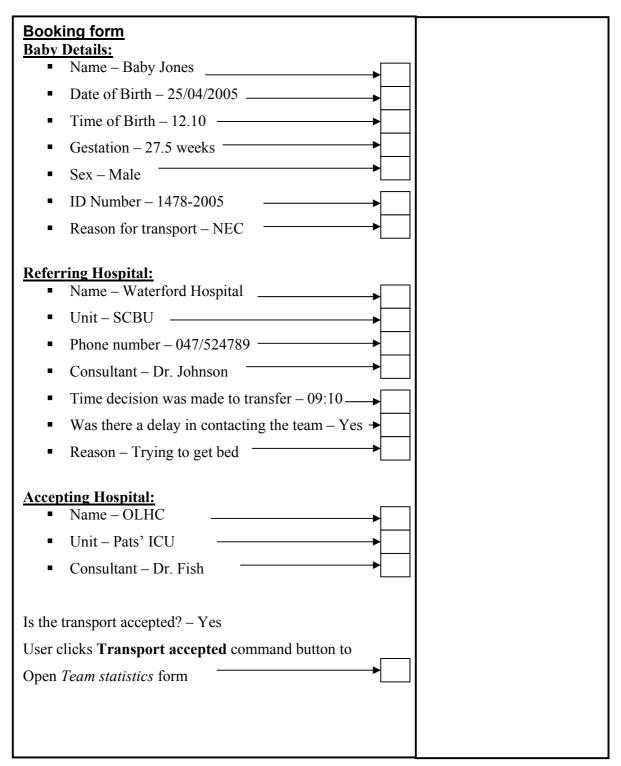
**Refused neonatal transport** 

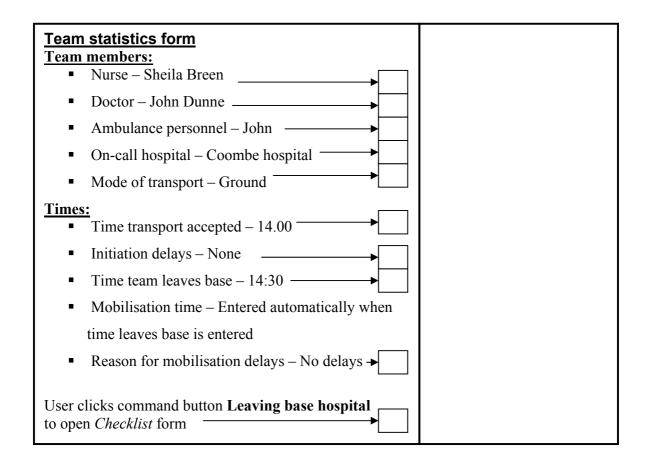




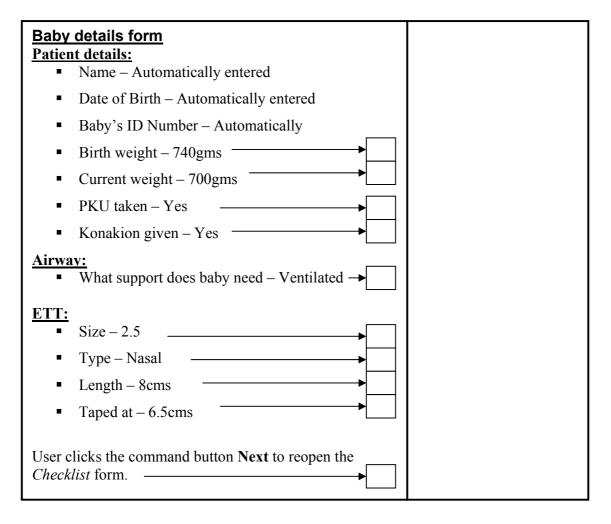
# Appendix 8 – Accepted neonatal transport

Accepted neonatal transport



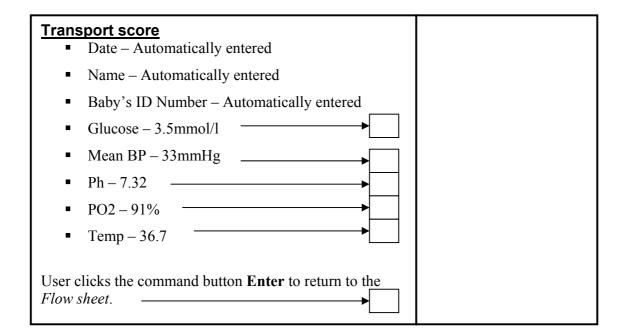


Checklist form	
User clicks only available command button <b>OK</b> to open new baby file	



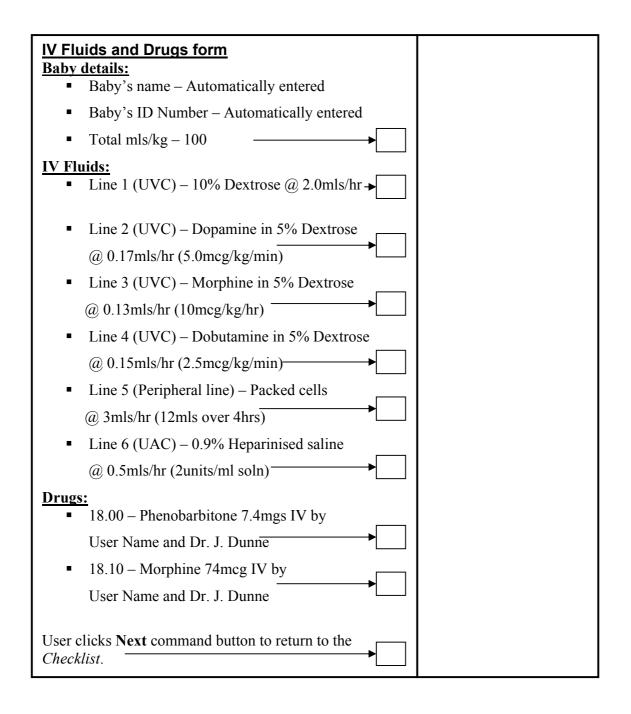
|--|

Flow sheet Baby details:	
<ul> <li>Date – Automatically entered</li> </ul>	
<ul> <li>Baby's name – Automatically entered</li> </ul>	
<ul> <li>Baby's ID Number – Automatically entered</li> </ul>	
■ Time of arrival – 17.00	
User clicks <b>Enter</b> , which opens <i>Transport score</i>	

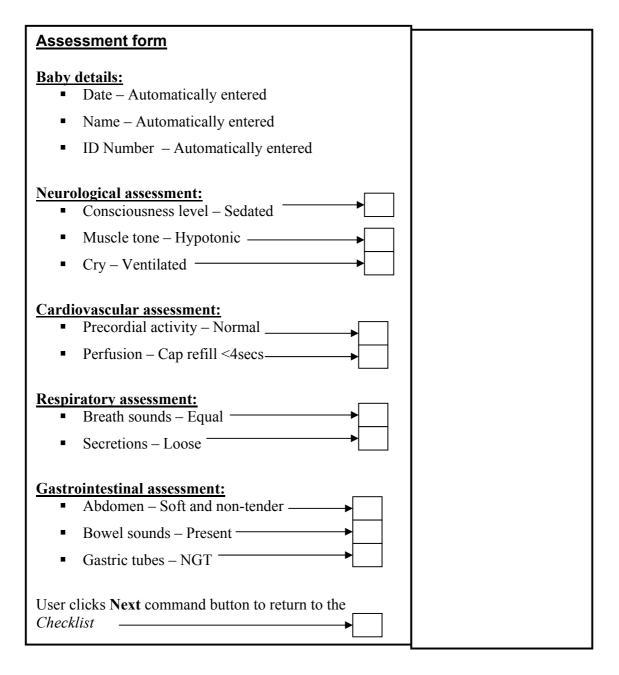


Flow sheet         Observation:         • Time – 17.15         • Axilla/Rectal temp – 36.7         • Skin temp– 36.2         • Incubator temp – 35         • Colour – Pink         • Heart rate – 166         • Resp rate – 60         • SAO2 – 95%         • NIBP (Sys/Dia) – 54/36         • IBP (Sys/Dia) – 50/30         • Mean (NIBP/IBP) – 41/33         • Cerebral signs – 0	Vent settings: Mode – IMV Rate – 60 FiO2 – 75% PIP – 20 PEEP – 5 MAP – 9 I:E Ratio – 1:1 I/Time – 0.4 Air entry – Equal Suctioned – ETT	
User clicks <b>Next</b> command button to <i>Checklist</i>	• return to the	

ist form cks only available command button <b>OK</b> to <i>Fluids and Drugs</i> form.
---



Assessment form.
------------------



Checklist form	
User clicks only available command button <b>OK</b> to open <i>Intake and Output chart</i> .	

# Intake and Output form

#### **Baby details:**

- Baby's name Automatically entered
- Baby's ID Number Automatically entered
- Date Automatically entered

# Intake:

The names of all fluids entered into the IV Fluid and Drugs form are automatically entered into the labels at the top of the intake and output chart. The volumes are entered into the first column of the relevant fluid

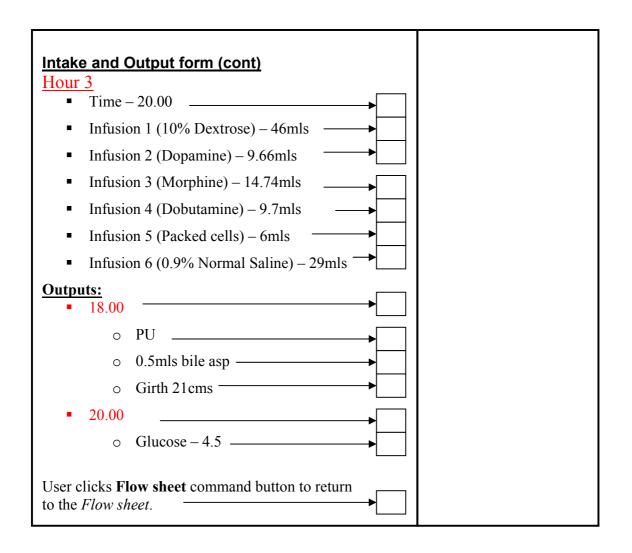
# Hour 1

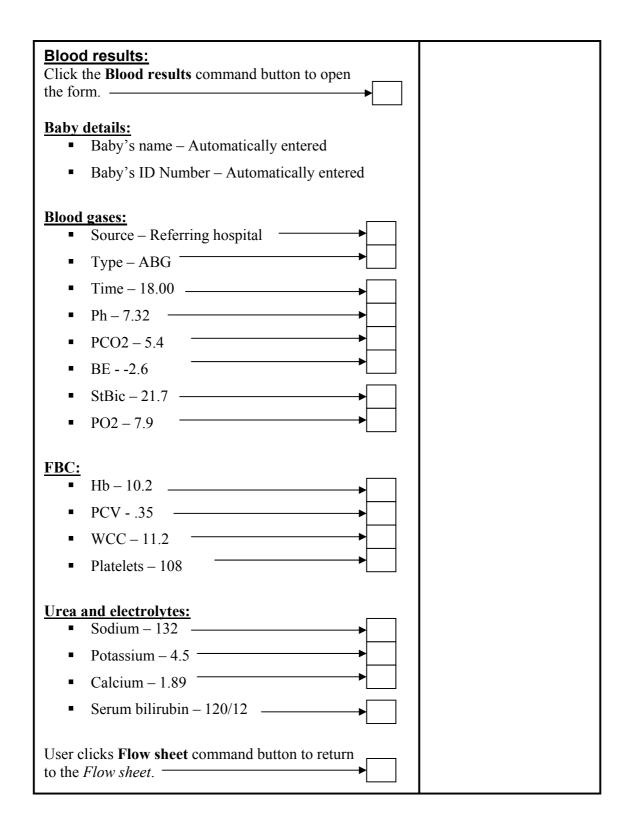
- Time 18.00
- Infusion 1 (10% Dextrose) 50mls
- Infusion 2 (Dopamine) 10mls
- Infusion 3 (Morphine) 15mls →
- Infusion 4 (Dobutamine) 10mls —
- Infusion 5 (Packed cells) 12mls
- Infusion 6 (0.9% Normal Saline) 30mls →

# Hour 2

- Infusion 2 (Dopamine) 9.83mls
- Infusion 3 (Morphine) 14.87mls
- Infusion 4 (Dobutamine) 9.85mls –
- Infusion 5 (Packed cells) 9mls —
- Infusion 6 (0.9% Normal Saline) 29.5mls –

These volumes are entered into the first column of the second hour. The hourly volume infused of each infusion is automatically calculated and inserted into the second column of the relevant fluid.



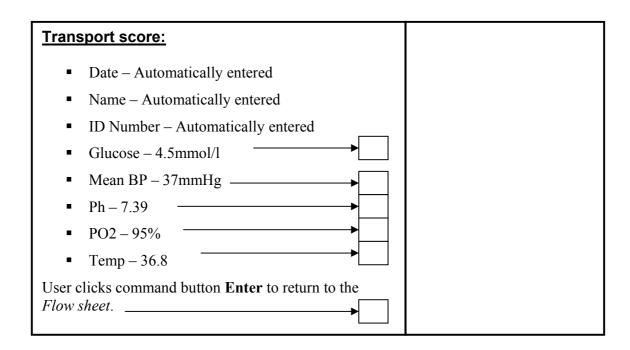


## Vital signs: Baby details:

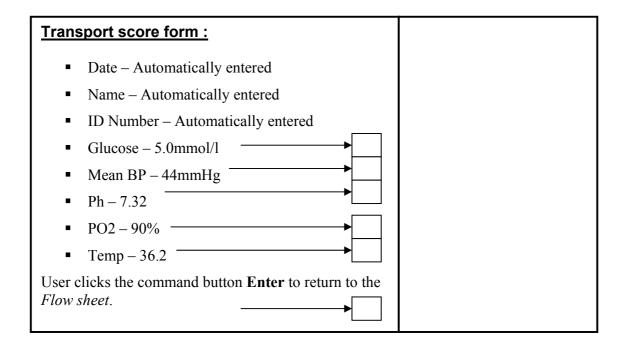
- Baby's name Automatically entered
- Baby's ID Number Automatically entered
- Date Automatically entered

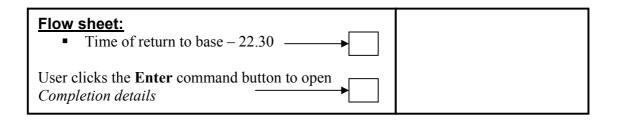
The user will see the graphs of the selected vital signs but will be unable to update them.

User clicks **Flow sheet** command button to return to the *Flow sheet*.

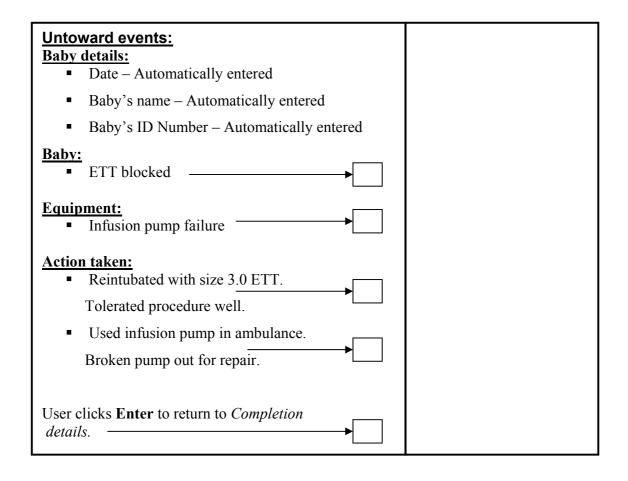


Flow sheet:		
<ul> <li>Time at accepting hospital – 21.50</li> </ul>	- <b>&gt;</b>	
Click the <b>Enter</b> command button to open the <i>Transport score</i>	- <b>&gt;</b>	





Completion details: ■ Untoward event – Yes	
Opens Untoward events form.	



Completion details:	
Incident form completed tick box automatically ticked.	
User clicks <b>Finish</b> to complete transport episode	