

**A DECLARATIVE MODEL OF
CLINICAL INFORMATION SYSTEMS
INTEGRATION IN INTENSIVE CARE**

**A THESIS SUBMITTED TO THE UNIVERSITY OF SALFORD FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY IN THE FACULTY OF HEALTH AND SOCIAL CARE**

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Declaration

No portion of this work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Further information on the conditions under which disclosure and exploitation may take place is available from Professor Stephen Kay, the director of SHIRE.

Dedication

For Stephen and for you Mum.

Abstract

The findings of this multi-site study emphasise the importance of Organisational Culture for integrating clinical information systems into intensive care units. A novel model, the Iterative Systems Integration Model, has two principle components, these being Organisational Culture and the Actual Usefulness of the clinical information system. The model is derived from empirical data collected in four intensive care sites in England and Denmark, with one site being used to validate the model. The model highlights clinical information systems as directly affecting the work processes of the sites investigated, which in turn affect the Organisational Culture and Actual Usefulness of the clinical information system used, and these features affect clinical information system integration. This forms an iterative process of change as clinical information systems are introduced and integrated.

Intensive care units are complex organisations, with complex needs and work processes. The impact of clinical information systems on these work processes is investigated in this thesis using Role Activity Diagrams. These diagrams are analysed to show that although clinical work processes are consistent at each site, the information processes differ. Intensive care information processes are found to have the potential to be much simplified with the introduction of seamless clinical information systems.

Qualitative data collection methods were deployed, i.e., observations, interviews, and shadowing of clinical staff, together with a questionnaire at each site for further validation. Data were analysed using grounded theory to extract salient variables, which informed the development of the model. These factors were indicative of the Organisational Culture of the sites investigated and the Actual Usefulness of the clinical information systems being used.

It was posited that clinical information systems that reconcile expectations of both hospital management and clinical staff – and that have the potential to adapt to their organisational environment – have a greater chance of surviving in complex environments such as intensive care. Despite decades of Health Informatics, no such systems exist in their entirety; this research shows that ‘ancient problems’ of clinical information systems integration are still prevalent, and presents the Iterative Systems Integration Model, the application of which may assist with the integration of clinical information systems in intensive care.

Prolegomenon

The research described in this thesis is conducted in the academic discipline of Health Informatics. This thesis considers the importance of Organisational Culture factors for integrating Clinical Information Systems (CIS) in intensive care, and was conducted in collaboration with intensive care units in Denmark and England. The research was funded in part by the Health Informatics committee of the British Computer Society, and in part by a University of Salford Bursary. Their support is gratefully acknowledged.

A paper (Munir and Kay, 2003) describing work in this thesis, and presented at the 2003 Fall Symposium of the American Medical Informatics Association, was one of eight papers short-listed for the Diana Forsythe Award; an award for work at the cross-section of Health Informatics and the Social Sciences that initially considered over 200 papers. Other published papers that discuss work in this thesis are (Munir and Kay, 2003; Munir, Hardiker, and Kay, 2003; Munir and Kay, 2004a; Munir and Kay 2004b).

Prior to this work, Samina's MSc (Munir, 2000; Munir, 2001a) at UMIST, UK, focussed on the issue of patient empowerment with regard to patients holding and managing their own electronic primary care health records. Samina then worked as a research assistant at UMIST where she published two documents for the National Health Service Information Authority (NHSIA). The first outlined the importance of Organisational Culture and Organisational Change required for implementing electronic health records (Munir and Boaden, 2001b). The second, an evaluation report, was a continuation from her MSc, and evaluated patient access to electronic health records (Munir and Boaden, 2001c).

Chapter 1

Introduction

This opening chapter presents the aim, objectives and contributions of this thesis and then discusses the motivation for the research. The aim and objectives will be revisited in the final chapter, where a discussion of how well they have been addressed will be given. A guide to the thesis concludes this chapter.

1.1 An Introduction to the Thesis

This chapter introduces the aim, objectives, and contributions of this thesis, describing ‘what’ the thesis investigates. The motivation (describing ‘why’ the phenomenon is worth investigating) follows this. The motivation is presented without reference to the literature; this is dealt with in Chapter 2, where the literature review is presented. The aim and objectives of the thesis were revised following consideration of the literature.

Clinical Information Systems (CIS) are an important part of the organisation of patient care. They can facilitate the coordination of patient care between clinical staff such as nurses and physicians, and can act as an aide memoir. Over the past 20 years there has been an increasing drive to develop electronic CIS in hospitals to extend and replace the paper-based systems previously used. However, many of these electronic CIS are met with resistance by those that use them, and are often not used sufficiently to justify investments – many are even rejected.

This thesis investigates the important issue of CIS integration. The research is focussed on the Intensive Care Unit (ICU), which is a complex and demanding area of the hospital that has equally complex information requirements. A combination of

observations, shadowing, interviews, and questionnaires were used to investigate the role of organisational factors for CIS integration and to detail the interactions between clinical staff and CIS, whether paper-based or electronic. Data were collected in four ICU in four different hospitals, two in England and two in Denmark. Each ICU was at a different stage of CIS integration (successfully implemented 5 years ago, recently implemented, about to implement, and with a failed implementation). Based on these data, a declarative model of CIS integration is proposed and validated.

1.2 Research Aim and Objectives

The aim and objectives described were developed following careful consideration of the issues that emerged in the literature review (see particularly Section 2.8). The aim and objectives will be revisited in the final chapter, where a discussion of how well they have been addressed will be given.

1.2.1 Aim

The specific aim of this doctoral research is:

To develop a declarative model of clinical information systems integration based on empirical evidence from intensive care settings.

The term, integration, as used in this thesis, requires explanation. Chambers Dictionary (1990) defines 'integrate' as *"to make up as a whole: to make entire: to combine, amalgamate."* And integration as *"the act or process of integrating: unification into a whole"*. In this thesis, CIS integration is concerned with the extent to which a CIS supports ICU work processes (i.e., the extent to which they *combine* with the work processes), are accepted by users, and are fully functioning and well used, i.e., the *unification* of CIS into intensive care organisations. Chambers (1990) defines implementation as *"the various steps involved in installing and operating a computer data-processing or control system"*. The process of CIS implementation is then subsumed by integration, since implementation is a part of CIS integration i.e., if a CIS is to be integrated, it must first be implemented.

1.2.2 Objectives

The research aim will be achieved by way of the research objectives outlined below. Three primary objectives are given (Arabic numerals). Each primary object is divided further into sub-objectives (lower case letters) to facilitate the achievement of the primary objectives, and subsequently the research aim.

The objectives are:

1. *To investigate the significance of Organisational Culture for explaining actual CIS deployment in intensive care.*
 - a. To determine the Organisational Culture characteristics that affect CIS integration into intensive care settings.
 - b. To determine the relationship between Organisational Culture characteristics found and CIS as they are used in practise.
2. *To investigate the interactions between clinical staff and CIS, so that it is possible to determine the effect of these interactions on intensive care clinical work processes.*
 - a. To determine the interactions that take place between clinical staff and their work processes.
 - b. To model the above interactions.
 - c. To explore the relationship between Organisational Culture, actual CIS use, and clinical work processes.
3. *To develop a theoretical model of CIS integration.*
 - a. To conduct a comparison of the findings from each site.
 - b. To apply the knowledge and understanding drawn from empirical evidence to develop a model for CIS integration.
 - c. To validate the model using an investigation at another site.

Based on the aim and objectives, the next section highlights the specific contributions of this thesis to the academic field of Health Informatics and also to Health Informaticians involved with the design, development and implementation of CIS initiatives around the globe.

1.3 Contributions of this Thesis

This thesis makes a number of contributions to Health Informatics and its practitioners. These are listed below, in order of significance:

- Develops an empirically validated model of CIS integration – The Iterative Systems Integration Model (ISIM) – for guiding CIS integration into ICU (Chapter 6).
- Contributes original work – based on empirical evidence – to the academic discipline of Health Informatics that investigates the significance of Organisational Culture for integrating CIS in intensive care (Section 2.8).
- Provides process maps of intensive care work processes, based on empirical observations from intensive care settings, to illustrate the interactions that occur between clinical staff, CIS, and intensive care work processes (Section 6.2.1).
- Provides insights into the interactions that occur between clinical staff, CIS, and intensive care work processes from the four sites investigated.
- Disseminates empirical evidence from four separate intensive care sites to support theory and contribute to knowledge and the academic literature about Organisational Culture, clinical information systems, intensive care, and the interactions between these areas in intensive care (Section 8.2.4).

The findings may be of particular interest to those involved with the introduction of the integrated care record service (ICRS) in the UK National Health Service (NHS) (DOH, 2002b), and those involved in national Electronic Health Record (EHR)* initiatives in Denmark, as data were collected from sites in these countries. Global EHR initiatives may also find this thesis of some use, for its insights into the context of clinical work and CIS integration.

1.4 Motivation

The precise aim of this thesis, i.e., ‘what’ is being researched, was given in Section 1.2, while the contributions of this thesis were given in Section 1.3. The critical question of why this thesis is necessary and important is now addressed. This section provides a short overview of the important issues, based on the literature review that is given in

* CIS/EHR/EPR: the terms and concepts are clarified in Section 2.2.1, where CIS is identified as the preferred term. However, when discussing work by other researchers, their term is used.

Chapter 2. It also provides directions to the relevant sections of the literature review where its arguments are supported.

1.4.1 CIS Potential and Pressures on Investment

Clinical Information Systems (CIS) are used throughout all healthcare settings by a variety of healthcare professionals. Electronic CIS are powerful tools with vast potential, attracting much demand for investment in developed countries across the globe. The primary purpose of these systems is to manage patient data in order to facilitate patient care and enable positive outcomes. This is discussed in Section 2.3.

However, CIS require much financial investment, and are resource intensive (not just financial, but also in terms of human resources, time, commitment, and energy deployed). It is therefore essential that CIS provide maximum utility and benefit to healthcare professionals, and maximum benefit to the patient, while causing minimum disruption (during integration of the CIS) to the care that a patient receives. Pressures on management to reap returns on their investment are also great, as the public healthcare sector is renowned for its shortage of resources. Justification of every investment becomes imperative, and successful outcomes essential.

1.4.2 CIS Capability and Acceptance

Given the growing emphasis on CIS, it is surprising to find that there is a huge disparity between what existing systems are capable of and the extent to which these capabilities are exploited. There is a body of evidence (discussed in Section 2.3 and Section 2.4) to suggest that CIS – when implemented in a clinical environment – may be greeted with scepticism and uncertainty as to their capabilities and integration with existing clinical activities. Many systems remain unused, or are used far below their potential – see Section 2.3 for more details. It is also surprising that CIS integration problems remain persistent, especially given the availability of smarter and more sophisticated methods for designing, developing and implementing CIS.

1.4.3 Organisational Factors for Understanding CIS

Integration

Despite decades of research on human and organisational factors by many researchers in different areas, it is only recently that this body of work is being recognised and

accepted by software developers and Health Informaticians. Human and organisational factors are now believed to have a strong part in facilitating understanding of CIS integration problems, alongside technical issues. This is discussed in Section 2.4.

The emphasis is shifting towards the use of more human-centred methodologies for evaluating CIS, as opposed to the sole use of randomised controlled trials and methods focussing on economic and cost-benefit analysis.

1.4.4 The Multifaceted Needs of Intensive Care

If we consider the complexity and multi-disciplinary nature of intensive care in terms of its critically ill patients, information requirements, work processes, and the need for timely and accurate information, then the impact of failed systems is heightened in this area of healthcare. The need to understand why these failures occur becomes very important, so that they can be avoided in the future.

In Section 2.8 it is concluded that intensive care is under-investigated in Health Informatics, and that organisational studies could strongly inform CIS integration in acute care. The generalisability of the findings could then be tested in other healthcare environments, since it is found in Section 2.6.2 that developing CIS in a complex area such as the ICU can inform developments in less complex areas of healthcare more reliably than vice-versa.

1.5 A Guide to the Thesis

CHAPTER 1 introduces the thesis. It presents the research aim and objectives, the contributions of this research, and the motivations for it.

CHAPTER 2 reviews the literature on CIS and Organisational Culture within healthcare. The chapter strongly supports the need for this thesis. The terms and concepts used within this thesis are also clarified.

CHAPTER 3 sets the context for this research by describing the national and government-propelled agendas for CIS development and implementation in Denmark and England, these being the two countries from which the data for this research are collected. Selection of the four sites, two in each of the countries, is explained. Each site is described, together with its CIS situation.

CHAPTER 4 presents the theoretical and practical principles guiding this research. It examines the assumptions underpinning the research paradigm and methodology, and then discusses pragmatics such as issues of access to the host sites, participants and research ethics.

CHAPTER 5 details the research methods used for data collection and how data were analysed.

CHAPTER 6 presents the Iterative Systems Integration Model (ISIM), a major outcome of this thesis. The derivation of the model is presented and discussed in terms of ICU work processes (illustrated by Role Activity Diagrams), the Organisational Culture, and the Actual Usefulness of the CIS, with respect to CIS integration, from data collected at three sites in England and Denmark.

CHAPTER 7 presents a validation of ISIM using a fourth independent site. Further validation using questionnaire data collected at all sites is also presented. A discussion of the connections between ISIM and the Technology Acceptance Models (TAM and TAM2) is given.

CHAPTER 8 completes the thesis by presenting a summary and a critical evaluation of the thesis, and highlights the scope for future research.

1.6 Summary

This chapter has suggested that there is much need for the research described in this thesis – the question of whether or not Organisational Culture can inform CIS integration is under-investigated, and remains to be tested. Further, empirically derived and validated Organisational Culture models in healthcare are few. Deploying theoretical organisational models developed outside this sector may not be immediately applicable or appropriate: a model developed and validated specifically for this sector may be more appropriate and useful.

This chapter has introduced the thesis, with the aim, objectives (Section 1.2), and contributions (Section 1.3) being given. The question of ‘why’ the aim and objectives were of importance was addressed in Section 1.4, which outlined the importance of CIS in healthcare, their capabilities, and the problems of integrating them in healthcare environments.

Whereas, in the past, evaluations of CIS remained focussed solely on the technical, human and organisational issues are becoming increasingly accepted as convincing approaches for investigating CIS implementations in Health Informatics. Finally, this chapter has outlined a road map to the entire thesis. Chapter 2 explores the literature relevant to this thesis, presenting evidence in support of the motivation for this research.

Chapter 2

Literature Review

The aim of this chapter is to present a synthesis of the literature relevant to this thesis, specifically literature about Clinical Information Systems, Intensive Care Units, and Organisational Culture, the terms that define the thesis. The scope of this review is discussed first, and then the terms and concepts are clarified. A review of the literature is presented next, with the chapter ending with conclusions and a summary.

2.1 Scope of the Literature Review

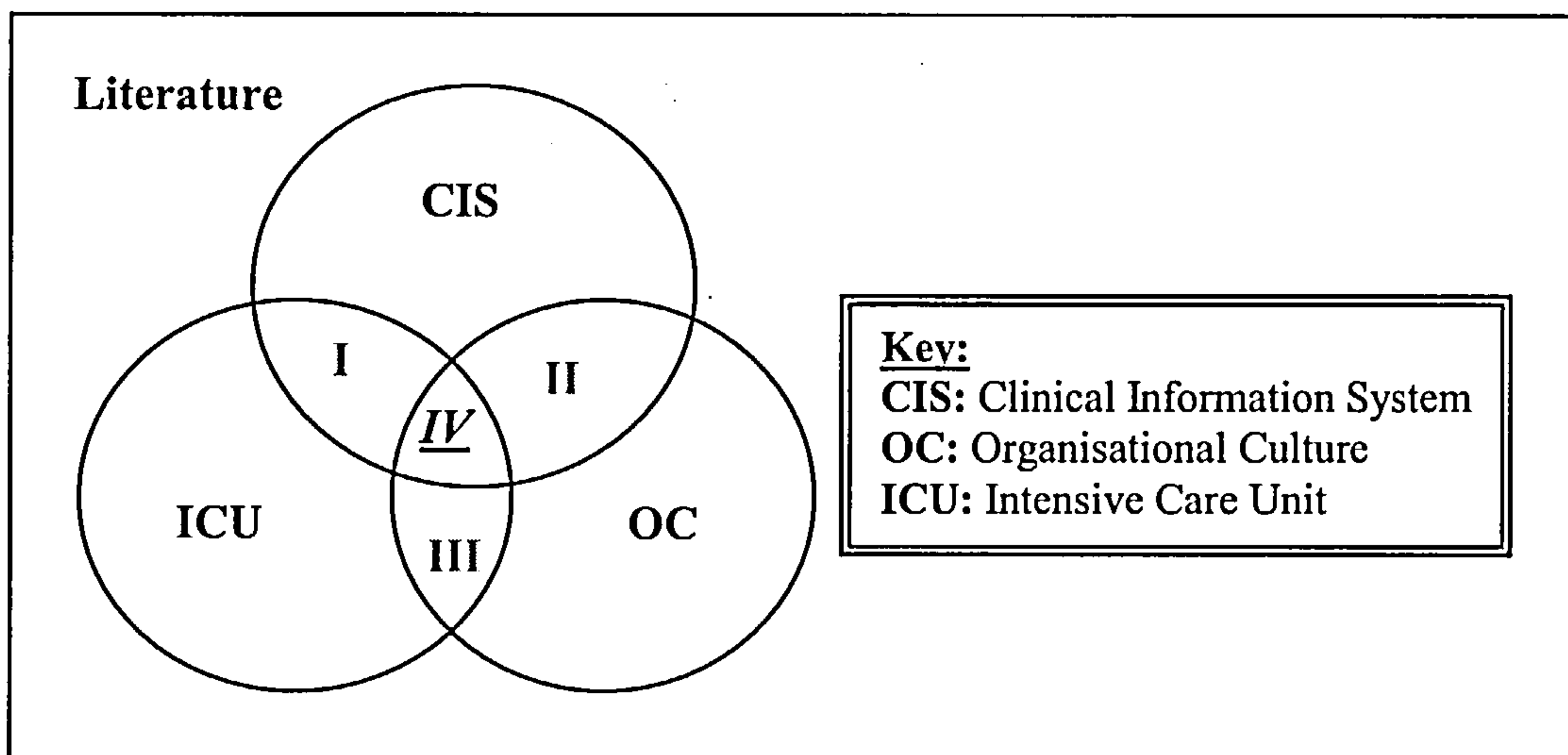


Figure 2.1: A Venn diagram illustrating the inter-relationship between the three areas that are the foci of this thesis.

Referring to Figure 2.1, the three areas of Clinical Information Systems, Intensive Care Units, and Organisational Culture are very broad, and generate vast amounts of literature during searches. In the specific context of this thesis the overlap areas

(labelled I, II, and III in the figure) are of direct interest. However, literature covering area IV is of greatest significance to this research, as it defines the extent to which this thesis is original, and describes the detailed context of this research. The focus of this literature review is therefore primarily concerned with areas I, II, III and IV.

However, generic literature on the broad categories of Clinical Information Systems (CIS), Intensive Care Units (ICU), and Organisational Culture will be discussed to obtain an overview of the fields. Figure 2.2 guides the reading of this chapter by presenting a road map of this literature review.

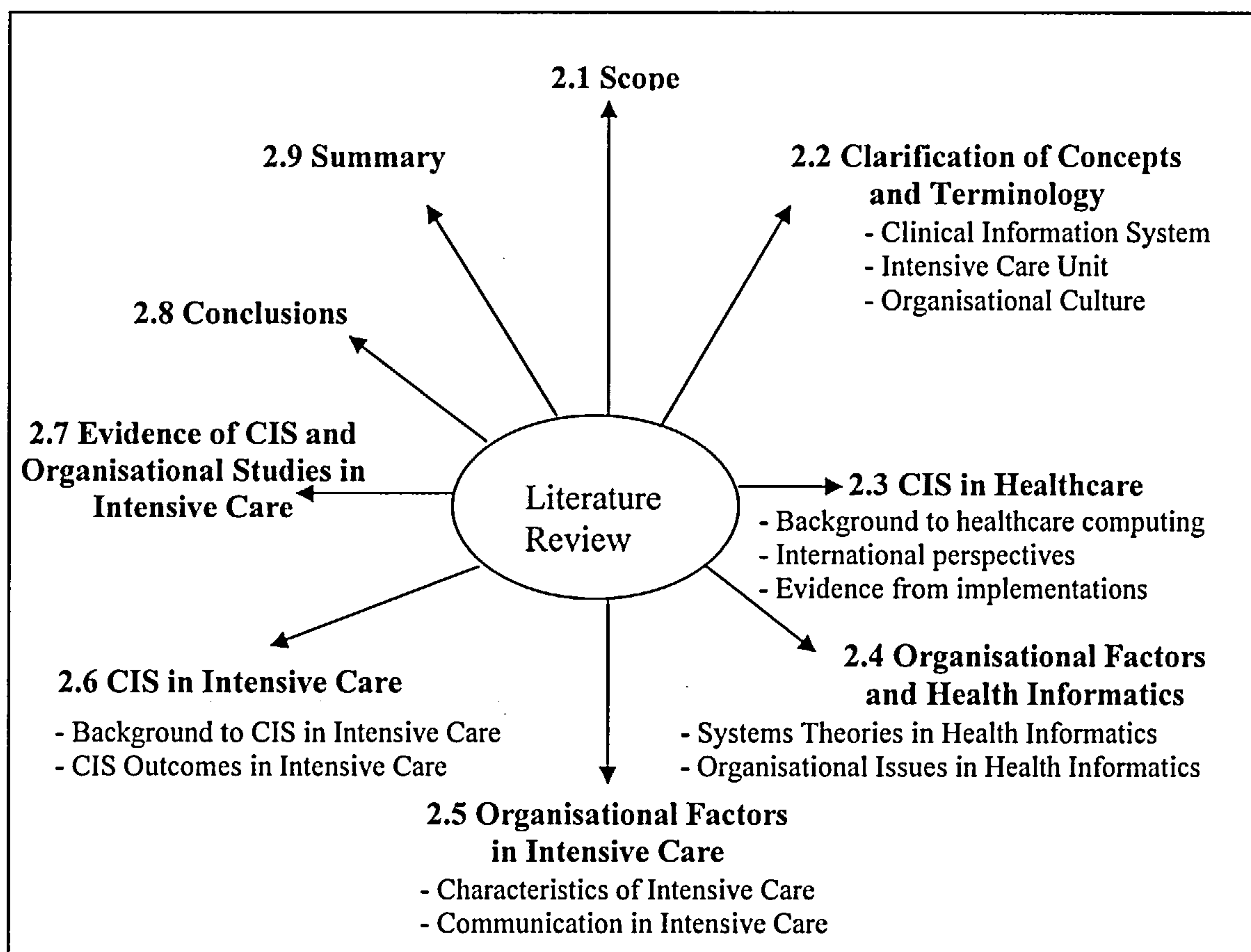


Figure 2.2: A road map of the literature review.

Sections 2.3 to 2.7 review the salient literature on CIS, ICU, and Organisational Culture in Health Informatics. It must be noted that a previous literature review about EHRs and patient records has been conducted by the author of this thesis (c.f. Munir, 2000), the literature presented in Sections 2.3 and 2.4 is an updated overview of the salient literature in these areas; they are not directly relevant to this thesis, but were considered necessary in order to present the context of the focussed literature illustrated in Figure 2.1 and reviewed in Sections 2.5 to 2.7. Section 2.8 presents the conclusions, and the chapter ends with a summary in Section 2.9. The terms used within this thesis and within this chapter are discussed next.

2.2 Clarification of Concepts and Terminology

This section clarifies the concepts and terms used within this chapter and the whole thesis. As they are referred to throughout this thesis, elucidating their meanings is vital. In particular, the terms Clinical Information System, Intensive Care Unit, and Organisational Culture, are now explained.

2.2.1 Clinical Information System

Much of the literature refers to Electronic Patient Records (EPR) and/or Electronic Health Records (EHR). Attempts to explain and define these muddy concepts have been made by many, (Gordon et al., 1998; Heathfield et al., 1999; Kalra, 1994; Kay, 1999a; Markwell, 1996; Munir, 2000; Neame, 1997; NHSIA, 2001).

The distinction between EPR and EHR in UK policy is unclear. The director of research and development at the UK Department of Health, Sir John Pattison (2002), asserted that explaining the differences between the two terms could be difficult for people to understand, but failed to convince. In a speech at the Healthcare Computing conference in Harrogate, Sir John Pattison (2002) suggested that Electronic Record might be more appropriate as it is less constraining and dependent upon previous definitions.

In North America, evidence from the Fall 2003 symposium of the American Medical Informatics Association confirmed that, to date, there is little or no consensus about a distinction between the two concepts. This is verified further in a report by the Institute of Medicine (IOM) on the key capabilities of an EHR, as is expressed in this quote:

“There have been many different views of what constitutes an EHR system. Some EHR systems include virtually all patient data, while others are limited to certain types of data, such as medications and ancillary results [...] In summary, EHR systems are actively under development and will remain so for many years.” (IOM, 2003)

Despite clarification of the concept by the International and European Standards bodies (ISO, 2000), who define the ‘Electronic Health Record’ to mean electronic representations of clinical records (which encompasses the former EPR), lack of consensus on this term is still apparent. This is highlighted in the UK with the recent development of the Integrated Care Record Service (ICRS), which subsumes the EHR; however, the term ICRS is now also under revision with the National Care Record

(NCR) being suggested as an alternative. It appears that defining EHRs is a challenging international problem. The confusing and difficult task of defining the EHR, and establishing a suitable term for it, stresses the fact that it may not be the most appropriate term to use in this thesis, as there is little consensus as to its definition and meaning on an international scale. In Europe, few hospitals have a working EHR – many are still in the process of understanding what it is and how it can be used, making it impossible to investigate:

“Very few implementations of the EHR exist as they are defined, despite 30 years of research and design. They mostly consist of administrative and management systems. It is rare to find a system combining administrative work and clinical patient information.” Iakovidis (1998)

Therefore, Clinical Information System (CIS) is the preferred term for the purpose of this thesis. Defining CIS is also problematic, however the definition given by Gordon et al. (1998) is drawn upon for this thesis. Gordon et al. (1998) distinguish between EPR and CIS, and logically define the constituents of both systems. However, it is the definition of a CIS that is of concern to this thesis.

CIS: *“a system dedicated to collecting, storing, manipulating, and making available, clinical information important to the delivery of healthcare. CIS may be limited in scope to a single area or may be comprehensive and cover all information e.g. EPR”*

In this thesis, CIS are the object of study, where CIS encapsulate paper record systems, electronic record systems, and hybrids of both; CIS will therefore be inclusive of EHRs and EPRs. However, when citing works by authors in the literature, the term used by those authors will be used.

2.2.2 Intensive Care Unit

The terms Critical Care Unit (CCU) and Intensive Care Unit (ICU) are used synonymously in the literature. To avoid confusion and to remain consistent, this thesis will refer to ICU. Definitions of intensive care are numerous (Jones et al., 1998). For the purpose of this thesis the author refers to a definition approved by the British Medical Association (BMA) (1967) where intensive care is defined as:

“The care of patients who are deemed recoverable, but who need continuous supervision and need, or are likely to need, prompt use of specialised techniques by skilled personnel.”

It is possible to break down ICU further into general ICU, specialised ICU, and High-Dependency Units (HDU). The definition below describes a general ICU, where admitted patients have a broad set of clinical conditions, but all have dysfunction or failure of one or more organs (Bennett and Bion, 1999).

“We have defined the ICU as a special unit providing the following: (1) a facility available to all medical staff giving more space, staff and equipment for the care of the patient than can be provided in the ordinary wards. (2) A service that provides continuous observation of the vital functions and can support these functions more promptly and efficiently than can be done elsewhere in the hospital. Both the facility and the service can be developed within a specialist division or ward, but the essence of the ICU is that, like most operating theatres, it is communal.” BMA (1967)

Jones et al. (1998) list five essentials for a successful general ICU, describing each category in detail. The five components are listed in order of importance, as rated by them:

- Permanent nursing team, specifically trained and giving continuous service.
- Readily available medical team.
- Standardised techniques of investigation and treatment.
- An ‘area’, ‘facility’, or ‘unit’.
- Revised philosophy of patient care.

A specialised ICU will focus on specific conditions such as cardiothoracic, neurosurgical, and paediatric care, etc. This means that it is possible to standardise methods of care and training of nurses. Because it is standardised it is possible to serve large populations (Jones et al., 1998). A HDU differs in that it segregates patients with severe illnesses that cannot be managed in a general or a specialised ICU. The patient requires intensive observation, and is cared for by at least one nurse, and sometimes more. The literature covers all three types of ICU.

2.2.3 Organisational Culture

Before discussing Organisational Culture, it is important to understand that ‘Culture’ was a precursor to Organisational Culture, and so a brief historical discussion may be helpful to the reader.

Culture

The origin of the term Culture dates to early archaeological finds, when attempts to learn about and classify objects were endeavours towards understanding other worldviews, societies and civilisations (Bodley, 94). Its origins have been described as analogous to the origins of life – evolutionary theory – so that, like life, culture has evolved, and is an evolving entity (Garbora, 1998; Dunbar et al., 1999). The first attempts to categorise culture were accomplished in 1872 by a committee for the advancement of science, led by Edward Tyler, a British anthropologist; 76 culture

topics were identified (Bodley, 1994). Since then, definitions of culture have expanded immensely, for example Kroeber and Kluckhohn in *ibid.* identified over 160 different definitions of culture, which have since been clustered around concepts as diverse as shared, symbolic, arbitrary meanings, human behaviour, and norms such as values and rules.

Bodley (1994) asserts that essentially culture can be reduced to three crucial components:

- What people think.
- What people do.
- The material products that people produce.

With regard to these three components, in a group setting culture becomes a social entity. It is this group, or organisational, perspective that is of interest to this thesis. That is, what people think, do, and produce, with regard to CIS in ICU. This leads us to the following discussion of Organisational Culture.

Organisational Culture

Burnes (2000) states that Organisational Culture has been known to industry since World War II. However, it was not until the late 1960s and 1970s (Blake and Mouton, 1969; Eldridge and Combie, 1974) that business research embraced the term, and by the 1980s it had exploded in the business literature on both sides of the Atlantic, with influential works by American authors such as Peters and Waterman (1982), Kanter (1989) and the Briton Handy (1984). Most authors share the view that:

“Managers and employees do not perform their duties in a value free vacuum. Their work and the way it is done are governed, directed and tempered by an organisations culture: the particular set of values, beliefs and customs and systems that are unique to that organisation.” (Burnes, 2000)

Many different and varied models describing Organisational Culture exist; some try to define culture, while others try to categorise the different types (Hofstede, 1990; Schein, 1985; Handy, 1986). Many critiques of proposed models of culture exist. Most tend to argue that it is overly simplistic and unrealistic to reduce a complex concept such as culture into levels.

Almost all of the definitions and classifications of culture have been developed and researched in business or industrial contexts, and their applicability to other sectors remains to be tested. Koeck (1998) believes that the literature on organisational behaviour and management is a valuable resource for complex organisations such as

healthcare, and notes that healthcare delivery systems in particular could benefit from it, although few make use of it.

While this overview of Culture and Organisational Culture was necessary to inform the reader, this thesis is not concerned with a particular definition or model of culture, as it is unrealistic to apply one definition to a term so complex, as has been discussed. Instead, the thesis takes the *concept* of Organisational Culture as a premise. This concept is best epitomised by Drennen (1992) as: *"how things are done around here."*

Further, Bodley's (1994) three components of culture are not specified as a model or prescription, rather they are his conclusions, which are very succinct and relate directly to what this thesis aims to investigate, i.e., what people (in this thesis, clinicians) think, do, and produce, with regard to CIS; including the concept of 'organisation' enables the investigation of a particular social setting, in this case, ICU.

2.3 CIS in Healthcare

This section reviews the role of computing within healthcare over the past five decades. An international perspective of CIS is given, and then literature on CIS applied within healthcare is presented.

2.3.1 Background to Healthcare Computing

It is common knowledge that Williams and Kilburn invented the first stored program computer, the Manchester Mark 1, in 1948 at the University of Manchester, UK. Kay (1999b) suitably asserted *"No one at the time, managed to predict what it all meant, nor appreciated its implications."*

Richard's (2001) paper provides a good summary of the status and progress of healthcare computing from its first consideration for healthcare by the UK Ministry of Health in 1956 to date. The paper highlights the seminal work conducted by Barber (1964), which shifted the emphasis of computers from being used solely for financial and administrative purposes to scientific use. A computer implemented in a London hospital was to be used by Dr Barber for hospital finances, data processing, and statistics. Barber used the computer to carry out operational research for patient queuing (Barber, 1974).

A landmark in healthcare computing was established when the first NHS IT strategy was launched in 1968. The difficulty of reaching consensus over issues such as

ensuring uniformity of hardware from a number of available suppliers and setting standardised computing languages was not just a problem of its time, but is still mirrored in many healthcare IT projects today, as this literature review will reveal. Of great interest is the fact that the first patient medical record in the world to be used by nurses was introduced in 1969 at Kings College, London. Unfortunately, the computer was regarded as an intrusion by consultants working in the hospitals, and was therefore abandoned (Richards, 2001). Similar organisational problems are still being found; the review by Kaplan and Shaw (2002) is a comprehensive and accurate account of much of the literature in this area, and it shows that human and organisational issues are only just beginning to come to the forefront, despite decades of research. EHRs remain an important research issue in the fields of Medical and Health Informatics.

Richards (2001) informs the reader of the international status of medical computing in the 1960s. He states that although hospital computing was being introduced in Europe and America, the UK was the first to introduce General Practitioner (GP) computing, which has continued to be at the forefront since its launch in 1970; this view is supported by Schloeffel (1998). Indeed, the UK is understood to be a world leader of primary care computing (Benson, 2002a; Schloeffel, 1998); yet the same cannot be said for hospital computing. Benson (2002a) investigates this phenomenon in his paper entitled 'Why general practitioners use computers and hospital doctors do not'. His study is based on personal experience spanning 30 years, first as a leader of a computer evaluation unit, and then as a GP system supplier. He reports that by 1996, 96% of general practices were computerised, and approximately 15% ran paperless consultations. He explains that this success is due to the gatekeeper role that GPs are able to play in primary care computing.

Going back to the 70s, a change of government in the UK meant that government funding was no longer available for research and development into CIS. This had a negative effect on hospital computing, so projects were abandoned until the recent change in government. GPs began working with suppliers, indeed suppliers offered incentives to GPs for their involvement. Benson concludes that hospital doctors had no incentives to become involved and that computers were treated as a management overhead. In a second paper, Benson (2002b) states that scalability is also a reason why GP computing was a success, "*GP computing is technically much easier than for a whole hospital or health district.*" He asserts that simple classification codes such as Read Codes cannot cope in a hospital. There is also an issue of common interoperability standards within

secondary care due to the sheer number of systems available and the variety of systems used; privacy problems are heightened due to the sheer number of users. The nature of the work is also much more complex, with job divisions creating diverse patterns of use; the requirements of multidisciplinary teams are very different to sole users of a system (Schloeffel, 1998).

Using current evidence, as opposed to academic or theoretical models, Ball et al. (2001) assess whether or not Informatics can improve healthcare. They conclude that it can. They state that Information Technology (IT) supports information management and knowledge creation through its four cornerstones. These cornerstones are described by Lorenzi (2000) as:

- Producing structures to represent data and knowledge.
- Developing models for acquisition and presentation of data.
- Managing change among people, processes, and technology
- Integrating information.

From the papers by Benson (2002a and 2002b), and the historical review of the literature so far, the challenging nature of setting standards for achieving the four cornerstones is magnified. Where Ball et al. (2001) focus on success stories of IT applications in the areas of disease management, tele-health, patient safety, and decision support, Benson (2002b) focuses on technical issues, which are problematic. Lorenzi (2000) stresses the importance of acknowledging human factors as the greatest obstacles to Informatics success. It is vital then, that these issues are given equal significance when designing, developing, integrating, and evaluating CIS in healthcare.

Section 2.3.2 presents an overview of CIS initiatives around the world, and is discussed next.

2.3.2 International Perspectives

An annual survey held by the Medical Records Institute (MRI, 2002) reveals that the major clinical factors driving the need for EHR systems, as seen by physicians, is to improve the ability to share the patient record among healthcare providers, to improve clinical data capture, and to reduce medical errors. Of great concern to managerial staff is the need to improve the quality of care and to improve the clinical process or work flow.

Major concerns were seen as problems related to mobile health devices and applications, such as lack of security and confidentiality of data, and major barriers to the plans for implementing EHRs were seen as due to lack of funding and resources and lack of support by medical staff.

The 2002 survey was conducted online, and 1131 people responded. Vendors and consultants were excluded to leave 761 valid responses. The survey respondents were predominantly based in the US (83%), 4.6% were Canadian and the remaining respondents represented the UK, Denmark, Germany, Israel, and Taiwan. This means that the results are not very generalisable to countries other than the US. Another limitation is the fact that respondents were predominantly managers (25%) or physicians (14%); other healthcare groups such as nurses (6.3%) were under-represented.

In another recent global study (Latimer, 1999), the IOM (1991) was cited as stating that the Computer Patient Record (CPR) would become a standard in healthcare within a decade; this is a deadline that has been missed. This paper reports how close the world is to realising this and invites *“leading informaticians from six continents to share their experiences.”* Leaders from South Africa, Australasia, East Asia, North America, South America, and Europe identified four common issues. These were:

- The CPR is not clearly defined.
- Technology should be seen as an enabler and not a driver.
- It is people and not technology that champion successful implementations.
“The human factor determines whether technology based innovations succeed, this is 80% dependent on people and 20% dependent on technology.” (Latimer, 1999)
- The system must be secure.

It must be noted that it is only developed countries that have the resources to invest in EHRs. Under-developed countries have little to spend on healthcare, and even less on Health Informatics. These countries have more pressing concerns, such as fighting diseases like Aids and malnutrition, and providing their citizens with health education (Tresling, 2003). It is interesting to note that having attended a recent panel on the emerging international trends on the EHR (AMIA, 2003), little has changed since the Latimer (1999) study. Developed countries such as Denmark, the UK, US, Australia, and Canada have revised national IT policies that enforce government-imposed deadlines to implement EHRs within the current decade. They all seem to be facing similar obstacles, such as creating solid communication infrastructures and record

architectures, interoperable systems, unique patient identifiers and standards, despite their diverse political and geographical infrastructures.

An extensive literature review was conducted of over 1832 papers indexed in MEDLINE, with the objective of understanding the evolution of publications dedicated to the EPR (Moorman and Van der Lei, 1999). The researchers found that the literature highlighted insufficient research into the effects of EPRs, and proposed the need for investigations on this theme.

In Europe and Australia, Schloeffel et al. (2001), who are working on the Good Electronic Health Record (GEHR), formally the Good European Health Record, echo these views. They believe that healthcare is the most information-intensive industry in the world, and that there are massive fragmentations of clinical data, which they believe contribute to the cost of information management. They also state that interoperability is an issue and that sharing and exchanging data is a must:

“Where EHRs have been implemented it has usually been in a spasmodic and uncoordinated manner, without any standards. This has created the biggest single problem in healthcare information management world-wide, fragmented, poor quality data creating islands of information.”

The monolithic way that CIS are being developed at present is said to impede progress.

Although Iakovidis (1998) approaches the subject of EHRs from a telemedicine perspective, his views about EHR progress are much the same as Benson (2001); Latimer (1999), and Schloeffel (1998). He states that across the globe, few EHRs are installed and functioning as they are defined. In hospitals, he asserts that not many in the world have shareable CIS that integrate both clinical and administrative patient information. In his list of challenges, similar to those presented by Benson, Latimer, and Schloeffel, Iakovidis also recognises that Organisational and Cultural factors have the potential to both encumber and assist CIS implementations, but notes that *“most cultures do not support the idea of sharing information.”*

Schloeffel (1998) reports that between 1992-95 the European commission issued a program to develop a widely applicable common data structure for using and sharing EHRs across Europe. This project, the GEHR (mentioned above), involved 21 participating organisations in eight European countries, and included many different professions and disciplines, such as academia, medicine, commerce, and computer science.

The GEHR had much influence on the evolution of European EHR standards. Interest spread beyond Europe to Russia, Australia, New Zealand, Singapore, and

recently the US (Schloeffel et al., 2001). However, so far Australia and the UK are the main centres for its development. In 1998, Australia and the UK took different routes as regards the EHR, mainly due to UK interest waning. The Australians however, developed the record further with funding from the Australian government, and hope to see major developments within the next ten years (ibid).

In Denmark*, Svenningson (2001) highlights the uncoordinated and local basis of EHR projects. As a result of this lack of coordination, the Danish Ministry of Health launched national strategies for the development of EHRs in Danish healthcare (Andersen et al., 2002). In her thesis, Svenningson reports that on a national level there are no clear answers as to how development and implementation of EHRs is succeeding. She also informs the reader of the difficulty of assessing the consequences of EHRs, since there are few investigations into how present systems function, and those few that do exist focus on isolated, quantifiable aspects. Perhaps the problem is not that few evaluations of EHRs exist, but the fact that the term is ill-defined, making evaluations of EHRs impossible.

Svenningson's claim that there are no programs to follow EPR progress in Denmark is countered by Andersen et al. (2002), whose group is involved in a publicly funded project, the EPR Observatory, which requires the authors to collect and disseminate experiences from all regional EPR projects. Work began in 1998, focussing on expectations; in 1999 the focus was experience, and in 2000-2002 the authors focussed on the analysis of EPR development and implementation in the Danish healthcare sector. Preliminary studies in 1998 and 1999 used interviews and observations as methods of collecting data, while in 2001 a survey was sent out to all EPR project leaders in Denmark. This included 15 County administrators, 100 hospitals and 657 hospital departments. A second survey in 2002 was directed at 52 local and regional projects. The authors found:

- 11-15 hospitals had an IT strategy.
- 52 EPR projects in the country, with only one county-wide and 24 department-wide.
- 5-10% of hospital beds were covered by an EHR.

As responsibility for EHR projects is decentralised to county level it is not surprising that each county is using different methods, developers, and suppliers to achieve the

*The status of both the Danish and English EHR, are given in more detail in Chapter 3.

same goal (Andersen et al., 2002). On organisational issues, they found that EHRs had significant impact on daily routines; failure to meet positive user expectations resulted in negative user reactions, and on explaining the number of different approaches used by different and multiple suppliers, they stated that this was due to no one best solution being available at present.

The National Programme for Information Technology (NPfIT) was launched in the UK in 2002, following the publication of 'Delivering the NHS Plan' (DoH, 2002a). This report further developed the proposals in the NHS Plan (HMSO, 2000) for a service centred around the patient. The NPfIT programme is focussed around four key developments:

- An electronic integrated care records service (ICRS), including a nationally accessible core data repository, and digital images.
- The provision of facilities for electronic booking of appointments.
- An electronic transmission of prescriptions service.
- An underpinning of IT infrastructure with sufficient connectivity and broadband to meet future NHS needs.

The aim of the ICRS programme is to facilitate the sharing of EHRs to provide clinical support across all care settings. It is due to be completed in 2010 (DoH, 2002b). Sissons (2003), the head of industry liaison for the NHS NPfIT programme, recently presented progress to date. He stated that the programme is probably the largest IT procurement programme in the world. A summary of patient data is to be stored in an information spine, but detailed information is to be stored with the organisation that records it. The Information Spine will provide a national store of information.

There are three phases to the programme. The first phase is to provide the facility for clinicians to book outpatient appointments, and to communicate and view patient information. The second phase is to give clinicians and health professionals' access to detailed patient information, and will include electronic referrals, requests, and orders. The final phase is to integrate care across healthcare and social services. Booth (2003) describes the benefits as readily accessible patient information, and the disbenefits as unauthorised access to confidential patient information. Concerns about the issue of responsibility for the information once it moves between institutions are also expressed.

A recent forum organised by the British Journal of Healthcare Computing on clinicians and the NPfIT programme was held in Birmingham (BJHC, 2003). The results of the Autumn Web Survey were presented, highlighting:

- The need to involve clinicians.
- Education and access to computers for all clinicians.
- Data protection and integration across the UK.
- Organisational and change issues, and staffing resources.
- Electronic prescribing and how to *really* involve clinicians in the ICRS.

Iakovidis, in Versweyveld (2000), states that the British government has fallen for the e-hype. That is, it invests in e-technology, but does not understand it, and that it is being implemented simply as a voting strategy. Although this viewpoint is harsh, it is based on more than just hearsay. Sissons (2003), the head of industry liaison for the NHS NPfIT programme, admitted that the 'rush' was due to the impending election and nothing else.

Despite each country having its own national EHR agendas, and the outward differences between each country in terms of structure and culture, the literature reviewed so far indicates that although concerns may not be identical, they are almost always congruent. A selection of papers that provide evidences of CIS applied in healthcare settings, are now reviewed.

2.3.3 Evidence from Implementations

An online patient record system in the Beth Israel Deaconess Medical Centre, USA (Safran et al., 1999) received much publicity. The authors developed this evolving system as part of an integrated hospital information system, for use in an ambulatory primary care practice, over a decade ago. Their aim was to facilitate workflow, support collaborative practice models, deliver practice guidelines, and become paperless. The motivation behind this system arose when the practice was physically separated from the emergency room in the hospital within which it was based. The practice wanted to share their patient information and practice guidelines with the emergency room.

The system has since been used widely in 61 different primary care and speciality clinics by physicians, nurses, and psychiatric social workers; it is reported as being able to supervise and monitor care, improve coordination and documentation, and has allegedly released healthcare providers to concentrate on interpersonal interactions

and the provision of healthcare. Improvements in quality of care are reported to have arisen from *“better documentation, facilitated communication among providers, and improved adherence to clinical guidelines”*. The aim of paperless practice was not attainable, due to medico-legal requirements to keep paper copies of medical records.

In another outcome study, Simpson and Gordon (1998) describe their experiences of a CIS developed and implemented in the Nephrology department of the Glasgow Royal Infirmary. The CIS is designed around four shells of clinical control loops. These shells cover clinical management, clinical administrative data, clinical services, and general management; they enable access to data about patient observations and results, investigative data from other departments, finance, hospital management, and administration. There are wire and wireless networks providing access to databases on over 50 terminals, and are linked to departments such as biochemistry, haematology, and microbiology. Simultaneous access to data is possible, and senior staff have modem links for access from home. The authors report few disadvantages. Those they list are initial disruption on implementation, ensuring staff commitment, and being aware of the possibility of power cuts. They state that introducing the system in phases reduced the risk of project failure.

In contrast, a study based at the same medical centre as that described by Safran et al. (1999), evaluated the actual interactions of two groups of physicians using paper and electronic patient records. One group of nineteen physicians with experience of using a hospital-wide EPR, and the second group of seventeen physicians, where only five had experience of using an EPR, participated in the study (Rodriguez et al., 2002). The authors applied principles from usability engineering and assessed:

- Learnability – ease of learning the system.
- Efficiency – level of productivity.
- Memorability – using the system without relearning it.
- Errors – capacity of the system to reduce error.
- Satisfaction – subjective satisfaction achieved by the user when using the system.

Both groups were asked to perform tasks specified by the authors, which involved using the records. A satisfaction questionnaire was completed at the end of the experiment. Although the authors conclude that an EPR system can significantly improve user acceptance and ease its adoption process, use of the EPR did not reveal significant differences in the overall time to complete typical physician tasks – it was found to be

faster for viewing, slower for documenting, and about the same for ordering. The obvious link between users with computer literacy and typing skills being faster than those without was proven positively.

Where Safran et al. (1999) and Simpson and Gordon (1998) report on the experiences and outcomes of their CIS, the Rodriguez (2002) study conducts a CIS usability evaluation. Although the two outcome studies are constructed over a much longer period of time, they do not provide an evaluation of user experiences with the system. Perhaps the studies by Safran et al. (1999), Simpson and Gordon (1998), and similar outcome studies could be informed by and inform usability evaluation studies like that of Rodriguez et al. (2002). The findings in the Rodriguez study and the experiences of the outcome studies imply that, over time, the benefits outlined in the outcome studies may still be achievable. A usability evaluation of the systems used in the two outcome studies could be undertaken to investigate this link.

Much of this literature has pointed to fairly successful implementations. However, it must be noted that these are in the minority rather than the majority (Berg, 2001; Kaplan and Shaw, 2002; Saur, 1993). The studies were presented to illustrate the benefits of CIS and their capabilities once accepted and integrated within healthcare institutions. A study by Laerum et al. (2001) shows that CIS do not necessarily provide positive or negative results, neutral results can also be achieved, where there are some positive outcomes, but few positive changes to existing procedures. This comparative survey study investigated the use of EPRs by 227 hospital doctors in 32 departments across 19 Norwegian hospitals (Laerum et al., 2001). A Likert scale from 1 (Never) to 5 (Always) assessed opinions about EPR use covering areas such as seeking patient information from the patient record, following results of tests and investigations, entering daily notes, etc. The authors found that the EPR was used mostly for reading the patient record. Despite high computer literacy, doctors used the EPR for far fewer tasks than it was designed. Overall, the EPR did not stimulate the development of new ways of conducting medical work. The authors state that the EPR simply reinforced existing routines, and that investigations into technology alone do not provide sufficient insight into their use – organisational aspects must also be considered.

Having reviewed papers on outcomes and evaluations, the often-ignored issue of user training and education is tackled well by Bygholm (2001). She stresses the importance of end-user support for users of EPR systems, and asserts that in addition to the quality of information and system interface, integration should also include end-user

support and learning. Though her study is based on 37 primary care sites, her findings may be of significance to other sectors of healthcare. An evaluation of learning strategies developed by the Aarhus Primary Health Care Services, Denmark, is undertaken. Bygholm separates knowledge acquisition into three types:

- Object knowledge – what the system can do.
- Tool knowledge – how to use the system properly.
- Praxis knowledge – organisational values norms and criteria for proper use, i.e., why a system should be used.

Bygholm argues that in her study there was a need for a distinction between different types of support depending upon the type of activity involved, i.e., depending on the what, the how, and the why aspects of systems education; user manuals and vendors alone were stated as insufficient educational resources.

All of the studies reviewed so far are biased towards physician use and experience of systems. Studies involving other healthcare professionals are few (Kaplan and Shaw, 2002). Following the theme of human and organisational issues, Section 2.4 reviews this in the context of Health Informatics.

2.4 Organisational Factors and Health Informatics

The aim of this section is to present an overview of the literature about Organisational Culture in Health Informatics to set the context for the focus of this thesis; see segment IV in Figure 2.1. This is not a detailed account, which is beyond the scope of this thesis. For a detailed review, an excellent literature review about organisational issues and evaluations in Health Informatics is given in a paper by Kaplan and Shaw (2002). Literature on organisational issues encountered within an ICU environment is given in Section 2.5.

The structure of this section is as follows. To begin with, the prominent systems theories are reviewed in Section 2.4.1, while the literature about organisational issues is reviewed in Section 2.4.2. This covers the impetus for investigating organisational issues in healthcare, and user reactions to CIS when they are implemented within healthcare settings.

2.4.1 Systems Theories in Health Informatics

There are many methodologies for the design, implementation, and evaluation of information systems. Kaplan (2001) conducts a literature survey of CIS evaluation methodologies in healthcare whilst critiquing randomised controlled trials (RCT) and experimental evaluation methodologies. Kaplan merges literature from many different fields to illustrate the need for evaluation designs beyond RCT that consider organisational concerns (such as cultural, social, and contextual issues) and that are grounded in evaluations from a variety of areas in medical informatics. She reviews cognitive, sociological, and social interactionist methodologies, the last of which she advocates. Kaplan's four C's methodology (Communication, Care, Control, and Context), developed for evaluating technology, is informed by much research on IT evaluations in healthcare. A theory that has had much influence in the development of the above-mentioned methodologies deserves reference. This theory is known as sociotechnical theory.

Sociotechnical theory has been much applied in industry since its origins in the late 1950s (Mumford and Weir, 1979). The notion of sociotechnical systems was created by the Tavistock Institute as a reaction to the mechanistic approach to job design, as advocated by proponents such as Fayol (1949) and Taylor (1911). The individual focus on job design was no longer considered appropriate, the organisation as a whole was given emphasis, as comprising of inter-dependent social and technical systems. A focus on workers' emancipation and social issues forced recognition of the human side of job-design. Reorganising the social system in isolation from the technical system was deemed to be inefficient and ineffective; to achieve maximum results, both systems were to be seen as inter-dependent (Burnes, 2000). The concept was subject to much criticism at the time of its development, not only as a backlash from the mechanistic school of management theory, but also from sociologists – who accused it of ignoring the wider social society of which organisations are a part – and trade unionists, who accused it of being a manipulative strategy that undermined them (ibid).

Sociotechnical systems, like most methodologies, advocate one best way for managing all organisations. There are cases where a holistic approach to organisational life may disregard the importance of individual input. Further, reorganising job design as separate from technology cannot always be viewed as detrimental, as there may be cases where technology is not the answer.

At the time that the theory of sociotechnical systems was developed, the technical systems it referred to were predominantly large, industrial machines used in labour-intensive jobs. The emphasis was on *social systems* that should not be reorganised with disregard to technical systems. At present, the technical systems referred to in healthcare are CIS and, as the literature reviewed in Section 2.3 has shown, there has been a shift in emphasis to *technical systems* that have been (and should not be) designed without consideration of the social system within which they operate. We can see that the emphasis has reversed.

Berg et al. (2003) state that the term and concept 'sociotechnical' has changed greatly from the original concept discussed earlier as work conducted by the Tavistock Institute. They claim that there is no such thing as 'the' sociotechnical approach. Instead, the authors take sociotechnical theory to aid:

"understanding of how information systems or novel electronic communication techniques are developed, introduced and become part of social practice".

Berg et al (2003) believe that a sociotechnical approach emphasises the social nature of healthcare practices, which is often ignored when designing and implementing information and communication technology in healthcare, yet this, they claim, can make the difference between success and failure.

Sociotechnical theory is recognised as introducing the notion that social systems, and all that they entail, are important. Berg's (1999) adaptation and application of sociotechnical theory steers it towards an empirical methodology in healthcare; he focuses on organisational issues and work practices. An important principle of his work is that *"Users adjust their work routines to a system just as they adjust system use to their work environments, each changing the other in the process."* (ibid). Although users influence how the system is used, and to some extent the system impacts the way in which users conduct their work, technology cannot alter humans per se, although it can alter how they perform certain tasks. Technical systems are static. Humans on the other hand, have the power to 'make or break' technology.

Kaplan (2001) suggests that Berg implies that user beliefs, values, practices, and norms influence the way in which an application is used. This is interesting, because Kaplan describes this as the 'fit' between the technology and the users. However, in the light of the culture discussion in Section 2.2.3, this can be interpreted as the 'fit' between the technology and the organisation's culture.

In 2003, the journal *Methods of Information in Medicine* ran a special issue on Information and Communication Technology (ICT) in healthcare, and sociotechnical approaches. Berg et al. (2003) stated that many of the articles included in the special issue were about failed systems, although they were not selected specifically for this reason. The reason for the high number of papers about failed systems was because many systems fail, they argued. Further, they state that failures are not primarily due to hardware and software limitations of technology, but because systems are built upon the wrong assumptions, and because evaluations are not conducted during implementations.

Cornford and Klecun-Dabrowski (2003) state that there is no single linear model of systems implementation and outcomes as they believe that success and failure is dependent upon complex and interrelating sociotechnical factors. The authors identify four systems theories:

- **Technological Determinism** – where technology is seen as an independent driver of changes in society.
- **Social Constructivism** – the idea that technological artefacts are both culturally constructed and interpreted such that the stability of artefacts is dependent upon many factors such as economics, politics, and culture in the development, implementation, and use of technology.
- **Actor Network Theory** – the notion that innovations are developed and/or adopted through the building of networks and alliances between human and non-human actors within a heterogeneous network. The key focus of this theory is to persuade actors to play their part in the network, and to accept that their attributes must be changed to fit other components of the network. The theory particularly scrutinises the inter-relationships between these entities. Further, it suggests that artefacts should be seen as inputs to an organisational network, and not as a cause of events.
- **Critical Theory** – the notion that all social phenomenon are historically created and conditioned. Technology is not seen as autonomous, but as an instrument for social control.

The latter three approaches advocate that technology is shaped by the conditions of its creation and use, and accept the context surrounding the technology as a major influence, for example, political, economical, and organisational influences. Cornford and Klecun-Dabrowski (2003) criticise Social Constructivism, Actor Network Theory, and Critical Theory as lacking an evaluative stance. Further criticisms are aimed at the lack of guidelines for selecting relevant groups as actors as other groups that may also be interested in technology may be excluded. Actor Network Theory is criticised as it does not make a distinction between technology and society, and states that both should be studied in the same way.

Other approaches, such as the cognitive methodologies promoted by Patel and Kaufman (1998), focus on psychological approaches for analysing tasks and user interfaces, drawing upon Human-Computer Interaction (HCI) theories; much of this work has drawn similar conclusions as the proponents of sociotechnical theory, although the focus is more on the way in which people *think about* particular tasks, and how this impacts the way in which these tasks are performed.

All the described approaches share a common factor in that they advocate a 'human' side to designing, implementing, and evaluating technology. These approaches recognise humans and their environments as being major contributors to the success and/or failure of systems in organisations, and promote investigation into these aspects. Investigations into CIS are usually carried out either for the design and/or implementation and evaluation of technical systems. These investigations take the form of either formative or summative evaluations (Protti, 1999; UKIHI, 2001). Literature on the human and organisational aspects of system design focuses on HCI and user involvement, to better inform design issues with the specific aim of *building a usable* technological system. Studies on implementation issues revolve around organisational change and the management of the change process. Their specific aim is to set a technological system *into action*.

Formative evaluations are conducted to investigate the organisational and user requirements for system design and/or implementation, whilst summative evaluations are usually conducted immediately after design and or implementation (UKIHI, 2001). Although conducting both formative and summative evaluations are ideal, they have also been found to be resource intensive (Kay, 1997).

2.4.2 Organisational Issues in Health Informatics

This section first presents literature that evaluates the impetus for investigating organisational issues in healthcare, and then provides evidence of the factors that affect the diffusion of CIS, and user reactions to it.

The Impetus for Investigating Organisational Issues in Healthcare

It is widely recognized that the healthcare environment in developed countries is evolving (Benson, 2002b; HMSO, 2000; IOM, 2003; Schloeffel, 1998, Tierney, 2000). A review report for the World Health Organisation (WHO) was conducted to examine the evolving role of the hospital within healthcare in industrialized countries (McKee

and Healey, 2000). They reviewed the literature on the desire for improved performance, and found that it was the main driver for organisational changes occurring in the hospital environment.

The authors also found that behavioural interventions such as quality assurance, changing the organisational culture, and the use of financial incentives are often the most popular reform strategies employed by hospital management to work towards improved performance. Where behavioural interventions are reported as having a limited impact alone, financial incentives are described as blunt. Organisational Culture however, is seen as an important determinant of quality of care, which they report has received little consideration.

Koeck (1998) is also of the view that to improve the quality of care, organisational changes are necessary. In particular, the complexity of the change process is stated as being derivative of the complexity of the organization. So the more complex an organisation is, the more complex the change process is expected to be. Integration is also a key factor for successes; isolating single areas for change is stated as being the major reason why change projects often fail. This assertion is mentioned as a chief concern by Iakovidis in Versweyveld (2000). Iakovidis reports that in the US 40% of IT users boycott initiatives because developers pay little attention to user needs, Kaplan and Shaw (2002) also support this statement. Iakovidis stresses the importance of targeting user profiles and analysing different contexts of IT within clinical routine. He asserts that the user is concerned with three things: speed, speed, and speed, and that users, developers, and decision makers need to work together, because they do not understand each other at present. His views concern most IT initiatives around the globe, and not just the case in point.

Brender et al. (2001) report the findings of a study involving 29 international experts who gathered to discuss the question 'what is needed to implement the information society within healthcare?' EPR and people issues were strongly emphasised as topics in need of research.

In their book, Mark and Dopson (1999) present a collection of articles in healthcare management and organisational behaviour from a symposium at Middlesex University, UK, in 1998. This collection of articles was composed to address the issue of how the research agenda in organisational behaviour has been, and is being, interpreted. The articles covered a variety of areas in healthcare and organisational behaviour, such as organisational development as a reactive and a proactive process, the

role of the consumer in healthcare, the issue of leadership and change, the sources of power and influence in clinical directorates, and interventions to health organisations. The editors concluded, amongst other things, that research into the areas of inter-organisational collaboration, people behaviour in healthcare, and international collaborations were critical to this field of study, and had been neglected in the past.

The importance of organisational issues is echoed in the seminal work by Sauer (1993). He is quoted by Aarts et al. (1998), as stating that

“Success and failure of implementation of information systems is mostly due to organisational factors. Only a minority are ascribed to the technology.”

Protti (2002) arrived at similar conclusions, as this quote demonstrates:

“It is people and not technology that make the difference between success and failure. When end users want to make information technology tools work for them, even ‘poor’ tools can deliver real business value.”

In terms of evidence in support of Organisational Culture, a literature search to examine the question ‘Does Organisational Culture influence healthcare performance?’ was conducted by Scott et al. (2003). The authors found ten studies that met their inclusion criteria. Of those only four reported on supportive evidence for the link between Organisational Culture and healthcare performance. The authors concluded that there is some evidence to support the link, but it is difficult to articulate the nature of that relationship. This may be related to the difficulty of defining culture and performance as variables.

In an empirical study by Nikula (2001) investigating clinician and management use of an EPR in two Swedish hospitals, it was found that there is a large discrepancy between the management and clinician frame of reference for the EPR. Interviews with senior management and clinicians revealed that a shared vision for resolving this problem was important, but communicating a shared vision was seen as problematic. Where management felt that clinicians had been involved and were informed, clinicians reported that they were not really involved in implementations, nor informed. For the benefits that an EPR may create, it was stated that inducing organisational change was necessary (ibid).

The importance of examining clinical activity before EPR development was established by Beuscart-Zephir et al. (2003), who analysed 50 pre-operative anaesthetic consultations, involving 13 clinicians. They found that where information management is closely linked with clinician activity, it is necessary to conduct analysis of these

activities so that the context of organisational factors can be understood, and used to inform EPR developments.

Iles and Sutherland (2001) present a comprehensive guide to organisational tools and concepts to better aid healthcare professionals involved with CIS implementations in the UK NHS. They review many tools and techniques such as: Five Whys, Soft Systems Methodology, Process Modelling, SWOT Analysis, Force Field Analysis, Total Quality Management, and Business Process Re-engineering. They state that:

“The literature is dominated by descriptions of models and approaches, prescriptions and no evidence...articles based on empirical research are relatively rare, and are predominantly single site case reports.”

Noted authorities on the subject of Organisational Culture and Health Informatics such as Aarts et al. (1998); Andersen et al. (2002); Ash (1997); Ash et al. (2003); Berg (1999, 2001, 2003); Kaplan (2000a,b); Kaplan and Shaw (2002); Protti (1999, 2002) are but a few examples from a large pool of proponents for investigating organisational factors in Health Informatics.

User Reactions to CIS in Healthcare

A survey to measure physician satisfaction with an EMR was conducted by Sittig et al. (1999). The survey was distributed to 75 primary care clinicians, of whom 65% responded. All respondents used the system heavily, and had been using it for over two years. The motivation for the research was the popular notion that if users do not like the system, they will not use it. Their findings suggest, that despite satisfaction with system design and interface, system capability did not meet user expectations. The authors report that the system was being used by 2000 more users than it was designed for, and that both hardware and software were becoming obsolete. However, there were no immediate plans to update the system.

Shortages of resources in healthcare indicate that this could be a problem that is common to many. Rather than buying a system with the potential for it to be upgraded and evolve with user requirements, healthcare organisations do not have the resources to perceive CIS as more than static systems. This paper highlights the need for, and the importance of, systems ‘evolving’ with user requirements. Issues of CIS transferability from one setting to another are highlighted in a report by Heathfield et al. (1994), which draws attention to the problems of applying CIS developed in one setting to another. The authors describe the application of PEN&PAD (originally developed for use by

primary care physicians), in the development of a nursing record system for use by nurses, based in a hospital department that cares for the elderly.

Despite the emphasis on user centred design, and despite extending the CIS to encompass the differences in context and work processes, nurses did not accept the system. Nurses preferred to be descriptive and to use free text as a method of recording data, rather than using structured data entry. The authors justified rejection by stating that the philosophy of how nursing work is conducted is very different to that of a physician. Their paper points out that encapsulating user requirements is beyond technical and structural issues such as work flow and data that represent that work; it also requires an understanding of psychological issues, i.e., rejection was not simply a matter of workflow or technical issues such as data capture and CIS interface, but was related to the norms and values that they were used to, and also about the preconceived notions about what their work entailed and how it should be conducted.

Rocha et al. (2000) conducted a study to analyse computer-generated reminders about infections, and whether this could influence clinical practice patterns. By clinical practice patterns they mean the frequency with which paper medical charts are referred to. They found that computer-generated reminders were unable to influence the practice patterns of clinicians, and stated the possible reasons for this as the CIS being only partially integrated into the healthcare process, inadequate training given to physicians, and methodological reasons such as sample size.

A study comparing two patient care information systems in the same hospital was conducted by Van der Meijden et al. (2003). The authors investigated human and organisational factors by way of interviews. The first system was a graphical user interface to the hospital information system, which had been implemented four years prior to the investigation. Only physicians were interviewed. The second system was a full EPR for stroke, and this evaluation was conducted a year after its implementation. Twelve users were interviewed at this site, including the head of nursing staff and physicians. Their results indicated that users found both systems to be user friendly, and enhanced coordination between different care providers, although communication between management and clinical staff was found to be poor. User requirements were not explicitly investigated before the system was developed. Although physicians and the head of nursing believed that the system improved coordination between different healthcare disciplines, it would have been interesting to elicit nursing opinions about the system, as compared to physicians.

Ash et al (2003) conducted a multi-site study investigating success factors for implementing computerised physician order entry in three secondary care settings. Two sites had a long-term history of using physician order entry, and one had recently implemented this. A multi-disciplinary team of researchers conducted observations, interviews, and focus groups with a number of hospital staff (administrative, clinical, and IT staff). The authors found that contextual issues are often uncontrollable by those implementing information systems, and need good leadership not only at a high level, but also intermediary, during implementations. They also found a difference between the purpose of the system and the way it was actually used, with users valuing speed as a key factor for encouraging system use. Although the results were stated as indicative of all three sites, no comparative discussion of the three sites was given.

Sections 2.5-2.7 review literature on organisational factors and CIS specifically within the ICU.

2.5 Organisational Factors in Intensive Care

This section introduces the ICU environment, and presents an overview of its characteristics in terms of structure, running costs, and changing requirements over time (Section 2.5.1). Section 2.5.2 concentrates on clinical communication in the ICU, so that it is possible to understand how, and for what purpose, information is used in the ICU.

2.5.1 Characteristics of Intensive Care

Bennet and Bion (1999) describe the organisation of ICUs historically. They report that the first ICU dated from a polio epidemic in Copenhagen in 1952, when doctors reduced the percentage mortality rates by separating patients with severe and acute illnesses from the rest of the hospital, instead of across different wards.

An ICU typically hosts a plethora of medical staff, usually consisting of between two and seven consultants responsible for clinical care, junior doctors – either anaesthetic senior house officers or specialist registrars – and nurses. Each patient is usually assigned one nurse at all times (Jones et al., 1998; Bennett and Bion, 1999).

It is an expensive area of the hospital, costing £1000 to £1800 per bed per day, with an average ICU containing between 4 and 6 beds in the UK. Salaries comprise more than 60% of these costs, with 10% being taken by pharmacy, and 10% being

disposables (ibid). Similarly, a study in Canada (Norris et al., 1995) compared ICU and non-ICU costs per day, by analysing the records of 386 patients. They found that ICU costs are six to seven times greater than most general wards. As well as the intensity of care required by patients, costs may also be spiralling due to a change in ICU characteristics (Jakob and Rothen, 1997). Reductions in mortality rates and length of stay, the increasing age of patients being treated, and the increasing number of patients admitted, is having an incremental effect on workload (Jakob and Rothen, 1997). Patient outcomes have also been correlated with nursing workload and nurse staffing (Celi et al., 2001).

This implies that investment in CIS must be carefully budgeted. Increasing reports of under-investment and bed shortages can mean that CIS are often not a priority (Øvretveit, 2001). However, investments of this nature are usually under pressure to prove their worth in a fairly short amount of time, so that it is justifiable to sustain them (Mitev & Kerkham, 2001). Organisational studies by Pronovost et al. (1999) and Zimmerman et al. (1994) focus on the relationship between ICU organisational characteristics and outcomes.

The Pronovost et al. (1999) study aimed to determine whether organisational characteristics of an ICU were related to clinical and economic outcomes of abdominal aortic surgery patients in all Maryland hospitals in the USA. The study employed observation as a primary source of data collection and concluded that clinicians and hospital leaders should consider the affect of organisational characteristics on patient outcome involving high-risk operations. Zimmerman et al. (1994) conducted a nine-centre study in the USA, and also used observation and interviews for data collection. The ratio of actual to predicted hospital death rate was used to measure ICU effectiveness, and the ratio of actual to predicted length of stay was used to assess efficiency. They found that those with excellent organisational practices also advocated a patient-centred culture, strong medical and nursing leadership, and effective communication and coordination; Celi et al. (2001) report similar findings.

2.5.2 Communication in Intensive Care

In 1997 the president of the society for critical care medicine, Nelson (1997), reported that intensivists were "*overwhelmed with a sea of data in the ICU.... there is much data, but of questionable quality...*" ICU has been reported as being a major site for medical errors (Celi

et al., 2001). In a review of 16,000 hospitals, Moss et al. (2002) cite Wilson et al., who state that communication errors were the leading cause of deaths, and Donchin et al., who found that 37% of errors in intensive care were the result of verbal exchanges between nurses and physicians. This is not far from the IOM (1999) estimate of between 44,000 and 98,000 deaths per year as a result of medical errors in the US. The need for reliable and accurate methods of managing, recording, accessing, and using quality patient data could not be more pressing, yet despite these findings, studies by Reddy et al. (2002), Parker and Coiera (2000), and Manias and Street (2000) reveal that face-to-face communication is preferred.

Reddy et al. (2002) state that before systems designers can build appropriate technologies, they not only need to understand the nature and scope of user information needs, but also the effect of the organisational setting on those needs. The authors conducted a qualitative study based in a surgical ICU. They observed the multi-disciplinary ICU team on morning rounds for three months. They found that organisational information was of great importance to the surgical ICU team, with their first source of reference being other members, rather than paper or electronic sources of information. Although humans are good at providing contextual information, how, if, and when they provide that information is dependent upon how amenable they are to others, as well as group dynamics.

Parker and Coiera (2000) found that the communication behaviour of clinicians is often inefficient; they favoured telephone calls and chance face-to-face meetings above other methods of communication. Because this method has a highly interruptive effect on the working environment, it increases the likelihood of errors being made. The paper centres around a cognitive psychological perspective, with a view to understanding how human memory functions, and the potential consequence of interruptions on the ability to work effectively. The authors observed the communication patterns of eight physicians and two nurses in a hospital in the UK, and concluded that there is considerable empirical evidence to suggest that interference can have powerful negative effects on attention and working memory.

Sections 2.5.1 and 2.5.2 highlight the complexity of an ICU environment, both in terms of its requirements and in terms of its structure. The need for timely, accurate, and comprehensive information about the patient is therefore imperative. Yet, despite the importance of availability of information in a complex environment such as an ICU, there is poor access to it (Hagland, 1998). The complexity, uniqueness, and variety of

information required by clinical staff in the ICU is reported by Hagland (1998), Campbell et al. (2001), and Randolph and Kane (1998). This affects CIS design and development, as well as the potential to meet some of these information needs (Mitev & Kerkham, 2001). CIS in intensive care is the next topic of discussion.

2.6 CIS in Intensive Care

The types of CIS to be found in ICUs are described in Section 2.6.1, and a brief description of their development is also presented. In Section 2.6.2 CIS outcomes in ICU are discussed in terms of findings from empirical studies.

2.6.1 Background to CIS in Intensive Care

An ICU is often more technically advanced than any other area of a hospital (Craft, 2001). CIS are described as having the potential to improve the quality and coherence of ICU patient information and subsequently the process of patient care (Varon and Marik, 2002; Campbell et al., 1999).

The ICU is home to many different types of CIS, of which only physiological monitors can be found in all settings. These aid observation of variables such as temperature, fluids in/out, and heart rate etc., and originated in the 1960s (Rockwell et al., 1966); a few in-house special purpose systems provide data from ancillary healthcare groups, such as radiology and laboratory systems. Other systems, such as respiratory therapy management systems, are used to automatically record and manage ventilator data. Again, these can be found in only a handful of ICUs (Campbell et al., 2001; Craft, 2001; Varon and Marik, 2002). Finally, critical care information systems (CCIS) are designed for the collection, storage, organisation, and manipulation of all patient data. They are usually placed by the bedside and networked to a central computer in the ICU (Campbell et al., 2001).

CCIS functions can range from all or some of the following: automated vital signs capture, laboratory results reporting, patient record management, admission and discharge, patient care plans, and decision support (Campbell et al., 2001). Yet in reality, very few ICUs house these systems in their entirety, and few achieve the vision of an integrated ICU, where data from all systems is incorporated so that it is accessible from a single system such as an EHR. Instant, electronic access to data from geographically separate sites is also a prospective vision (Craft, 2001; Hagland, 1998).

CIS are usually customised to specific ICU and clinician requirements. However, this is costly and resource intensive (Bürkle et al., 2001; Campbell et al., 2001; Varon and Marik, 2001) and may be why, in the opinion of Beuscart-Zephir et al. (2003), CIS in hospital departments such as emergency, ICU and anaesthesiology:

“tend to remain cut off from the general development of hospital information systems: they are still badly, or not well computerised.”

Varon and Marik (2002) also express dejection:

“It seems somewhat absurd that we can put a man on the moon, yet most hospitals in the US use outdated technology that cannot ensure that the right drug gets to the right patient.”

These views are in contrast to the optimistic descriptions of CIS capabilities given by Campbell et al. (2001).

This section has described the types of CIS used in ICU and their utility, however Fraenkel et al., (2003) state that *“there is little literature on the outcomes of CIS implementations.”* This is explored next.

2.6.2 CIS Outcomes in Intensive Care

In this review section, literature giving empirical evidence of CIS outcomes in intensive care is reviewed. Outcomes centre around quality benefits, the availability of clinical information, savings in time and processes, and the transferability of CIS developed in ICU to other areas of a hospital.

A longitudinal study over a period of four years, employed observational techniques and surveys to assess user perceptions and the quality benefits of a CIS replacing paper (charts, patient records, and results reporting) in a twelve-bedded ICU in Australia (Fraenkel, et al., 2003). The evaluation was conducted before and after the implementation of the CIS. It was found that medical incidents were reduced from 85 to 55, intravenous incidents were reduced from 140 to 46, and ventilator incidents were reduced from 51 to 10. The survey results revealed that nurses had a positive perception of the electronic CIS. They felt that it reduced time spent documenting, and increased time with the patient. Reductions in incident reporting were measured using a quality improvement database, where clinicians would record any adverse incidents as they were identified, and these would be reviewed by clinical supervisors before being analysed. As this quality improvement database existed prior to any CIS implementation initiative, it could be said that the unit was already surrounded by a culture that aimed to improve patient care and outcomes. Perhaps the fact that the CIS

replaced many functions, and did not create many others of its own also meant that information sources were integrated, thus saving time switching between systems and looking for information from disparate systems. Time and experience may also be a factor for its success, since the CIS was evaluated over a four-year period; often evaluations are conducted under much shorter time scales (Kaplan and Shaw, 2002).

Improved availability of clinical information is also a key benefit. It has been stated that intensive care clinicians' information needs are much broader than individual patient decision-making (Forsythe et al., 1992). In the US a web-based CIS was developed and evaluated by Randolph and Kane (1998). Initially, this development was a precursor to a web-enabled bedside charting system that was to be implemented in the ICU. The authors wanted to maximise the information requirements that could be met via this system. An inventory of existing paper and electronic information sources was undertaken; these were enveloped in the prototype. After implementation they found that 56% of the identified requirements were met by the prototype, while 23% were partially met, and 19% were unavailable. After implementation of the bedside CIS, over 73% of information requirements were now met. Although many of their information requirements were available from paper-based systems, they were not as readily accessible. This system was also linked to the hospital information system, and as well as providing links to evidence-based practice, clinical practice guidelines, and other sources of clinical information, patient profiles were also attainable on password entry. Again, attempts to integrate the system with the hospital information system may have improved acceptance. A longitudinal study would indicate how these findings change over time, if at all. Issues such as training and user acceptance were not evaluated in this study.

The time taken for a radiographer to process X-rays decreased by 15 minutes overall upon the implementation of a picture-archiving and communication system (PACS) in a UK hospital according to Cox and Dawe (2002). The 20-bedded ICU was the first part of the hospital that it was linked to. Cox and Dawe (2002) assessed the impact of the PACS introduction on clinical staff. Questionnaires and interviews were deployed before and after the implementation. Of 50 distributed questionnaires, 39 were returned – 17 from radiographers, with the remainder quite evenly spread out between physicians and nurses. Overall, 94% of the ICU staff felt that the service provided by radiology had improved significantly, it was faster, fewer images went missing, and the quality of the images was acceptable. Staff did, however, express concerns about

technical problems such as breakdowns, and desired it to be compatible with other systems in the ICU.

Research by Marasovic et al., (1997), Pierpon and Thilgen (1995), Lee et al., (2002), and Apkon and Singhaviranon (2001) are all concerned with the impact of CIS on ICU activity. Apkon and Singhaviranon (2001) focus on physicians, while the others focus on nurses. The CIS assessed replaced a set of paper-based patient information, for example, charting systems, registration systems, or nurse care plans. The CIS were also isolated examples, and not networked to the hospital CIS. The Marasovic et al., (1999) study used RCT methods and compared the effect of a paper-based registration system with an electronic one. They found that over an 18-hour shift nurses achieved a time saving of 29 minutes. Pierpon and Thilgen (1995) found that although the computerised charting system they evaluated reduced time gathering and charting patient data, nurses also spent 10% of their time entering and viewing it, which meant that the net effect was neutral, i.e., 24% of nursing time was taken up charting patient information both before and after CIS implementation. Whether this would change over time could be tested, as nurses may become faster at typing and viewing information on the computer if they become more experienced; the level of IT competence is not clear within this study.

Weigle et al. (2001) give an example of a fully computerised ICU. They describe clinical activity over a period of one week from a physician's perspective. Complete patient records were held on a wireless mobile computer, which gave access to laboratory results, trends, orders, the internet, and summary statistics. It was not yet networked to a radiology system, as that department did not have the required infrastructure for it. Physician access to the EMR was also available, via ethernet, from home. This paper is an excellent example of a very nearly complete exploitation of Internet- and ethernet-enabled technology.

Junger et al. (2001), who evaluate the suitability of a Patient Data Management System (PDMS) for ICUs on a general ward, describe the transferability of CIS developed in ICU to other settings. The PDMS was developed on the ICU, and then also implemented in a patient management clinic in 2000. A survey of 14 clinical staff from the general ward revealed that it was user friendly, useful, and easy to use and learn. The authors found that working from an area with complex information requirements to one that was less intensive enabled them to cope better with transferring the system to a less complex ward. This is also echoed by Hagland (1998) who quote the clinical director of an ICU in a Californian hospital:

“In selecting the system we did, our feeling was that a system that worked in the ICU could easily be scaled down to work for the floor, whereas a system designed for the floor would not necessarily scale up to the ICU.”

Having reviewed the types of system in an ICU and their effects, the next section reviews literature that tackles the intersection of all three areas: CIS, Organisational Culture, and intensive care. It must be noted that the section title includes organisational studies and not Organisational Culture, because it was found that very few studies tackled Organisational Culture as it was defined in Section 2.2.3, however some of the Organisational Culture factors may also be found in the organisational studies.

2.7 Evidence of CIS and Organisational Studies in Intensive Care

This final review section aims to provide evidence of the existing literature on CIS, organisational studies, and intensive care.

Carmel and Rowan (2001) conducted a rigorous literature search using electronic (Medline, and the National Library of Medicine database) and hand (Critical Care in Medicine, Intensive Care Medicine, conference abstracts) searches for publications that provided empirical evidence on the role of organisational factors in the critical care literature. The search was conducted for all literature published between 1966 and 2000. They found 63 publications that related to 54 different studies, which they grouped around eight main categories:

1. Staffing (44)
2. Teamwork (14)
3. Pressure of work (13)
4. Protocols (11)
5. Admission (2)
6. Technology (6)
7. Structure (6)
8. Error (2)

They proved that studies evaluating organisational factors in ICU do exist, but in terms of this thesis it is interesting to note that only 6 studies considered technology.

Two papers (Celi et al., 2001 and Qavi et al., 2001) are based in the US and the UK respectively, and deal with the subject of telemedicine in ICU. The Celi et al.

(2001) paper describes a futuristic 'technology-enabled' care model that utilises telemedicine to enable 24/7 patient care. They believe that this model will support the multi-disciplinary ICU team by enabling a centralised eICU team that allows remote monitoring of patients across many geographically dispersed hospitals. This team would be able to conduct virtual rounds using teleconferencing facilities, as well as hold virtual meetings. The use of tele-videoing would enable constant monitoring of patients who demand this. It would be possible, they state, to monitor and treat patients remotely by communicating with the bedside caregiver, who would administer care. Patient records and monitoring information would be available to them electronically. This, they believe, is a workable solution, especially as many ICUs are under-staffed, and suffer a shortage of intensivists. They fear the acceptance of this model is dependent upon hospitals being able to foresee its value and physicians being able to change their working practices.

In contrast, the Quavi et al. (2001) study examines the actual outcomes of telemedicine in an English neonatal intensive care unit (NICU), where videoconferencing was used to monitor infants. The research was conducted using interviews and questionnaires, and involved 49 ICU nurses. 20 nurses returned questionnaires, of which 18 were usable. They found that nurses viewed videoconferencing as an unsuitable alternative to face-to-face communication, but would consider it when face-to-face communication was not possible. The authors identified several cultural factors that influenced this outcome. Nurses felt that sight and sound rated higher than smell and taste in the NICU, as many of the observations depend upon infant pallor and the sounds that they make. Nurses felt that the image and sound quality of videoconferencing could not match the quality of the human senses. Further, they proposed that it lacked a sixth sense, that of intuition, which was only gained by face-to-face contact with the infants. CIS acceptance in ICU then, is beyond accepting organisational changes such as work practices as suggested by Celi et al. (2001); it also concerns cultural factors as demonstrated by Quavi et al. (2001).

Mitev et al. (2001) follow the implementation of a patient data management system (PDM) in a UK ICU. They too found that implementation was a complex process that involved many organisational issues, such as costing of health technology, legal purchasing requirements, training and staff experience, and relationship with suppliers. Although users were very involved with PDM development and were enthusiastic, this enthusiasm lagged as the implementation progressed. It was thought

that this was due to high user expectations of the system that were not realised. Users also had poor IT skills, and remained unsupported by management. As neither purchaser nor supplier had an understanding of what was required, software also had to be extensively modified to fit in with ICU work practices.

Yet Alasad (2001) describes ICU nurses as more technically competent than nurses from other areas of a hospital. Alasad's (2001) research concerned investigating the effect of technology on ICU nurses. 22 nurses were interviewed and observed. The technology investigated consisted of technical equipment, such as physiological monitors. Nevertheless, her findings showed that new nurses felt the technology to be demanding and time-consuming, but over time, more established nurses felt it was safe, secure, and informative. Alasad argues that experience improves acceptance, to the extent that the technical equipment was seen as part of the patient care process, as without it, the patient would probably die.

2.8 Conclusions

The specific issues identified in the literature review are given first, and then they are discussed:

1. Since the introduction of CIS in healthcare in the 1960s, little has changed in terms of organisational problems when implementing CIS (Richards, 2001).
2. Despite decades of research in Health Informatics, implementing and integrating a CIS into secondary care remains a major problem (Benson, 2002a and 2002b; Schoeffel, 1998).
3. The issue of integrating CIS successfully into complex areas with equally complex information needs becomes much more salient with government imposed deadlines for EHR developments across the globe (AMIA, 2003; Iakovidis, 1998; Moorman and Van der Lei, 1999).
4. ICU information requirements differ substantially from other areas of a hospital, and this will affect the design and development of CIS (Hagland, 1998; Campbell et al., 2001 and Randolph and Kane, 1998).
5. The issue of transferability of CIS developed in one setting to other healthcare departments and institutions is challenging (Heathfield et al., 1994). However, it has been demonstrated that CIS developed in complex areas such as ICU are

more likely to succeed in other less complex areas of healthcare, rather than vice-versa (Junger et al., 2001 and Hagland, 1998).

6. Few large-scale studies of ICU exist (Bennet and Bion, 1999) and very few tackle the issue of Organisational Culture and CIS in intensive care.
7. Few organisational models developed for informing CIS implementations are based on empirical evidence (Iles and Sutherland, 2001).

The healthcare environment is changing; the emphasis on better standards and quality of care for patients has never been greater (HMSO, 2000; IOM, 2003). This shift is creating a change in the way that care is delivered from single clinicians to multidisciplinary teams (Benson, 2002b; Schloefel, 1998; Tierney, 2000). The role of the patient is also changing, from one of passive recipient of care, to one which proactively seeks information and demands to be more involved in decisions related to their own healthcare (DoH, 2003; Munir, 2000; Protti, 2002), while litigation is becoming a rising concern as patients are becoming less tolerant of medical errors.

The EHR is one answer to managing the complex web of health-related patient information proffered by academics, medics, and CIS developers. Yet this entity is also a cause of anxiety amongst many healthcare professionals (BJHC, 2003; MRI, 2002). Several development and implementation problems are emerging in common with CIS problems faced in the past (Benson, 2002b; Richards, 2001). However, where previously there has been a tendency to focus on technical problems, there is a growing body of literature in support of human and organisational issues. In the review by Kaplan and Shaw (2002), these issues are reported as having been investigated for decades, yet it is only recently that this body of literature has gained momentum and is being considered seriously as useful and influential in informing CIS related issues (Cameron et al., 2002; Iles et al., 2002; HMSO, 2000; IOM, 2003; Protti, 1999, 2002).

EHR developments must consider the variety and complexity of information requirements of different hospital departments if the EHR is to be implemented and integrated effectively. Literature in Section 2.6 emphasised the importance of understanding organisational factors when designing EHRs, so that the multitude of CIS failures mentioned (Berg, 1999, 2001; Kaplan, 2000a,b; Kaplan and Shaw, 2002; Sauer, 1996; are but a few) become a minority, rather than remain in the majority. This is a challenging task, and one that will require a major change in the status quo of CIS design, development, and integration.

This literature review has demonstrated that although many studies consider organisational factors within Health Informatics (Section 2.4), few empirical studies tackle the issue of Organisational *Culture* with regard to CIS *in intensive care*, as defined in Section 2.1.1, and those few that are conducted are single site studies (Iles and Sutherland, 2001). This implies that this thesis will be contributing original work based on empirical evidence to the existing academic literature; specifically a thesis that investigates *Organisational Culture issues with regard to integrating CIS, in intensive care*.

2.9 Summary

The aim of this chapter was to provide a synthesis of the literature of relevance to this thesis. Section 2.2 clarified the scope of the literature review and the terms and concepts referred to in this thesis, specifically, CIS, Organisational Culture, and intensive care unit. Figure 2.1 showed a Venn diagram illustrating the boundaries of the literature review, to clarify the scope of this chapter.

Background to CIS in healthcare was given in Section 2.3, and current global perspectives and CIS situation were also discussed, ending with evidences of CIS application in the healthcare sector. Organisational factors, tackled within the Health Informatics literature, were reviewed in Section 2.4. This section put forward prominent systems theories that are also used within the discipline of Health Informatics. Literature demonstrating the impetus for investigating organisational factors and user reactions to CIS implementations was also reviewed.

While Sections 2.3 and 2.4 reviewed the more general literature to set the context of the literature review, Sections 2.5-2.7 presented more focussed literature, which spanned the intersecting areas (I, II, and III in Figure 2.1). Literature of immediate relevance, area IV (see Figure 2.1), was presented in Section 2.7. This was the precise focus of this thesis i.e., evidence of the types of studies already conducted in the area of CIS and organisational factors in Intensive care.

In conclusion, it was found that the literature recognises the importance of organisational issues. It supports the view that organisational factors, although researched for over 50 years, have only recently gained any standing within Medical and Health Informatics, and can inform greatly CIS implementations such as the EHR. Although the area of Organisational Culture has been investigated, studies of this sort

remain sparse in Health Informatics and are often conducted under the broader subject heading of organisational issues/factors.

Moving onto Chapter 3, the focussed context of this research is presented, i.e., the context of the current CIS situation in Denmark and the UK, where data were collected, is explained first, and then the four sites used for data collection are described.

Chapter 3

Setting the Scene

Chapter 3 focuses upon introducing the ICU settings in which the data on which this thesis is based were collected. It begins with an overview of the national EHR initiatives in England and Denmark, so that the broader context can be understood, before describing country and site selection and the locally based initiatives at each of the intensive care settings investigated.

3.1 National Perspectives

This section is concerned with presenting an overview of current EHR initiatives in England and Denmark, as the ICUs investigated are based in these countries. Section 3.1.1 discusses the government reports that lead to the current National Programme for IT (NPfIT), and subsequently the development of the Integrated Care Record Service (ICRS) in the UK, while Section 3.1.2 examines the Danish EHR in terms of instructions from the Danish Ministry of Health and the precursor to the Danish EHR, the Green System, is described. A discussion on EHR contexts for England and Denmark in terms of the literature, and in comparison to global activities, is given in Section 2.2.2.

3.1.1 The English Context

The aim of this section is not to report the minutiae of EHR development in the UK, since excellent reports on this subject are already available (DOH, 1998-2002b; Protti, 1999, 2002). Rather, it is to present an *overview* of developments in order to set the context for this thesis.

Many reports have been written for the UK Department of Health since the seminal 'Information for Health (IfH)' (DoH, 1998), which stressed that the national information strategy would support the delivery of patient care, and the work of all healthcare professionals involved in the care of the patient. The EHR was considered a mechanism for achieving this, and so a set of six levels of acute EHRs were identified. These are given below:

Level 1	Clinical administrative data – patient administration and independent departmental systems.
Level 2	Integrated clinical diagnosis and treatment support.
Level 3	Clinical activity support.
Level 4	Clinical knowledge and decision support.
Level 5	Specialty specific support.
Level 6	Advanced multi-media and telematics.

The above levels were accompanied by target dates for achieving them, so that by 2002, 35% of all acute hospitals would have implemented a level 3 EHR, and by 2005 all acute hospitals will have a working level 3 EHR. It has been five years since the publication of IfH, and the Department of Health has been much criticised for these targets, as reported by Protti (2002). The six levels of acute EHR have now been abandoned. However, despite the commotion it caused, IfH did introduce the notion that an electronic system of patient records, integrated across all sectors of healthcare, would be of great benefit for patients and their care providers. What it did not manage was to foresee the extent of changes required to achieve this.

In 2002, Protti was asked by the Department of Health to review the EHR situation in the UK (Protti, 2002). The Electronic Record Development and Implementation Programme (ERDIP) was set up by the NHS Information Authority (NHSIA) to record all initiatives regarding EHR development; of the 82 published reports reviewed by Protti, only 17 were considered sufficient for recommending a course of direction to follow. Protti reviewed a large tract of literature that discussed EHR success, not all about ERDIP. From this literature he identified 150 factors that predicted EHR success. Of these:

- Only 'top management support' and 'user involvement' were consistently associated with successful implementations.
- Involving the whole organisation was stated as being important if the EHR was to be supported by users.

- Recognising the extent of changes to an organisation that an EHR requires was regarded as important, and therefore it was deemed imperative to acknowledge that errors at any of these stages may have negative results for the implementation.
- A local ‘champion’ is required to lead and support the implementation.
- The organisation must allow at least six months before it can determine whether or not the implementation has been a success or a failure.

Protti stresses that it is *‘people, and not technology, that make the difference between success and failure’*. His conclusions emphasise the need for developing and implementing systems in collaboration with the intended users.

It will be interesting to see if the recently launched National Programme for Information Technology (NPfIT) embraces Protti’s findings. NPfIT was launched in the UK in 2002, following the publication of ‘Delivering the NHS Plan’ (DoH, 2002a), which further developed the proposals in the NHS Plan (DOH, 2000b) for a service centred around the patient. The NPfIT programme focuses upon four key developments:

- An electronic integrated care records service (ICRS), including a nationally accessible core data repository and digital images.
- The provision of facilities for electronic booking of appointments.
- An electronic transmission of prescriptions service.
- An underpinning of IT infrastructure with sufficient connectivity and broadband to meet future NHS needs.

The aim of the ICRS programme is to facilitate the sharing of patient records in order to provide clinical support across all care settings. It is due to be completed in 2010 (DoH, 2002a). A great number of suppliers and developers will be involved with the design, development, and implementation of the ICRS. Data collected for this thesis, and discussed in Section 6.2.3, shows that the Danish EHR suffered many integration problems. These difficulties stemmed in part by the fact that a number of different suppliers were employed. The suppliers remained disconnected from each other, and did not communicate with either each other or the healthcare institutions. This has also been reported to be true in other studies in Denmark, as discussed in Section 2.3.2. The NPfIT programme is also using a number of different suppliers and consultancies to aid ICRS integration.

Chapter 2 showed that the ICU is an under-investigated area of healthcare. The implications of the ICRS for intensive care are in need of investigation. This thesis

explores the use of existing CIS in terms of Organisational Culture and the use of CIS by clinical staff, in order to assist CIS integration into ICU.

3.1.2 The Danish Context

In Denmark, all decision-making is decentralised to county councils, including decisions concerning healthcare. In 1998, the Danish Ministry of Health instructed each county in Denmark to develop hospital-wide EPRs by 2004 – a timescale not dissimilar to that of the UK. Prior to EHR development, Denmark used a national hospital information system known as the Green System, which is still used by 50% of Danish hospitals. Bardram (1997) describes the Green System as consisting of five modules:

- **Patient Administration** Supports registration of services for patients, and is also used for budget planning and control.
- **Booking Internal Communication and Electronic Data Interchange (EDI)** Supports requesting services from one department to another. EDI supports communication between hospital and GP and between different hospitals.
- **Management** Charging and billing internally in health sector, and internal management information
- **Data Warehouse** National shared database holds information on patients treated at different hospitals using the Green System. Provides historical view of patient treatments.
- **Classification Registers** Statistically processes services according to classifications provided by Danish Ministry of Health.

The Green System was predominantly used by trained secretaries and administrative staff for patient administration purposes. Although the Green System was designed to support co-ordination of treatment between different departments, few hospitals adopted this particular part of the technology (Bardram, 1997). Apart from the Patient Administration module it was not used very extensively, as hospital work practices were unsupported by it (Bardram, 1997).

Patient Identification Numbers (PIN) were used by the Green System to identify patients. This enabled the hospital to obtain administrative information about the patient from other counties, if the patient had been treated there. The Green System also enabled the treating hospitals to contact other hospitals where the patient had been admitted for medical records, if required. The PIN is given to every Danish citizen at birth, and is also essential in other areas, such as education, employment, and transport;

without it, it is impossible to obtain a job, education, healthcare, and even smaller things such as a bus pass.

Denmark, then, already had a very sophisticated system in place, but as adoption was low, and since only one of the five modules was actually used, the Ministry of Health decided that it was time to update this national system. However, since decisions relating to the EHR are the responsibility of County Councils, EHR initiatives across the country have been described as disjointed and ad hoc (Bygholm, 2001). As a move to remedy this, a publicly funded project, the EHR Observatory, was set up to collect and disseminate experiences from all regional EPR projects (Nøhr et al., 2001; Andersen et al., 2002). Andersen et al. (2002) have found that EHR initiatives remain disjointed due to the different suppliers and strategies employed by each county council. The authors also found that failure to meet positive user expectations resulted in negative user reactions.

The county* in which the two Danish ICUs used in this study were based provides one example of the approach taken towards EHR development. This EHR was divided into six user modules, and different software and hardware companies were developing each module. The modules were:

- Medication.
- Order and Results.
- Imaging.
- Patient Record.
- Patient Administration System.
- Booking.

A seventh ‘integration’ module was to act as an interface between the legacy systems. The county’s Office of Information built a virtual hospital to test the modules in a virtual environment. However, lack of resources meant that this was abandoned.

Each hospital selected as a test site by the county council was responsible for collaborating with software developers and testing the modules. Once a module had been fully developed the hospital responsible for it would implement it, and then share their experiences with other hospitals within their county.

* For ethical reasons, discussed in Section 4.2.3, the county cannot be named.

Having set the broader context, this chapter goes on to describe the rationale for selecting the host countries and ICU sites before describing the ICU settings on which this thesis is based.

3.2 Selecting the Countries and ICU Sites

For ethical reasons (see Section 4.2) the hospitals, CIS, and Danish EHR modules are not named. The ICUs will be referred to as Sites A, B[†], C, and D and are described in Sections 3.3.1, 3.3.2, 3.3.3, and 3.3.4 respectively.

This research is based on data collected from four ICUs, two each in England and Denmark, with the Iterative Systems Integration Model (ISIM) being derived from three of the ICUs. The second English site, Site B, was used as an independent evaluation site for validating ISIM (see Section 7.2). All four sites were selected before data collection commenced, including the evaluation site. All four sites were at different stages of CIS integration: successfully running an electronic CIS (Site A), having a history of a failed CIS (Site B), integrating a newly implemented CIS (Site C), and about to install a CIS (Site D).

Using data collected from CIS at different stages of integration meant that it may be possible to apply ISIM during many stages, not just one, since it was developed from data about CIS integration at three different stages, and validated at a site at a different stage of CIS integration. As a consequence of each site being at different stages of CIS integration, comparative analysis was more difficult than if all the sites had been at the same stage of CIS integration.

The countries selected needed to be similar in terms of health service provision, so any countries where healthcare is a private concern, rather than publicly funded, were not considered. Opting for England was entirely pragmatic, since it is the home base of the researcher. Denmark was chosen from a set of suitable comparator countries because of the presence of suitable contacts who agreed to facilitate access to the sites.

While language was an important issue, it was decided that most Danes speak at least functional English. This was found to be correct, although Danish was spoken more often than not, as should be expected. This was challenging, since the researcher was not fluent in Danish. It was a steep learning curve that sharpened the researcher's observation and aural skills; much can be understood from observation and intonations

[†] Site B was used as an evaluation site for validating ISIM, the model that is developed in this thesis.

of voice. Anything that was unclear or needed explanation was queried and the participants would explain in English, if possible.

It would have been extremely interesting to investigate more countries, and although initially a third country was proposed, obtaining research ethics approval for the English sites (see Section 4.2.3) proved to be more time-consuming than anticipated. It was also increasingly impractical as PhD timescales are constraining. This does not rule out future work investigating a greater number of countries; indeed a contact in New Zealand has already expressed an interest in further validating the model developed in this thesis. This is discussed in greater detail in Section 8.2.6.

In terms of selection of sites, again pragmatics dictated the actual sites studied. The contacts at each country suggested sites that they had contacts with, and that they thought would be useful to the study (this is discussed in greater detail in Section 4.2.3). Section 3.3 now presents the details of the four sites.

3.3 A Description of the Settings

Sites A and B are located in England, and Sites C and D in Denmark. For a summary, please refer to Tables 3.1 and 3.2.

Sites A and C used an electronic CIS to hold patient information, while Sites B and D used paper records. Sites C and D were both situated within the same county of Denmark; a laboratory results and blood ordering system was shared by all hospitals in the county, which had been used successfully for over a decade.

3.3.1 Site A

Site A, an ICU of a hospital situated in northwest England, had eight beds and four Hyper-Dependency Unit (HDU) beds. Approximately 90 shift nurses and 58 duty doctors were employed at the time of data collection. The CIS consisted of a workstation at the foot of each ICU bed, and one station shared between two HDU beds. ICU nurses and doctors used the system for all of their patient record requirements, and physiotherapists would also use it to type their notes.

A pictorial representation of this unit is given in Appendix A, together with a descriptive key to the layout, so that any reference to particular rooms or places within the unit can be located on the picture given. As well as the CIS described below, a

laboratory reporting CIS was also used. Results were downloaded from this computer and retyped into the main CIS.

Site A: CIS Situation

The system was first implemented in August 1998, with full changeover from paper to computer eight months later in April 1999. As the ICU was being redesigned, the clinical director at the time thought it appropriate to computerise all aspects of the ICU, so an application for funding a CIS was made in conjunction with a financial proposal for ICU refurbishment.

The clinical director aimed to eliminate paper in the ICU; the CIS was to aid report writing and statistical analysis of data, as well as to carry out calculations that were described as 'vexing' by nurses, particularly towards the end of a shift, when fatigue sometimes led to human error. The system is widely regarded to have been successful in these aims.

The CIS, a complete patient information system, replaced all paper records, including doctor's notes and patient care plans. It was tailored for nurses and doctors, so that nurses had an area in the system for patient care plans, and doctors had a separate area for their notes. Some observational data were downloaded directly from monitoring equipment; this was in contrast to Site C, where all patient data was typed into the system. Drugs calculations were performed automatically, and full patient administration was offered by the system.

Using the bedside CIS station it was only possible to access information for that particular patient. There were two central computers from which it was possible to access information for all patients in the ICU. One of these computers was located at the nurses' workstation (a central area in the ICU where clinical staff congregate; see the figure in Appendix A), and the other in the server room. A star network operated within the ICU, but the CIS was not networked to any other CIS, either internal or external to the hospital. Once a patient had been discharged, data about them was archived on CD-ROM. For a complete list of CIS functionality (both from the central computers and by the bedside), please refer to Appendix B.

Site A: CIS Maintenance and User Support

The ex-clinical director, who was involved in procuring, implementing, and maintaining the CIS, also provided user support. She was assisted in this by a nursing sister who was involved in all aspects of the system since it was first implemented, and was in charge of educating the nurses about it. The CIS developers were also the system suppliers, and

had a direct link to the ICU. They were able to update and make changes online upon request; usually these changes were completed overnight. Indeed, Site A had a contract with the company who developed the system such that they acted as a demonstration site for potential customers, in exchange for free upgrades.

The server room housed a notice board where details for support contacts at the company were available. The ICU had a direct line to the company, so that staff could contact them if problems were encountered. However, both the clinical sister and ex-clinical director were the first port of call, and were approachable 24 hours a day.

During implementation, training nurses and doctors to use the system was the responsibility of the clinical sister and ex-clinical director. A group of nurses were trained, and then cascaded this training to other nurses in the unit whilst they worked. Primarily the ex-clinical director of the unit trained doctors. No explicit training programme was followed to train new staff, who were initiated into the system by other members of staff.

3.3.2 Site B

Site B was used as an evaluation site for validating ISIM, a major focus of this thesis. Site B was a university hospital located in northwest England. The ICU began as an eight-bedded unit, but in the 1980s it expanded to its current size of twelve beds. Eight of these beds were ICU beds, with another three for HDU, and one for patients requiring isolation.

The unit employed 120 shift nurses and 25 duty doctors, some of who were junior doctors. The ICU had a small biochemistry laboratory dedicated to it. A teaching room was made available two years ago. This room was used for teaching new/clinical staff, predominantly nursing staff, to use new software, and also physiological apparatus. The teaching room has a capacity for 10 trainees. A nursing workstation area similar to Site A was the place where most clinical staff tended to gather: this is shown in the pictorial representation of the unit given in Appendix C.

Site B: CIS Situation

The ICU had a history of a failed clinical charting system that replaced nursing observation notes and was to be used by management for making better use of patient data for improving clinical quality and resource management. The clinical director procured the system in the 1980s, in consultation with a few clinical consultants, who

were interested in creating a paperless ICU. The CIS became obsolete in the 1990s after a decade of struggling with it; the system failed the Year 2000 test, and users believed it failed to support the information needs of the ICU.

At the time of this research, the unit also used a computer radiography system, which presented X-Rays electronically. A computer dedicated to laboratory results was also available, from which results were copied onto paper records by hand. These systems were not connected to each other in any way. All clinical staff, pharmacists, doctors, nurses, and physiotherapists etc., used a paper system of patient record keeping. Each care provider had his or her own paper record systems. In addition to this, a diary-type record at the foot of each patient's bed, was used by all clinical staff to record their encounters with the patient.

Site B: CIS Maintenance and User Support

The ICU shared its three technicians with cardiology and HDU. The technicians were responsible for the maintenance of all physiological and computer equipment, as well as training all clinical staff to use these systems. An information officer was responsible for collecting and analysing patient data for auditing purposes.

3.3.3 Site C

Site C was one of five university hospitals in a county of Denmark. The ICU offered 20 beds, and was divided into four specialist areas: heart, respiratory, kidneys, and child-specific intensive care. All four areas had the same staffing, technologies, and physical layout (please see Appendix D for ICU layout). Over 220 shift nurses, and approximately 100 duty doctors, were employed in this ICU, making it one of the largest in Denmark. Like Site B, this site had an electronic radiography system that enabled staff to view X-rays electronically. Unlike Site B, two large monitors were provided for viewing the X-rays, so that previous and current X-rays could be compared. A county-wide electronic blood ordering system was also used.

Site C: CIS Situation

A paper system of patient record keeping existed and an electronic charting system had just been introduced. Nursing staff had their own notes, which were handwritten by them. They were separate to the doctor's notes, which were dictated into a handset located in the main area of each specialist unit. The doctor stated the patient's identification number and their own I.D. number before and after dictating the notes.

The dictation was recorded on tape in the secretaries offices. The secretaries were able to access the recordings, and transcribe the notes, taking a printout of the transcribed notes to the relevant unit. Site D used a similar system, and both sites had the problem that the secretaries were only available 9am-5pm on weekdays, which meant that notes dictated at any other time could not be transcribed immediately.

The Charting Tool

The patient data management system (PDM), a charting tool, was introduced in September 2002 in parallel with the paper system, which was phased out in December 2002. The system was introduced simultaneously in the operating theatres. As well as replacing the nurses' 24-hour paper observation charts, the PDM facilitated management to make better use of patient data for planning and financing resources. The system comprised of four areas:

- An automated charting facility to record observations at point of care.
- Automated clinical documentation such as treatments, care protocols, and patient progress.
- Remote documentation of findings for observational data.
- A reporting tool that enabled analysis for quality assurance, cost containment, process monitoring, scoring, and outcomes management.

Nurses and doctors had their own areas in the system, although both were able to access all areas if they desired. The monitors were quite small, though users had a choice of data views that they could select. A mouse with a large tracker ball was fixed in position, and a small keyboard on a tilt table was provided for data input. The system was located at the head of each bed. The work process change for nurses involved using the system to record data that they would otherwise have recorded on the 24-hour paper observation sheet, an A3 size double-sided chart. For doctors this meant that their paper record doubled in size, due to printouts from the system.

Site C: CIS Maintenance and User Support

Training consisted of one 3-hour lecture session offered to nurses and doctors. Staff were expected to learn the system on-the-job, and were supported by super-users (the clinical director, one consultant, and three core nursing staff were trained, so that they could cascade the training to other users). At least one super-user was available every day, and a telephone hotline was set up for the first few weeks. No dedicated technicians were available, although a hospital-level IT support group existed. As this

was a new implementation, it was not yet clear how new staff would be trained, but no formal training procedure had been identified.

3.3.4 Site D

Part of a Danish university hospital, this ICU had eight beds, of which six were in use during this study (see Appendix E). Approximately 40 shift nurses and 30 doctors were employed in the unit, making it the smallest of the four sites investigated. The unit was heavily involved in testing two of the five modules of the Electronic Health Record (EHR) that were to be implemented hospital-wide in all hospitals across the county. A consultant was employed by the county council to oversee this work, and was also assigned six nurses for the project. Site D used the same X-Ray system and electronic blood ordering system as Site C.

Site D: CIS Situation

At the time of this research, all records of patient information, such as nursing care plans, doctor's notes, and observations, were held on paper, but there were plans to move to the electronic system once a set of technical problems had been resolved. The EHR modules that the site was involved in testing had been delayed by six months due to technical difficulties, although training of staff had already begun.

As at Site C, doctor's notes were transcribed by secretaries from voice recordings. However, at Site D doctors dictated patient notes into hand-held dictation machines. This enabled doctors to record their notes while they were on the move. The downside to this was that tapes needed to be taken into the secretaries' office and left there, where it was not uncommon for them to be misplaced.

Site D: CIS Maintenance and User Support

The only official IT support that was provided was a hospital-wide IT department, whom staff were able to contact, but who usually took days to respond. Informally, one of the medical directors of the unit (who was also the primary contact for the EHR modules being tested in the ICU) was approachable regarding user problems, but did not have technical know-how. Staff training in the ICU consisted of training six core nurses as super-users. One of the two ICU leaders, who was involved with the development and implementation of the EHR modules, taught the super-users. This training was to be cascaded to other nurses in the unit once the system was fully implemented.

3.3.5 Summary of Sites

A summary of all four sites is given in Tables 3.1 and 3.2.

Table 3.1: A summary description of the four sites

<i>Site Aspect</i>	A	B Evaluation Site	C	D
Country	England	England	Denmark	Denmark
No. Nurses	90	150	220	40
No. Doctors	58	25	100	30
No. Beds	8	8	20	7
Stage of CIS Integration	Electronic CIS implemented 1999.	Failed system was removed 1999.	Recently implemented (2003) electronic CIS (Charting Tool).	About to implement electronic CIS.
CIS Situation	Complete replacement of paper-based patient records in the ICU only. The CIS provides tailored areas for both doctors and nurses. It provides full patient administration, and also aids statistical analysis and report writing. Introduced in August 1998 in parallel with paper, which was phased out in April 1999.	Paper-based patient records. Small biochemistry lab within the ICU for the ICU only. History of failed charting system introduced in 1988, discontinued in 1999.	Recently implemented a CIS to replace the paper observation chart used to record nurse care observations every hour. The system comprises automated charting of observations, automated clinical documentation, care protocols and patient progress, remote documentation of findings for observational data, and a reporting tool for quality assurance. Introduced in Sept. 2002, with paper phased out in Dec. 2002.	Paper-based patient records. Involved in development and testing of two of the five EHR modules. The EHR was meant to be implemented county-wide in Summer 2003.

Table 3.2: Information processes at the four sites

<i>Site</i> <i>CIS</i>	A	B	C	D
Observation Chart (OC)	<p>Typed in CIS by nurses. Accessible at the foot of patient bed or the nurses' workstation. Large colour monitors aid visibility. Can access observations for current and past 24 hours only. Observed by all clinicians who may need to see it.</p>	<p>All data are hand written on an A3 sheet of paper at the foot of patient bed. Observed by all clinicians who may need to see it.</p>	<p>Typed in CIS that replaces OC only. Input by nurses only. Patient plan no longer recorded. Instead, nurses memorise the plan and use their nursing notes more. Doctors use screen dumps that have increased the size of the patient record, as many computer screens have replaced one chart. Data extracted for quality control.</p>	<p>Recorded by hand on an A3 sheet of paper at the foot of patient bed. Observed by all clinicians who may need to see it.</p>
Patient Record	<p>Typed in the CIS by doctors only. Can be read by all clinicians authorized to do so. One CIS used for OC, patient record and nursing notes. Clinical staff do not search for records. Very little paper is visible.</p>	<p>Format is similar to a diary and is placed at the foot of the patient bed. All clinical staff except nurses record notes in it. Can be read by all clinicians.</p>	<p>Dictated into an office-based dictation system that allows doctors to record their notes at any time, but only from a central office within the unit. These are then transcribed by a group of secretaries, who also print the notes and place them in the patient record.</p>	<p>Dictated into a hand-held Dictaphone carried by the doctors. Left with the secretaries, who transcribe them (0900-1600 on weekdays only). Often secretaries' desks are full of tapes, which can be scattered anywhere in the office. Notes printed and placed in patient record folder when found! Testing two of the Electronic Health Record Modules is causing problems, as they are not provided with the technical support that they require.</p>

<i>CIS</i> \ <i>Site</i>	A	B	C	D
Nursing Notes	A section in the computer system written and read by nurses only.	Recorded on paper. Written and read by nurses only.	Recorded on paper. Written and read by nurses only.	Recorded on paper. Written and read by nurses only.
Radiology	Manual System. Wait for X-rays to be developed. Used by doctors only.	Local computer system, X-rays arrive electronically. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.
Laboratory Results	Arrive on a separate computer system. Printed, and then typed into the ICU CIS.	Arrive on a separate computer system. Copied by hand into relevant notes.	Arrive on a separate computer system. Copied by hand into relevant notes.	Arrive on a separate computer system. Copied by hand into relevant notes.
Overall	Faster – nurses and doctors do not have to hunt for notes or relevant information as it is organized in a systematic way and collated in one system. Duplication of data is evident when interacting with systems connected to other parts of the hospital, as they are not connected to the ICU, therefore data are printed and typed into the ICU system.	Much duplication of data as it is gathered from other systems, both electronic and paper-based.	Patient record has increased in size. More paper here than the other units. Doctors and nurses miss the overview of a paper OC, and nurses prefer not to have to memorise the patient plan, as is required by the system. Have to wait for secretaries to print out the relevant sections of the system when they need them for the doctor-nurse discussion and also when a new shift begins.	Problem of locating the patient record as it can be anywhere from the secretaries' office to the operating theatre. Doctor's most current notes are not accessible until the secretaries have transcribed them. Particular problem on weekends and evenings. Duplication of data as it is gathered from other systems, both electronic and paper-based.

3.4 Summary

Chapter 3 has outlined the national and local context for this research in terms of the two countries where this research was conducted, Denmark and England. Evidence in support of this thesis and a synthesis of the literature was given in Chapter 2, which reviewed literature on the key concepts of this thesis (CIS, ICU, and Organisational Culture). Section 3.1 supplemented this with a discussion of EHR status in England and Denmark.

In England, a summary of EHR progress since the publication of the IfH – NPfIT programme was overviewed in Section 3.1.1. Progress towards an EHR in Denmark was presented in Section 3.1.2, and the CIS preceding the EHR, the Green System, was also described. In Section 3.2 the rationale for selecting Denmark and England for the ICU sites researched was given. Finally, Section 3.3 described each ICU site in detail, and presented the status of each CIS project. Two overview tables that summarised the four sites and the information processes at each ICU were also given in Section 3.3.5.

Chapter 4 presents the paradigms underpinning this thesis, before data collection and analysis methods are discussed in Chapter 5.

Chapter 4

Approach to the Research

Identification and justification of the principles guiding this research are given in this chapter. Research pragmatics such as choice of sites and access issues, are considered, and the important topic of research governance is also discussed.

4.1 Identifying the Research Paradigm and Methodology

Prior to conducting this research, it was important that the underpinning assumptions were made clear, so that the research paradigm and methodology could be identified. The research paradigm guided and influenced how the research was conducted; it impacted on the research methodology, which directed the data collection and analysis methods to be employed. An exploration of the research assumptions enabled clarification of the paradigm to be adhered to (Creswell, 1994). This is explored in Section 4.1.1. The research paradigm is discussed in Section 4.1.2, and the research methodology is discussed in Section 4.1.3.

4.1.1 Research Assumptions

Two main paradigms, phenomenology and positivism, exist. These terms are synonymous with qualitative and quantitative paradigms (Hussey and Hussey, 1997). However, as these terms are also used to describe data collection methods, the terms phenomenology and positivism are preferred.

The two paradigms can be visualized as two extremes along a continuum. In reality, research is often placed somewhere between the two extremes. Creswell (1994) outlines the assumptions that define the two paradigms at the extreme. This can be seen in Table 4.1.

Table 4.1: Research assumptions underpinning the two main paradigms at their extremes.

Assumption	Question	Positivism	Phenomenology
<i>Ontological</i>	What is the nature of reality?	Reality is objective and singular, apart from the researcher.	Research is subjective and multiple as seen by participants in a study.
<i>Epistemological</i>	What is the nature of the researcher to that researched?	Researcher is independent from that being researched.	Researcher interacts with that being researched.
<i>Axiological</i>	What is the role of values?	Value free and unbiased	Value-laden and biased.
<i>Rhetorical</i>	What is the language of the research?	Formal; based on set definitions; impersonal voice; use of accepted quantitative words.	Informal evolving decisions; personal voice; use of accepted qualitative words.
<i>Methodological</i>	What is the process of research?	Deductive process; cause and effect; static design categories isolated before the study; context-free; generalizations leading to prediction, explanation and understanding; accurate and reliable through validity and reliability.	Inductive process; mutual simultaneous shaping of factors; emerging design categories identified during research process; context bound; patterns and theories developed for understanding; accurate and reliable through verification.

Source: Hussey and Hussey (1997)

Using this table, it is possible to identify the research paradigm. However, prior to this it may be useful to refer back to the research aim and objectives, as stated in Chapter 1.

These were stated as:

Aim: To develop a declarative model of clinical information systems integration based on empirical evidence from intensive care settings.

Objectives:

1. *To investigate the significance of Organisational Culture for explaining actual CIS deployment in intensive care.*
2. *To investigate the interactions between clinical staff and CIS, so that it is possible to determine the effect of these interactions on intensive care clinical work processes.*
3. *To develop a theoretical model of CIS integration.*

In terms of the research aim and objectives, the assumptions of this study are as follows:

Ontological: The nature of reality is bound in context. That is, in order to conduct objectives 1 and 2 the researcher must accept that the 'world' is socially constructed, rather than objective and apart from the researcher. Although objectivity can be strived for, it is often difficult to achieve, as the researcher is based in the world where data is collected and it is necessary to interact with participants in order to collect this data.

Epistemological: The researcher interacts with that being researched, and is based in the setting in which the phenomenon exist as opposed to measuring and observing phenomenon outside their natural setting. In order to meet the three research objectives, the researcher is required to talk with participants, observe them in their natural settings, and to try to understand the setting from their point of view, so that the aim of this research can be achieved, i.e., the development of a model based upon empirical evidence, that captures the participants points of view, and represents reality as it is.

Axiological: Taking Creswell's (1994) extreme definition from Table 4.1, this research would be value-laden and biased. However, this depends upon the values of the researcher, and the extent to which the researcher is engaged with participants. For example, non-participant observation would enable the researcher to remain partially unbiased, as opposed to participant observation, which requires the researcher to take the role of the phenomenon being investigated, in which case it would be impossible to remain even partially objective. As this research is based in an ICU, it is impossible for the researcher to take on the role of clinical staff, as she is unqualified to do so, and this would also be detrimental to the patient. This then, affects the methodology employed, and data collection methods used (Section 4.1.3 and Chapter 5). Although the researcher accepts that bias and values are likely to affect interpretation, she attempted to remain as

neutral as possible, rather than take the two extremes of the positivist and phenomenological paradigms on this assumption.

Rhetorical: The language of the research refers primarily to how data will be reported. Although phenomenology advocates the use of informal language (see Table 4.1), as this is a thesis, academic language is used.

Methodological: This research does not follow either extreme of the two paradigms. However, it does accept that the research is inductive, since data is collected from a few cases, from which a model will be developed. The model will be informed by data that is rich in context, and findings will be based upon accurate representations of the situation, so validity is high. In a positivist paradigm, validity would be low, since it ignores context and the phenomenon's viewpoint. Reliability is high in positivistic research, as it is associated with measurement and control variables that are not feasible in phenomenological research (Hussey and Hussey, 1994). The validity and reliability of this thesis are discussed in Section 8.2.2.

Having addressed the research assumptions, it can be seen that the research paradigm to be followed is inherently phenomenological. Before defining and discussing this term, the above assumptions are summarised:

- This research is primarily concerned with process, i.e., how things are done, rather than outcomes and products.
- This research is concerned with meaning and context i.e., how people make sense of their experiences with CIS in the ICU, rather than being concerned with frequency and measurement, which can give static results that ignore context.
- The researcher is the primary research instrument, i.e., it is by and through the researcher that data is collected, analysed, and interpreted.
- This research is conducted in a natural setting, rather than an artificial setting such as a research laboratory.
- The process of this research is inductive, as it aims to construct a model from abstractions.

4.1.2 Research Paradigm

In the previous section, the paradigm to which this research closely adheres was identified as phenomenology, but it will not be followed to the extreme. The researcher views the paradigm as a guide, rather than dogma. Hussey and Hussey (1997) define phenomenology as:

“The science of phenomenon. It is concerned with understanding human behaviour from the participant’s own frame of reference. It is assumed that social reality is within us; therefore the act of investigating reality has an effect on that reality.”

Phenomenology originated as a reaction to positivism, which was historically deployed in the natural sciences, and was concerned with facts and causes. It treated subjects as separate from the social world in which they were based. Phenomenologists argued that it was impossible to separate the researcher from that being researched when the subject was a part of the social/human world (Hussey and Hussey, 1997). The phenomenological paradigm focuses upon the subjective nature of humans and their activity. This paradigm is not ideal, and some criticisms of it are:

- It may be difficult to separate meaning from the social setting in which the researcher is based.
- The findings are entirely dependent upon the researcher’s frame of reference and interpretation. Using a team of researchers to collect and interpret data may overcome some of these biases. However, this is not always possible, for example in a doctoral study; therefore findings rely upon the researcher’s ethics, and are based on an element of trust.
- Because the research is set in the social world, the researcher is open to ‘real world’ problems that cannot be controlled in the same way as if the study was based in a laboratory.

As mentioned earlier, the paradigm is to be used as a guide, rather than exact instruction, and the researcher is aware of its limitations. However, this paradigm will now enable the researcher to select the research methodology (Section 4.1.3) that will guide the selection of appropriate methods for data collection and analysis (Chapter 5).

4.1.3 Research Methodology

A plethora of research methodologies exist. As for the research paradigm, it is often unrealistic to adhere strictly to all the rules and regulations of one particular methodology as this can constrain the creative and explorative nature of research (Glaser, 1992). However, the major principles underlying a methodology must not be compromised if it is to be used. Qualitative methodologies, by their nature, are inherently subjective, and such research cannot be conducted objectively, as any interpretation requires some level of subjectivity. Hussey and Hussey (1997) identify the main methodologies often used in phenomenological studies. Those relevant to this research are:

- **Case Studies** – An extensive examination of a single instance of a phenomenon of interest.
- **Ethnography** – The researcher uses socially acquired and shared knowledge to understand the observed patterns of human behaviour.
- **Grounded Theory** – A set of procedures to develop an inductively derived grounded theory about a phenomenon.

Grounded Theory

Grounded theory was originally developed as a methodology that requires the joint collection and analysis of data, where both inductive and deductive thoughts are used to constantly compare data and derive theory (Glaser and Strauss, 1967). Glaser (1992) later made the distinction between data collection and analysis, and stated that the methodology could also be used as a tool solely for analysing qualitative data.

To clarify, grounded theory is used in this thesis as a tool for analysing the qualitative research data (Section 5.2.1), and not as a methodology, since case study and ethnography are more suited to this. These methodologies are discussed next.

Case study and Ethnography

By deploying the principles of both ethnography and case study it is possible to achieve methodological triangulation (Section 5.2.4). Factors common to both methodologies are:

- The phenomenon can be studied in its natural setting, and meaningful relevant theory generated from the understanding gained through observational practice.
- They allow the questions of ‘why’, ‘what’, and ‘how’ to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon.
- They allow exploratory investigations where the variables are still unknown and the phenomenon not understood.

Voss et al. (2002) state that the above factors are major strengths of case study, however they are also applicable to ethnography. According to Yin (1994), case studies ‘enables the exploration of social processes as they occur in organisations’, and are useful in ‘capturing emergent and imminent properties of life in organisations’. In ethnography the aim is to ‘interpret the social world in the way that the members of that particular world do’ (Hussey and Hussey, 1997). Robson (1993) states that case studies are particularly useful where the boundary between the phenomenon and the context is unclear.

The methodologies differ in that case study allows the study of any phenomenon, is open to mixed methods of data collection, and can also be used in the positivist paradigm (Robson, 1993). Ethnography is biased towards investigating humans, since its roots originate from the discipline of anthropology (Robson, 1993). Although ethnography deploys observation as its primary method of data collection, it does advocate the use of other methods alongside observation. Further, ethnography is primarily deployed in phenomenological research, however it has also been applied in software engineering (Sommerville et al., 2003); a discipline in which it is becoming increasingly popular (Viller and Sommerville, 2000).

The problems associated with case study that are also common to ethnography are (Hussey and Hussey, 1997):

- Negotiating access can be time-consuming.
- Placing the boundaries of the research can be difficult.
- It may be difficult to understand events in a particular period of time, without knowledge of its past.
- Developing trust is seen as a major challenge in ethnography; however this also applies to case research.
- Both methodologies have a common criticism of generalisability. However, Robson (1993) and Yin (1994) argue that phenomenological researchers may generalise to theoretical propositions rather than to the population; this means that findings are still generalisable, but in a different sense to positivist research.

Whereas case study does not have any time constraints in terms of time spent at the field site, ethnography (as initially described in anthropology) requires that research be conducted over a long period of time, i.e., years rather than months. In the current case the researcher is constrained by the time period that PhD research imposes, so that it is not possible to collect data over a long period of time. Further, gaining ethics approval from the relevant research ethics committees is a lengthy process that limits the amount of time available for data collection (see Section 4.2.3). For this reason, 'quick and dirty' ethnography is used, as described by Crabtree (2003), i.e., acquiring knowledge about the phenomenon in its natural setting in a fairly short space of time. Again, case study does not exclude this.

Although ethnography requires observation as a primary method of data collection, 'pure' forms of ethnography advocate participant observation (Waddington,

1994). Due to the nature of clinical work, this is impractical for the researcher, who will employ non-participant observation (see Chapter 5).

The researcher believes that research should not be constrained by methodologies or methods; rather, research should be conducted with those methods that compliment the research, be they hybrids of different methodologies, or a number of complete methodologies. Robson (1993) cites many studies using ethnographic case studies; in fact, mixing methodologies enables methodological triangulation (this is discussed in Section 5.2.4), which increases the validity of the study.

Although both case study and ethnography have their limitations, this research uses those aspects of the two methodologies that best suit this research; where one fails to meet the research requirements, such as timescale, the other methodology aids it. It must be restated that the methodologies are used as guiding principles rather than constraints.

Having discussed the choice of theoretical concepts guiding this research, Section 4.2 discusses pragmatic issues, such as issues concerning access to each site, the participants and research ethics.

4.2 Research Pragmatics

As theoretical underpinnings are important guides to the way in which research is conducted, analysed, and presented, so research encounters issues that theory is unable to envisage. These issues are concerned with pragmatics – factors that cannot be addressed by theory alone, but need to be addressed practically. Section 4.2.1 describes the participants of this research, and Section 4.2.2 discusses the issue of gaining access to the sites. Finally, but of great importance, research governance is presented, as it affects this thesis (Section 4.2.3).

4.2.1 Research Participants

The study focus rests with ICU nurses and physicians, as they are the primary and most frequent users of CIS in these settings. Other clinical staff were also observed when they interacted with the primary users.

Participants were informed about the research during their morning meetings, and also via email, in order to legitimate presence and to facilitate co-operation. Where

staff did not receive any such message, the protocols were explained to them when asked.

4.2.2 Negotiating Access

Gaining access is a sensitive and important issue (Hornsby-Smith, 1993; Hussey and Hussey, 1997; Lofland and Lofland, 1984). The question of whether research is overt or covert is one that should be addressed. Due to increasing emphasis on research ethics, especially within healthcare (DOH, 2002c), it was decided that overt procedures were the most honest methods of gaining access. There are many benefits and disbenefits of this type of access; for further readings refer to Hornsby-Smith (1993); Hammersley and Atkinson (1995); Robson (1993).

Initial meetings were set up with a single contact at each of the Danish sites. In England, meetings were arranged where terms of access were negotiated with the ICU sister (Site A) and subsequently the ICU director. In Site B a meeting was set up with the ICU director. The aims of these meetings were to ascertain whether the sites were suitable for the task, and for the ICU directors to consider whether or not the research would be of any value to them. In Denmark, contact was made by email, and the primary Danish contact evaluated suitable sites for the research. Similar meetings to those in England were arranged with the ICU directors upon arrival in Denmark. A research protocol (Appendix F) was given to the ICU in both countries.

4.2.3 Research Governance

This section outlines the research ethics procedures that the researcher went through, before conducting research at sites A, B, C, and D.

England

This research adheres to the Research Governance Framework for Health and Social Care, published by the UK Department of Health (DOH, 2002c). Prior to this publication, ethics approval was not required where research involved staff only. Gaining approval was therefore not anticipated sooner than 2002, as it was not thought necessary. However, since the publication of the research governance framework (ibid) it was imperative that ethics approval was applied for. The clinical directors of the two ICU were asked to read an information sheet about the research (Appendix G) and sign a consent form (Appendix H), giving permission to conduct research at their ICU.

Ethics approval from local research ethics committees (LREC) and the research and development unit (RDU) (Appendix I) were also required.

An application was made to the relevant ethics committees. To assess the proposal, the researcher was asked to participate in an interview about the research to the ethics board for Site A. Subsequently, approval was attained (Appendix J). As Site B came under the same geographical vicinity as Site A, a reciprocal arrangements form was completed, and approval was gained (Appendix K). Please note that any information identifying Sites A and B in the appendices is blanked for confidentiality reasons. For similar reasons, information identifying hospitals, participants, and CIS cannot be given in this thesis. The consent form in Appendix H is therefore blank.

Denmark

Before arriving in Denmark, the researcher confirmed the research ethics status for conducting research in healthcare centres in Denmark. The researcher was told that research with staff did not require ethics approval, however on arrival, informal procedures were pursued by the contact to ensure this. Speaking with the ICU directors, the researcher promised that, where possible, confidentiality and anonymity would be retained. Despite the lack of formal ethics agreement, the researcher thought it necessary that research ethics applied to the English sites would also be applied to sites C and D in Denmark.

4.3 Summary

Having discussed the theoretical research assumptions in Section 4.1.1, the research paradigm was identified as phenomenology, as discussed in Section 4.1.2. Subsequently, the research methodology was ascertained as a mixture of case study and 'Quick and dirty' ethnography. It was decided that methodologies are guides to how research is conducted, and should therefore compliment the thesis, rather than become restrictive rules.

Once the theoretical aspects had been discussed, it was important to address the research pragmatics. In Section 4.2.1 the participants of this research, ICU nurses and physicians, were identified. The issue of negotiating access to the four ICUs was discussed in Section 4.2.2, and finally, the important issue of research governance was addressed as it impacts on this thesis. Chapter 5 discusses the research methods deployed in this thesis in detail.

Chapter 5

Research Methods

The aim of this chapter is to detail the data collection methods used in this thesis, and also to outline how the data were analysed.

5.1 Data Collection Methods

Section 5.1 presents and discusses the data collection methods employed in this thesis. The methods selected are non-participant observation (Section 5.1.1), semi-structured interviews (Section 5.1.2), and questionnaires (Section 5.1.3). The primary data collection tools were non-participant observation and semi-structured interviews. Observation focuses upon ‘watching and listening’, and interviews enable ‘asking’, so that discrepancies between what is done and what is stated as being done can be evaluated. Questionnaires were utilised to verify findings, to gauge wider population experiences, and to support the two previous data collection methods.

The data collection methods used in this thesis are guided by ethnography and case study methodologies (Robson, 1993), which were discussed in the preceding chapter.

5.1.1 Non-Participant Observation

This section provides an overview of the different ‘types’ of observation. It discusses the choice of non-participant observation, and then outlines the pragmatics of how it was used for collecting data from the four ICU sites.

Observation

Many different approaches to observation have been identified, from participant observation common in qualitative research to the polar extreme that is structured observation, which is commonly associated with quantitative research studies (Robson, 1993; Hussey and Hussey, 1997; Hanson, 1980; Gold, 1958; Lofland and Lofland, 1984). The different levels of observation are widely agreed (ibid.) as:

1. **Complete participant:** Where the researcher takes on the role of the participants being observed, but remains covert about being a researcher.
2. **Participant as observer:** Similar to complete participant, but is overt about the role as researcher.
3. **Marginal participant:** Again, the researcher is covert about their role as a researcher and takes on a minor participant role, for example, as a person in an audience, a member of public using public transport, etc.
4. **Non-participant observation:** In this role the researcher is overt about conducting research and observing participants. However, the researcher does not take on the role of participants, for example, as a nurse or as a doctor. This role is also known as observer as participant. Gold (1958) argues that once the role of researcher becomes known, the non-participant observer becomes a member of the group being observed and their role in the group is to observe, hence the term '*observer as participant*'.
5. **Structured observation:** Unlike the above four types of observation, structured observation is commonly undertaken in a laboratory, where variables are controllable, unlike in a 'natural' setting. The researcher does not participate at all.

As mentioned in Section 4.1.3, it is not practical to carry out observer roles 1-3, since the researcher does not have the necessary training or skills as clinical staff; taking on this role would therefore be detrimental to the patient.

Observer role 4, non-participant observation, is described by Gold (1958) as "*someone who takes no part in the activities, but whose role as a researcher is known to the participants*", and is appropriate here since role 5 would entail observing clinical staff outside of their natural setting. This is against the research paradigm, phenomenology, that this research adheres to, where the emphasis is upon capturing the phenomenon within the context of its natural setting.

As with any method, observation has its share of advantages and disadvantages (Robson, 1993; Hussey and Hussey, 1997; Hanson, 1980; Gold, 1958; Lofland and Lofland, 1984):

Disadvantages:

- It is impossible to control variables in their natural setting.
- It can become difficult for the researcher to remain objective.
- Observation relies heavily upon the researcher's interpretation of the situation.
- The researcher might have an impact upon the phenomenon being observed.
- It is not possible to observe everything.

It can be argued that if the researcher is aware of the above-mentioned disadvantages, then it is possible to prepare for the eventualities that might occur. For example, observing over a period of time enables the researcher to repeat observations so that it is possible to allow for disruptive events.

The argument regarding objectivity is one that has been under much debate between the social and natural sciences for decades, and is one that cannot be solved in this thesis. However, as mentioned in Section 4.1.3, the aim of this research is to capture context and meaning. Although remaining objective can become a problem, being conscious of this will enable some degree of impartiality. The type of observation, non-participant observation, should also aid this.

The advantages of observation can be given as:

- Participants can be directly observed, so it is not necessary to ask, but just to watch and listen.
- Observation verifies other methods such as interviews and questionnaires, where it is possible to resolve to some extent, the discrepancies between what participants say they do and what they actually do.
- Observations in natural settings limit the degree of artificiality.
- Observation enables the researcher to take in the 'bigger picture' and retain context.

Non-participant Observation as Used in this Thesis

The aim of deploying non-participant observation in this thesis is to make possible the observation of staff in the ICU, in order to understand their work processes relative to the CIS that they use. Ultimately, this data will inform the development of Role Activity Diagrams (RADs) that are discussed in the findings (Chapter 6).

Period of data collection

Non-participant observation was grouped into two categories by the researcher. A broader category, where the researcher would try and observe everything related to clinical staff and CIS, and a more focused category of shadowing individual clinical staff, nurses, and doctors to obtain a more precise picture of activities (please see Appendix L for a list of participants who were shadowed in each ICU).

The period of data collection consisted of four weeks at each ICU setting, where the researcher would conduct general observations for between 5 and 7 hours per day, and the complete morning shift when shadowing, from 0730-1530 hours. The exact timings did vary, since ICUs are very unpredictable; some days were quiet and not much would happen, and other days would be hectic.

The data collection period was finalised after conducting this activity at Site A, in England. As saturation (when it is decided that enough data has been collected and that everything seen had been seen before) approximated to 4 weeks, it was decided that a month at each ICU in Denmark (Sites C and D) would also suffice, however an extra month was allowed in Denmark due to the researcher being unfamiliar with the Danish language. Subsequently, approximately one month was also spent at Site B for validation purposes. It must also be noted that the period of data collection concerning observation will vary between researchers, since each will have varying degrees of simulating the data as they collect it, and they will also have different saturation points.

The day shift (0730-1530 hours) was considered the most appropriate time period for collecting data for this thesis, as it enabled the observation of a majority of clinical staff interacting. In order to understand the context of the day shift compared to other shifts, participants were asked about their routine on all shifts during the interviews. Many nurses and doctors described the night shift as much quieter in all respects, with encounters limited to core staff: duty doctor, sister in charge, and nurses (but this was dependant upon the status of the patient's condition). Nurses and doctors stated that during this time most patients were usually asleep, and time was used to complete paper work or to catch up on activities not possible during the day. Table 5.1 describes the nursing shift patterns, which were common to both Denmark and England.

Table 5.1: Nurses shift patterns

Shift	Period	Duration
<i>Day</i>	0730-1530	7 hours
<i>Evening</i>	1530-2330	7 hours
<i>Night</i>	2330-0730	7 hours
<i>Long</i>	0730-1930 /1930-0730	12 hours

For doctors, the shift pattern was similar to nurses, but usually doctors commenced their shift about 1-2 hours later than the nurses.

Process of recording observations

The researcher carried a notepad for jotting down observations. A more thorough account was recorded at the end of each period of data collection. Observation notes were categorised into three types when this was possible (Schatzman and Strauss, 1973):

Observational notes: recording exactly what was observed, with no 'noise' from the researcher.

Methodological notes: pragmatics of the research.

Theoretical notes: where the researcher noted any patterns or theories emerging.

5.1.2 Semi-Structured Interviews

An overview of the different 'types' of interviews for collecting data are given in this section. A discussion outlining the type of interview opted for is then presented. Finally, the pragmatics of how interviews were conducted at the four ICU settings is given.

Interviews

Interviews are used in this thesis to verify observations (Section 5.1.1). They enable the researcher to distinguish between what participants say they do and what actually happens when they are observed. They are also useful for clarifying any observations that the researcher is uncertain about and are a useful method of gleaning more detailed information, if necessary.

Britten (1995) outlines three varieties of interview techniques: unstructured interviews, semi-structured interviews, and structured interviews; these interview techniques have been cited by many authors (Britten, 1995; Hussey and Hussey, 1997; Robson, 1993; Lofland and Lofland, 1984) as the most commonly used.

- Structured interviews are predominantly used in the natural sciences; they consist of closed questions demanding answers such as 'yes/no'. They are also conducted in a standardised manner, so that other researchers can replicate similar answers.
- Semi-structured interviews consist of open-ended questions, and as their name suggests, they are structured around a few topics to guide the interviewer, and are usually used in qualitative research.

- Finally, unstructured interviews usually consist of one or two questions that open a discussion on a specified topic. Unstructured interviews are not always planned, and are also not replicable.

This thesis deploys the semi-structured interview technique, where questions are open-ended. Hussey and Hussey (1997) describe semi-structured interviews as “*a method of collecting data in which selected participants are asked questions in order to find out what they do, think, and/or feel*”. Britten (1995) states that semi-structured interviews enable the researcher to discover the interviewee’s own frame of meanings about a phenomenon without imposing predefined assumptions and rigid structures. This type of interview is appropriate when an understanding of the participants’ view is important to the research to verify observations and clear up misconceptions (Hussey and Hussey, 1997; Robson, 1993). However, it is also important to be aware of the downside of interviews. They can be time-consuming to conduct, transcribe, and analyse, as they generate vast amounts of data; controlling topics can become difficult and the researcher’s presence can affect the participant’s answers.

Semi-structured Interviews as Used in this Thesis

Participants consisted of clinical staff and ICU management. Specifically, nurses, doctors, ICU directors, and technicians. Exact participants varied between the four sites, as this depended upon the availability and willingness of those that were approached. Approximately ten staff were interviewed at each ICU site.

In Site A, an interview schedule was pinned on the staff notice board. However, as no member of staff had volunteered, the researcher approached staff at random and asked them if they would be willing to participate. This approach was then employed in the three remaining sites. The researcher arranged interviews with management via telephone or email. For a list of participants please see Appendix L.

The interview questions were open-ended and were grouped under core areas that the researcher wanted to explore:

- General information
- CIS procurement
- Implementation
- System
- Usability
- Information
- ICU organisation

The areas and questions were used as probes and guides, rather than definitive questions that had to be asked. This meant that the interviews could be described as semi-structured conversations, steered by the interviewer so that the topic of conversation remained loyal to the investigation of the aim and objectives of this thesis. Two sets of guides were developed, one for management, and one for clinical staff, so that it was possible to attain meaning for those areas that clinical staff may not know the answer to and vice versa. The two interview guides are given in Appendix M.

The duration and timing of interviews Interviews were conducted between the second and fourth week of data collection, so that issues picked up during observations could be explored further. However, this does not mean that observations were no longer conducted – data collection activities were not conducted in isolation of each other, i.e., when shadowing a member of staff, it was possible to ask them if they would be willing to be interviewed, either later that same day or another day. In Appendix F, the research protocol outlines exactly when each of the data collection activities would occur. In reality this was not possible, since the researcher had to allow for the unpredictable nature of an ICU, and the demanding nature of ICU tasks, which restricted the availability of clinical staff participation. The duration of the interviews varied between 10-20 minutes depending upon the availability of the interviewee.

Process of recording observations Interviews were taped using a Dictaphone. The researcher would ask each interviewee for their permission to record before the interview commenced. Once taped, the researcher made a transcription of each interview.

5.1.3 Questionnaires

The questionnaire used in this thesis was not the primary source of data. Rather, questionnaires were utilised to verify findings after the model had been derived (see Section 7.3) to gauge wider population experiences and to act as an extra method of validating the results of the research. The questionnaire was a useful validation tool for confirming findings.

The Benefits and Disbenefits of a Questionnaire

Hussey and Hussey (1997) describe the disbenefits of questionnaires. They are stated as resulting in low response rates, known as non-response bias, and incomplete questionnaires, known as item bias. Questionnaires also have the potential to be

illegible and incomprehensible, and respondents can misinterpret questions. Oppenheim (1992) outlined the benefits of questionnaires as being easy to process, relatively low cost, and less time consuming than interviews and observations.

In an attempt to overcome low response rates and misinterpretation, the questionnaire was accompanied by a cover sheet explaining any terms that might be misunderstood, and also outlining clearly how it should be completed, and where it should be returned. Respondents were not asked for their names, and were assured that anything they wrote would be treated with confidence. The English questionnaires had the additional benefit of a local research ethics committee approval number, which was typed on the cover sheet. However, for confidentiality reasons, this number is not on the cover sheets given in appendices N-P. Reminders were also sent to the senior nursing sisters at the two English sites, who urged staff to complete the questionnaires. In Denmark, reminders were written on staff room notice boards and also placed in staff folders.

Questionnaire Design

Oppenheim (1992) provides a useful guide for designing questionnaires. This was referenced while designing the questionnaire for this thesis. The questionnaire was also informed by the research aim, objectives, and the relevant literature. Questions consisted of both closed and open questions. Closed questions were of the form of multiple choices; a space for comments was also given, so that respondents could expand on a point if they so wished. For a copy of the blank questionnaire, please refer to Appendix Q.

Questionnaire – Pilot

A pilot was conducted in England, where two researchers from the University of Manchester, who were experienced in conducting questionnaire research, assessed the questionnaires. The questionnaires were also sent to the contacts at each ICU, who asked at least two nurses to review the questionnaires. Although they were met with approval from the English hospitals, the Danish nurses felt that the cover sheet should state in Danish where the questionnaires should be returned, and by what date. Nurses also felt that they should have the opportunity to write their answers in Danish. This was accomplished by writing a paragraph at the end of the questionnaire stating that answers in Danish would be welcome. The researcher's contact at the Danish ICUs wrote the second request for dates and return location in Danish, and this too was added

to the cover sheet. Copies of the questionnaire cover sheets are given in Appendix N (Site A and B), Appendix O (Site C) and Appendix P (Site D).

Questionnaires were given to ICU leaders, such as senior sisters and equivalents in the Danish ICUs. These were placed in a central place, from where all clinical staff would be able to take the questionnaire and complete it in their own time. Questionnaires were to be returned to a central place in the ICU (in England) or in the secretary's office (in Denmark). The researcher then collected these at the end of the data collection period.

Sample Size

As Site A was the only site for which the number of staff was known initially, a sample size of 75 was selected, since this was approximately half the number of clinical staff employed at this site, which seemed like a sensible number from which to expect a reasonable response rate. However, once in Denmark, the size of ICUs varied from 70 to 320. Apart from Site D, where only 70 questionnaires were distributed, Sites B and C were both given 75 questionnaires. It was decided that if a reasonable number were returned, it would be quite easy to send more via mail once the researcher returned to England. For response rates, please refer to Chapter 7.

Having discussed data collection methods used in this thesis, Section 5.2 discusses how data were analysed.

5.2 Analysis

In this section the data analysis methods employed are discussed. The data analysis methodology of grounded theory (Glaser, 1992) is deployed in this thesis. In Sections 5.2.2 and 5.2.3 the computer tools QSR[®]™ NVIVO and the Statistical Package of the Social Sciences (SPSS) are described, as these were the tools used for analysing the qualitative and quantitative data collected. Section 5.2.4 discusses the subject of triangulation and how it was achieved in this thesis.

5.2.1 Grounded Theory

In 1967 Barney Glaser and Anslem Strauss 'discovered' grounded theory as a phenomenological methodology (Glaser and Strauss, 1967). However, after the publication of their seminal work, 'The Discovery of Grounded Theory', Glaser and

Strauss no longer agreed on the precise details of their methodology, and so subsequently developed their own versions of it.

Babchuck, (1996) found that the main differences between the two versions are that Glaser remains rooted to the principles that grounded theory is inherently flexible and guided by informants and their socially constructed realities, and that findings should emerge from the data. In contrast, Strauss tries to state exactly how grounded theory should be conducted, and lays out rules and regulations that should be followed. Strauss's version emphasises the need to replicate, generalise, and verify findings; in a sense, he attempts to formalise the method by rooting it in positivist ideology, which goes against the reason why it was originally developed.

Glaser's later book (Glaser, 1992) makes a distinction between research and research analysis. He confirms that grounded theory can be used as a method for analysis. Other authors (Hussey and Hussey, 1997; Robson, 1993) have since cited grounded theory as a useful method for analysing qualitative data, and it is this that is of interest to this thesis, i.e., the use of grounded theory to analyse the qualitative data collected during this research.

Glaser, (1992) states that the process of 'doing' grounded theory is the ability to *"absorb the data as data, to be able to step back or distance oneself from it and then to abstractly conceptualise the data"*.

The main tenets of Glaser's (ibid) grounded theory are:

- Data are absorbed.
- Each incident in the data is categorised into as many categories as possible, and open coding commences.
- While coding an incident for a category, it is compared with previous incidents in the same and different groups coded in the same category.
- The researcher steps back and absorbs these categorisations.
- The process of coding and recoding is iterated (this is known as constant comparison) until saturation occurs, and theories emerge from the data.

The resultant theory is therefore, said to be grounded in the data.

Glaser (ibid.) describes open coding as the initial stage of coding data and constant comparison. Saturation is said to occur when the incidents being coded indicate the same pattern and no new properties emerge. In Section 5.2.2 a tool developed to aid coding of data, QSR®™ NVIVO, is described. QSR®™ NVIVO was used to analyse data using the constant comparison method outlined by Glaser.

5.2.2 QSR[®]™ NVIVO

Data were analysed using QSR[®]™ NVIVO (QSR, 2003), a software package that aids the analysis of rich text documents. It was chosen specifically as it facilitates the management and organisation of qualitative data, enables automatic coding, provides modelling tools not found in any other software and is suited to the analysis needs of the researcher.

Data collected from observations, interviews and open questions from the questionnaire were saved as text documents and coded using QSR [®]™NVIVO. Each document was read, and the document attributes were recorded. Each document was re-read and open coding commenced, i.e., factors emerged but were not assigned to any particular category. These factors were coded under 'free nodes'. After re-reading the documents a number of times, categories emerged, and these were grouped under 'Trees', which are the parent nodes for factors identified (known as child nodes). Child nodes were then compared (constant comparison) with each other and between documents. These were then grouped under the 'parent node' categories (Trees). The modelling tool was then used to assemble the nodes to show patterns in the data. The results are presented and discussed in Chapter 6. The methods of analysing the quantitative data are given next.

5.2.3 SPSS

Closed questions in the questionnaire were analysed using SPSS, a package that provides many statistical tools for data analysis (Rose and Sullivan, 1996). The questionnaire was coded using SPSS to enable analysis using this package. A frequency analysis of the data was conducted for each ICU. The results are given in Section 7.3.

5.2.4 Triangulation

Denzine's (1970) work on triangulation is frequently cited (see works by Ammenwerth et al. (2003); Hussey and Hussey (1997); Robson (1993) for further references). The concept of triangulation is 'borrowed' from navigation, where it refers to the process whereby a position is fixed using different kinds of measures, such as compass bearings, depth sounds, and radio lines from different positions (Porter, 1994). Denzine (1970) argues that this concept can be applied to qualitative research in that the wider the variety of evidence that can be gathered, the smaller the area of doubt. He states that

using different methods for studying the same phenomenon should lead to greater validity and reliability than using a single approach.

Denzin (ibid) identified five types of triangulation:

Data A variety of data sources are used with regard to time, space, and/or persons.

Investigator A variety of researchers investigating the same phenomenon.

Theory The use of multiple perspectives to interpret a single set of data.

Method A variety of data collection methods, questionnaires, and interviews etc.

Environment A variety of locations where the research is conducted.

Most research usually aims for two of the above types of triangulation (Hussey and Hussey, 1997). However, this research deploys three of the above types of triangulation, namely data triangulation (i.e., a variety of informants), method triangulation (i.e., a variety of data collection methods), and environmental triangulation (different locations and settings). This is very important, as it emphasises the reliability and validity of this research as being high. A thorough discussion of this topic is given in Section 8.2.2.

5.3 Summary

In this chapter the data collection and analysis methods were identified. The data collection methods used in this thesis were primarily non-participant observation (described in Section 5.1.1) and semi-structured interviews (in Section 5.1.2). Questionnaires were also used, and are described in Section 5.1.3, but they were not a primary source of data. The benefits and disbenefits of these methods were discussed, before how they were used in this thesis was stated in Section 5.1.4.

Grounded Theory was defined as the methodology guiding data analysis, using the constant comparison method as defined by Glaser (1992). Software packages QSR®™NVIVO and SPSS were employed to aid computer analysis of the qualitative and quantitative data, respectively. The important issues of reliability and validity of the research methods were introduced in Section 5.2.4, where triangulation was discussed. The validity and reliability of the findings will be discussed in Section 8.2.2.

Having discussed the research paradigm and methodology in Section 4.1 and having outlined the data collection methods in this chapter, the research findings are presented and discussed next, in Chapter 6.

Chapter 6

The Iterative Systems Integration Model (ISIM)

This chapter is concerned with presenting the key contribution of this thesis, ISIM. The model is described, and its formation discussed, before hypothetical examples of the use of ISIM are given. ISIM is comprised of several features, which are the result of the application of grounded theory, used for the analysis of data collected in the ICUs described in Section 3.3.

6.1 ISIM

This section presents the principal contribution of this research, the Iterative Systems Integration Model (ISIM). Section 6.1.1 illustrates ISIM and provides a description of its components and is followed by a description of how ISIM was formulated in Section 6.1.2. To facilitate an understanding of ISIM in the context of CIS integration, hypothetical descriptions of how ISIM may be applied are given in Section 6.1.3. The derivation and discussion of ISIM in terms of its constituent parts – and in terms of the sites at which data were collected – are left for Section 6.2, which is more readily understandable once ISIM has been clearly defined.

6.1.1 Description of Components

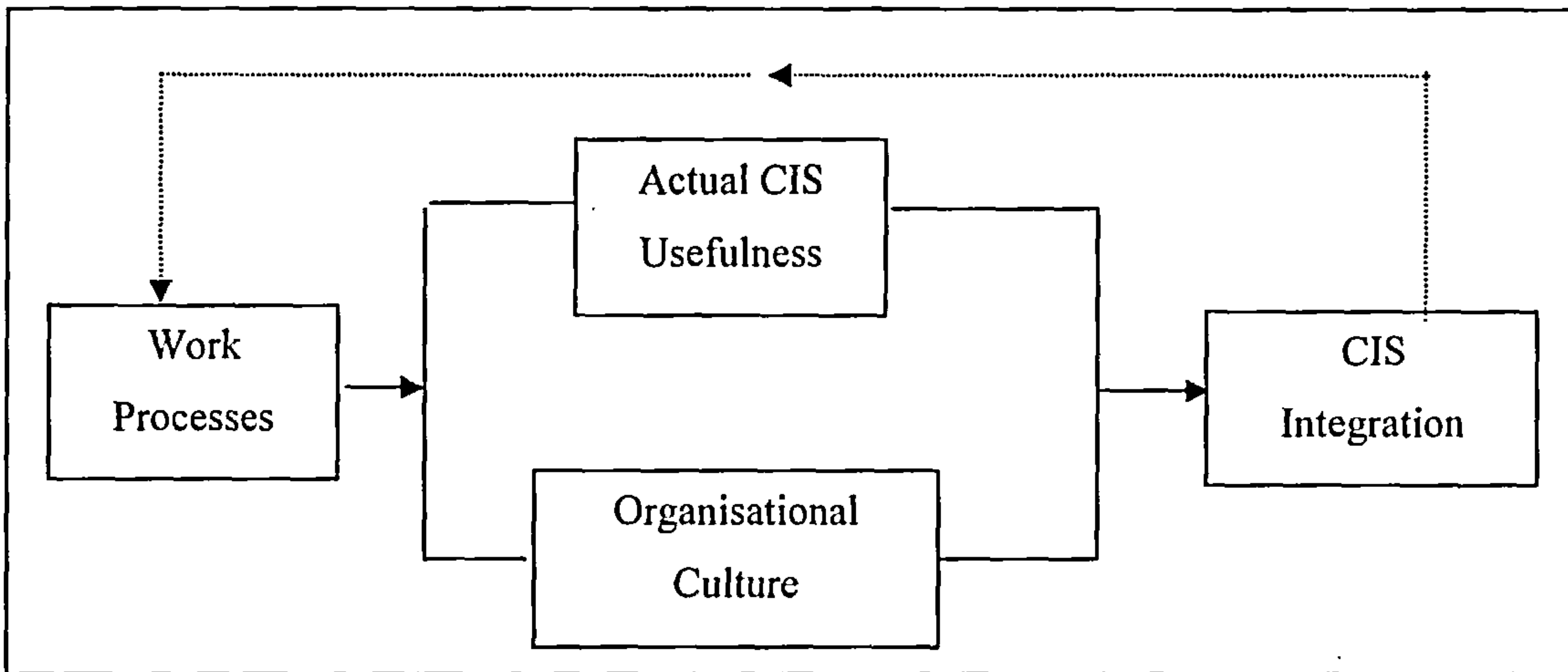


Figure 6.1: The Iterative Systems Integration Model (ISIM).

ISIM is a conceptual model derived from empirical data collected from three ICUs (Sites A, C, and D, which were described in detail in Chapter 3; Site B is used to validate ISIM in Section 7.2). The model is shown in Figure 6.1, and evidence of its derivation from the data collected is given in Section 6.2. The model consists of four components: 'Work Processes', 'Actual Usefulness', 'Organisational Culture', and 'CIS Integration'. These components are described in more detail first, and then the formation of ISIM is detailed in Section 6.1.2.

Work Processes

Work processes describe how organisations conduct their work. They can be illustrated using work process diagrams, which are used here to demonstrate the work processes concerning CIS and ICU staff, simplifying the complexity surrounding ICU environments. Work process diagrams were developed as snapshots of how work in the ICU was conducted at a given point in time.

Work processes can obviously change, for example, when new equipment is installed in an ICU. Therefore, it was impractical to state that any one particular method of creating work process diagrams would be suitable for all ICUs. For this reason, ISIM does not specify the use of a particular method for illustrating work processes, as the chosen method may vary between individual ICUs and researchers, each of whom should opt for the one that best suits their needs. In this thesis, Role Activity Diagrams (RADs) were used as a tool for illustrating ICU work processes; see Section 6.2.1.

Actual Usefulness and Organisational Culture

Data analysis (the analysis methods used are described in Section 5.2, and more details are given in Section 6.1.2) enabled the identification of 16 salient features that were found to be important for CIS integration. These are separated into two categories: Organisational Culture, which describes the human and organisational factors that can affect CIS integration and Actual Usefulness, which focuses on experiences of using the CIS in practice, and how beneficial the CIS is to those that use it. The factors of Organisational Culture and Actual Usefulness that were identified through grounded theory are shown in Figure 6.2, and are discussed in Section 6.2. Discussion about each factor in Figure 6.2 varies in length, as it was dependent upon how much data was collected for each factor. For example, 'Training and Education' was found to be a very important factor at each site, and so this is discussed in great detail.

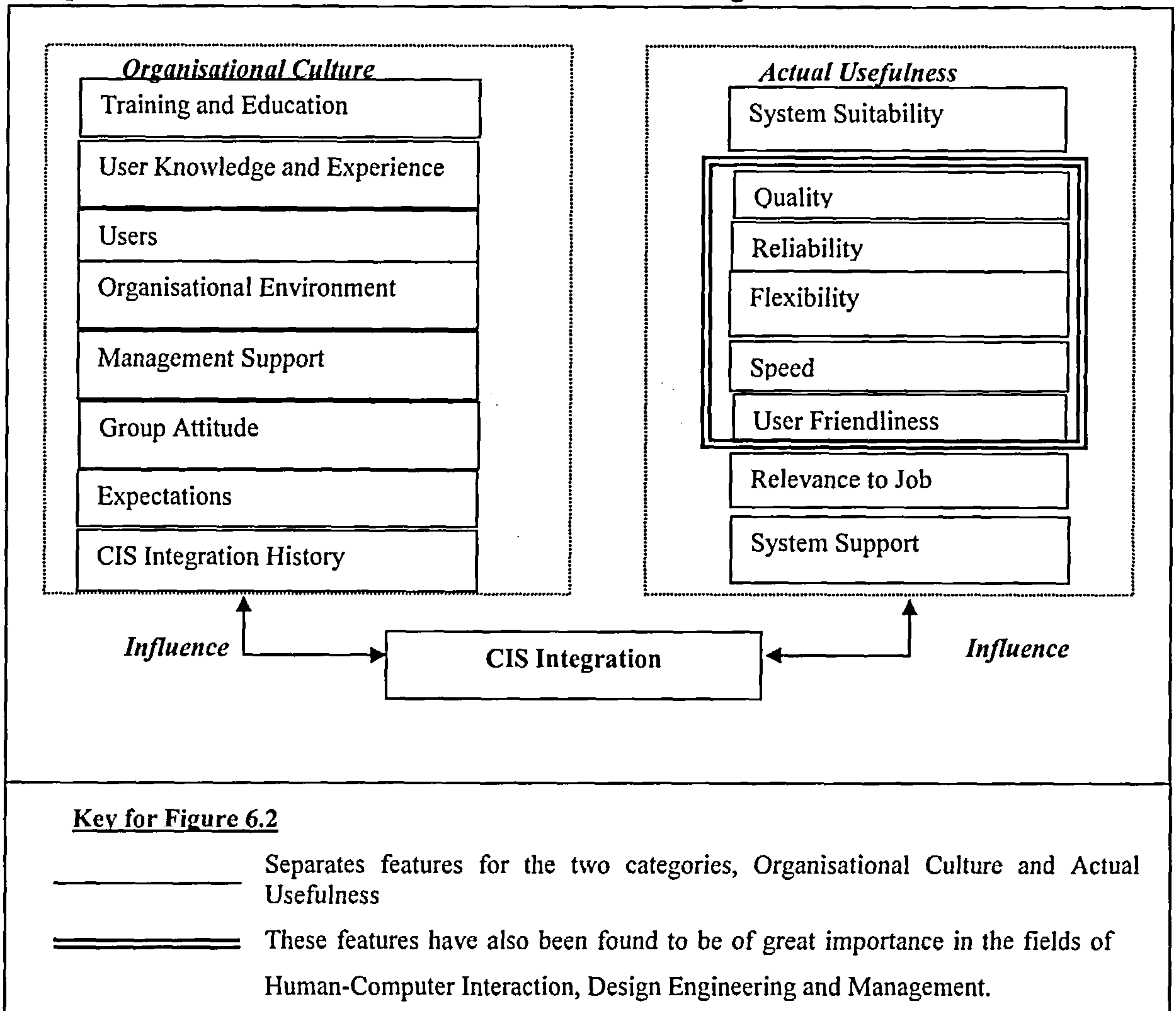


Figure 6.2: Detail of the Organisational Culture and Actual Usefulness elements of ISIM – factors that affect CIS integration.

CIS Integration

In Section 1.2.1 CIS integration was defined as the extent to which CIS support ICU work processes (i.e., the extent to which they *combine* with the work processes), are accepted by users, and are fully functioning and well used. This is given in ISIM (Figure 6.1) as an outcome of work processes, Organisational Culture, and Actual Usefulness.

A Description of ISIM

CIS integration is an iterative process, and directly affects ICU work processes, with the amount of change being dependent upon the system introduced and the extent to which it is integrated at a given point in time. For example, a change in the CIS will change the Organisational Culture (*“how things are done around here”*). The factors identified in the Organisational Culture category (see Figure 6.2) influence CIS integration either positively or negatively depending upon the Organisational Culture factors in place. The cycle then iterates and directly affects the work processes, i.e., *what* is done in the ICU. As the CIS is being used, the Actual Usefulness factors will influence CIS use in practice, and hence CIS integration, while the Organisational Culture factors will do the same in parallel. Both the Actual Usefulness of the CIS and the Organisational Culture of the CIS will then influence CIS integration, again, either positively or negatively depending on the factors identified in the two categories. The cycle iterates, until it stabilises with the CIS either fully integrated or rejected. The number of iterations required for full integration will depend upon the amount of change required in the culture of the organisation, the actual usefulness of the system, and the impact of the CIS on work processes. Because both Organisational Culture and Actual Usefulness impact on the extent to which the system is integrated and the resultant change in work processes, where a change is made in one category, it will affect CIS integration and work processes, and hence affect the other category. However, changes in Organisational Culture and Actual Usefulness do not affect each other directly, but only through changes to CIS integration and work processes. The first two iterations of ISIM are shown in Figure 6.3. A description of how ISIM was formulated is given next.

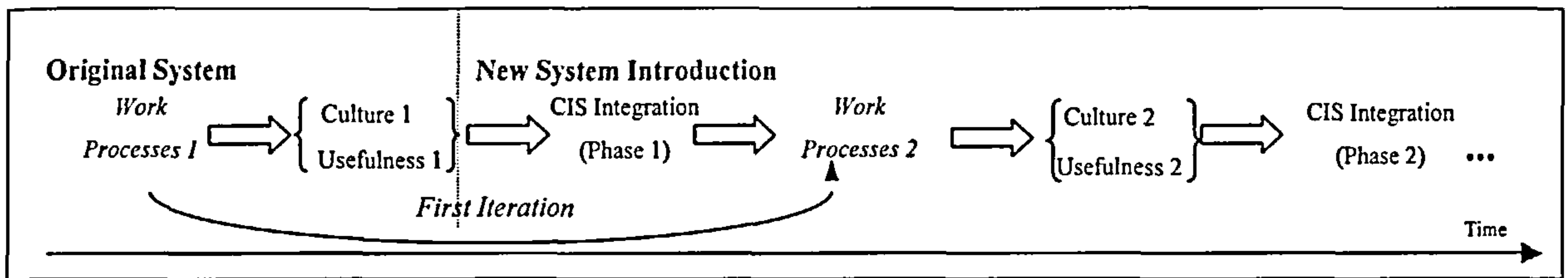


Figure 6.3: The first two cycles of ISIM

6.1.2 Formation of ISIM

In Chapter 5 the methods used to assist with the collection of empirical data, from which the findings are derived, were discussed. Non-participant observations and interviews were the data sources used to derive ISIM. Grounded theory (Glaser, 1992) was identified as the method of analysis for the data collected, and QSR NVIVO®™ was used to code and aid the analysis of data. The process of deriving ISIM is as follows:

- Data were recorded as text documents.
- All the documents were read and re-read until concepts emerged.
- All factors were initially coded using open coding, which means that they were not as yet assigned to categories.
- A 'not relevant' category was formed for data that was not of significance to this thesis. This category was revisited after the formulation of each part of ISIM to check that nothing was missed.
- All codes under Organisational Culture were identified and compared with each other, and in relation to CIS integration (hence the emergence of Figure 6.4, i.e., a one-way arrow showing that Organisational Culture affects CIS integration).
- The documents were read again, and the remaining codes were compared against those under Organisational Culture. Subsequently, the concept of Actual Usefulness emerged, and the remaining codes fitted under this category (Figure 6.5).
- The documents were re-read again in light of the findings, focussing upon the 'not relevant' category and CIS integration; Figure 6.6 gives the emerging concepts, the notion that CIS integration is not only affected by Organisational Culture and Actual Usefulness, but also affects these factors; CIS Integration influences Organisational Culture and Actual Usefulness, which influence each other.

- So far, work processes are disparate from Organisational Culture, Actual Usefulness, and CIS integration, but having already analysed work processes, it was evident that they significantly affected the other three categories (Figure 6.7).
- The notion of iteration enabled the formulation of the final model that is ISIM i.e., Actual Usefulness and Organisational Culture influenced each other through the work processes and CIS integration, so that a change in work processes meant a change in Organisational Culture and Actual Usefulness, the effects of which merge to influence CIS integration, which again affects work processes, and so on. This meant that the link between Actual Usefulness and Organisational Culture as shown in Figure 6.7 was now unnecessary, and the final model ISIM emerged (Figure 6.1, this is given again, over page, for completeness).

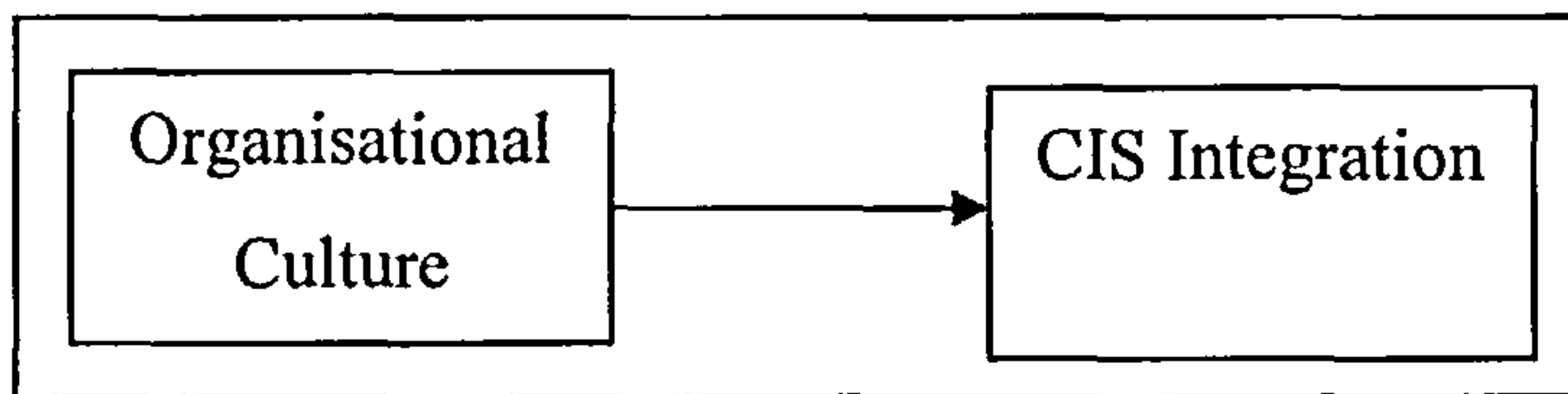


Figure 6.4: Organisational Culture affecting CIS Integration.

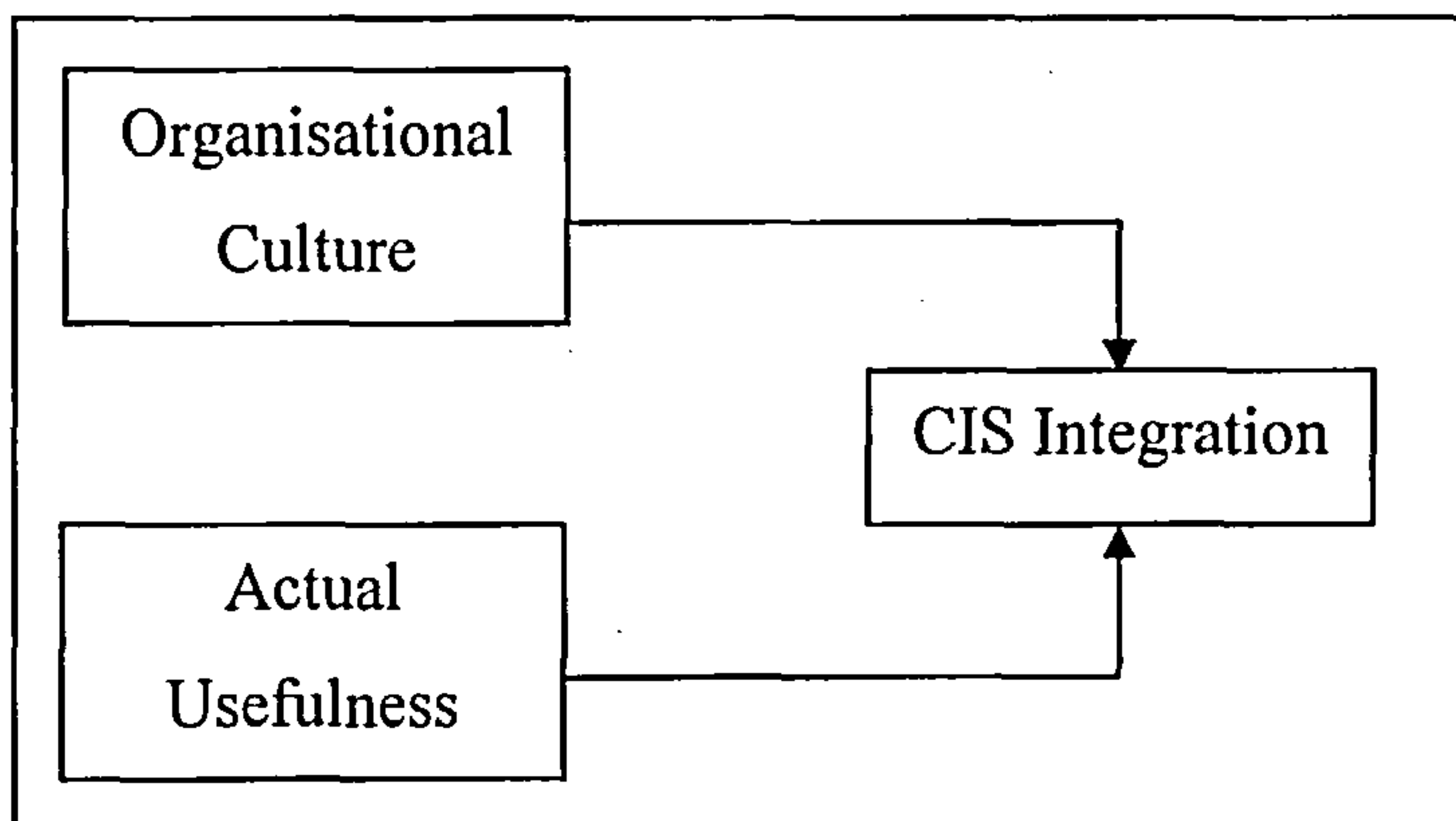


Figure 6.5: Organisational Culture and Actual Usefulness affecting CIS integration.

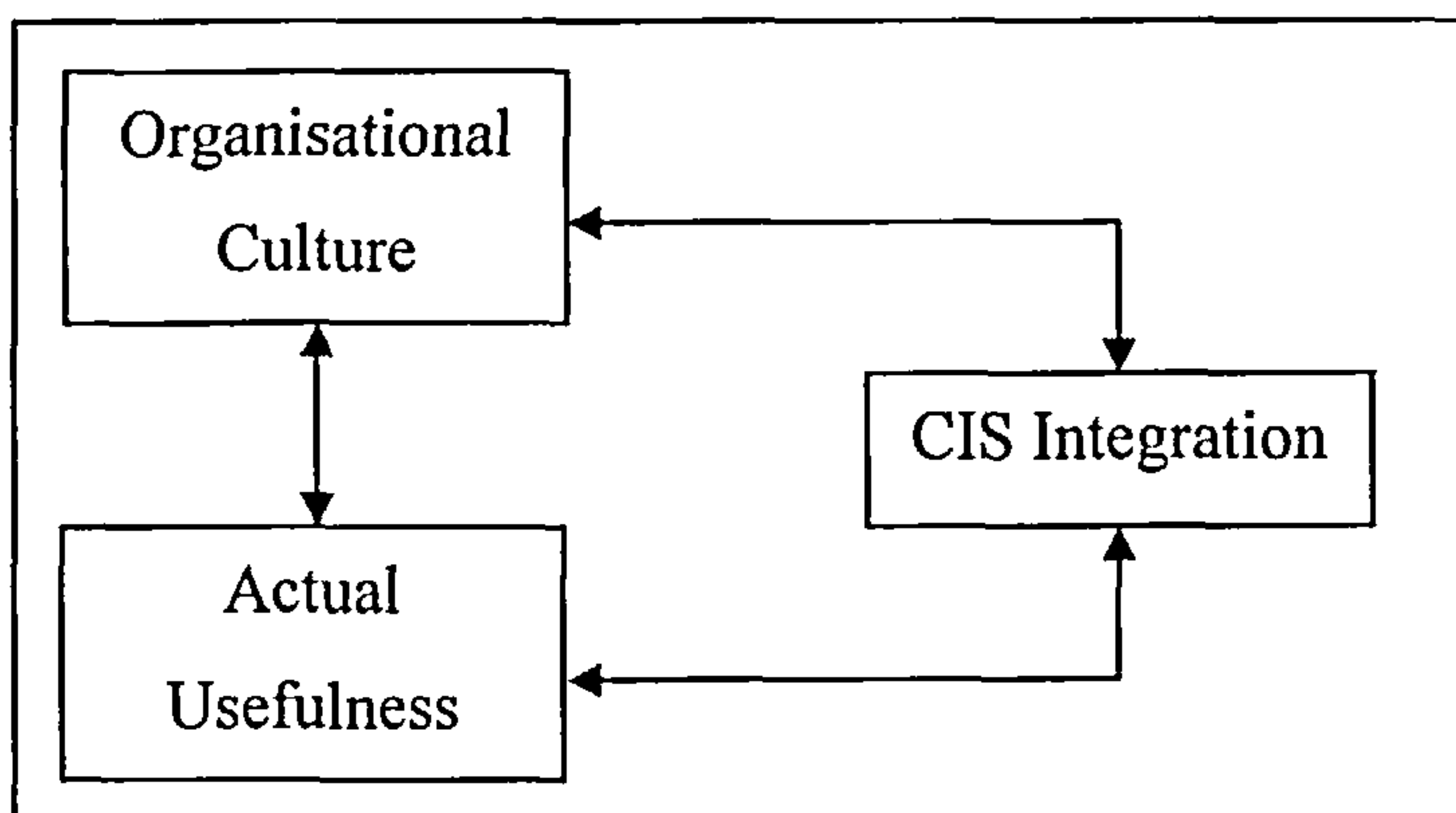


Figure 6.6: Organisational Culture and Actual Usefulness affecting, and being affected by, CIS integration.

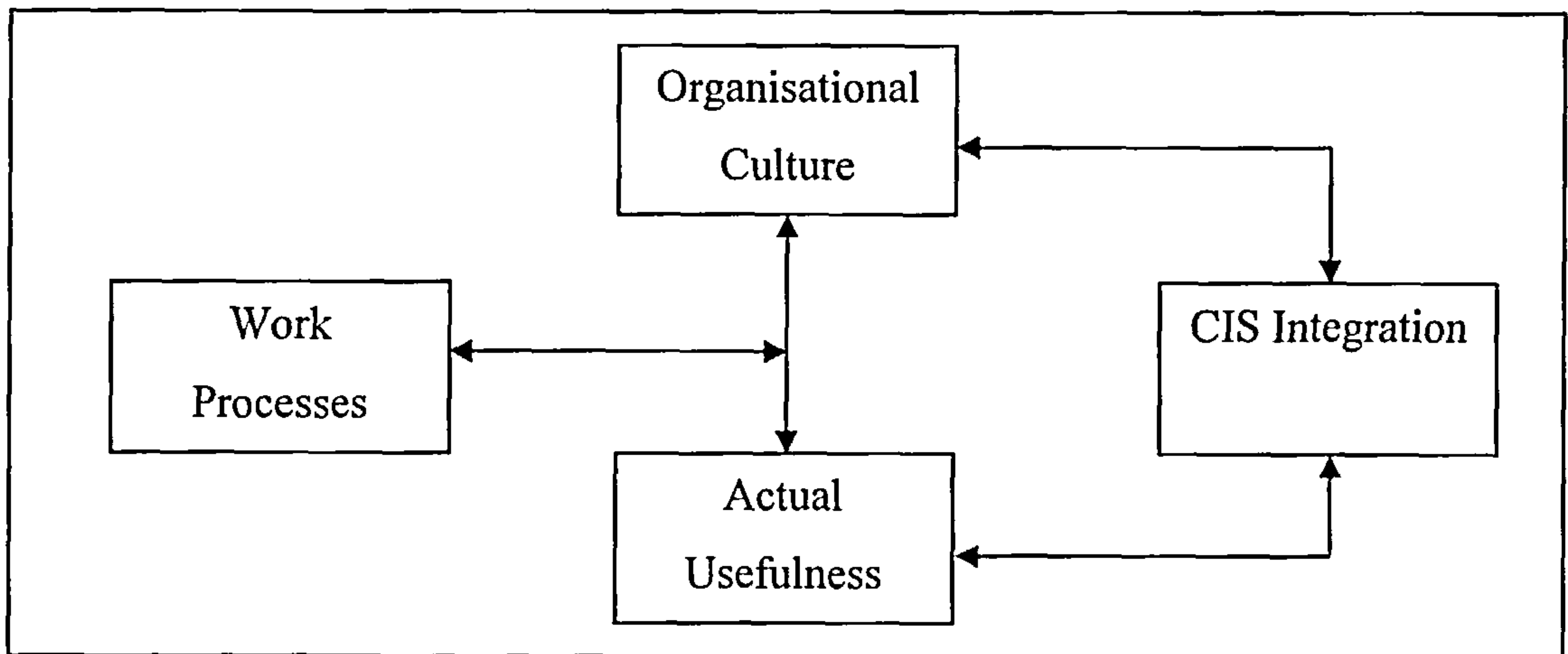


Figure 6.7: Work processes in relation to Organisational Culture, Actual Usefulness and CIS integration.

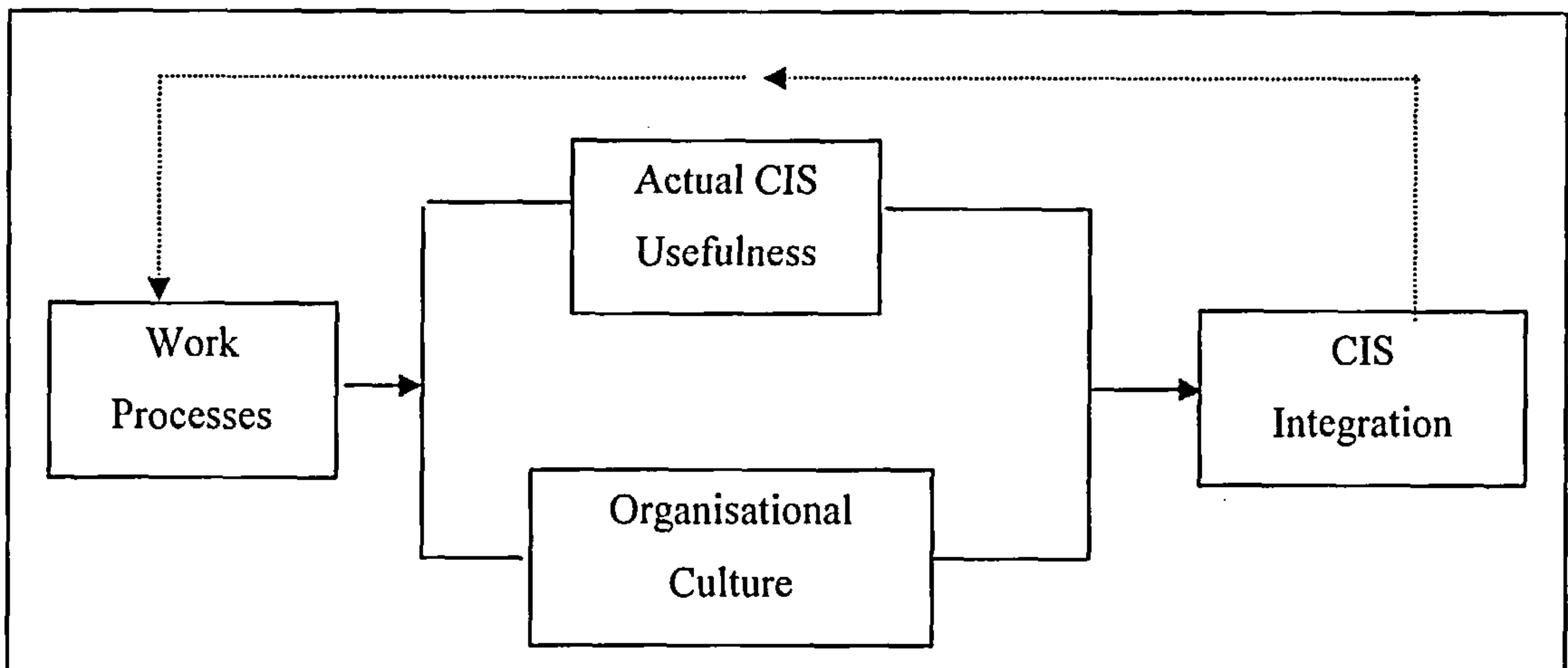


Figure 6.1: The Iterative Systems Integration Model (ISIM).

6.1.3 Hypothetical Applications of ISIM

To facilitate the contextual understanding of ISIM, this section describes hypothetical cases when ISIM may be used. It must be noted that ISIM is a model that offers a guide rather than a prescription. The factors identified in Figure 6.2 are by no means static, and different ICU organisations may have factors of Organisational Culture and Actual Usefulness that are unique to them. Using ISIM as a guide may enable ICUs to identify these factors.

ISIM may be applied to guide the development of interview and questionnaire categories, and observational factors to watch for, so that an ICU can assess Organisational Culture and Actual Usefulness factors in their organisation, informing them about how and why a CIS is used. Mapping the work processes in conjunction

with assessing Organisational Culture and Actual Usefulness may enable organisations to capture the context of these factors and how a CIS may affect existing work processes.

This thesis is not concerned with providing scales for measurement. Tools for measuring performance and conducting economic analysis are ubiquitous: these tools could be used in conjunction with ISIM if measurements are important to the organisation. The primary focus of ISIM is *understanding* (the why), rather than *measuring* (the what). ISIM may be used as a conceptual model to guide and explore CIS-related decisions before, during, and after CIS implementations.

Before CIS Implementations

The ICU will almost definitely have some sort of CIS in place to organise and manage patient information, be it paper-based, computer-based, or some combination of the two. Before procuring a system, the application of ISIM could guide and inform decision-making regarding CIS procurement. Analysing work processes may force the organisation to notice how things are actually being done, as opposed to how they should be done.

The application of ISIM as a guide may also enable the ICU to understand *why* things are being done the way they are. By conducting this analysis themselves, as opposed to using external advisors, the organisation would be able to see, first hand, how their work processes and Organisational Culture, together with the Actual Usefulness of a particular system, may affect CIS integration. This may then enable the organisation to recognise how a given CIS may be accepted if it were implemented in the ICU in its current state. It may guide them to evaluate the feasibility of introducing a system, what factors they need to change before implementation, and what factors need to remain the same.

As mentioned previously, introducing a CIS alters work processes; a change in Organisational Culture is inevitable i.e., "*how things are done around here*". It is not enough to simply know what is being done; the application of ISIM may enable an understanding of *why* things are done the way they are. This gives ICU management the opportunity to use this information to facilitate optimal integration of a new CIS, or to decide to remain with the system that they currently use.

During CIS Implementations

Continuously assessing how an implementation is progressing with regard to the organisational environment and the people that use the CIS is important because it provides feedback on progress, and enables changes to be made if necessary. The application of ISIM may enable implementers to understand progress towards CIS integration in terms of acceptance and actual use. This may guide the organisation in identifying the factors that facilitate integration. If the implementation is not going well, evaluating progress may provide an opportunity to rectify any problems by understanding why they are occurring. If implementation is going well, success could be reported to participants realistically, based on the evidence that they have collected.

After CIS Implementations

Applying ISIM after CIS implementation may not only enable the organisation to learn from the implementation, but also indicate how they may sustain and improve CIS integration. Interview questions and questionnaires could be developed using the broad categories in ISIM to survey user reactions and experiences of the CIS. Evaluating the CIS after it has been integrated may enable the organisation to assess user satisfaction with the system, and those factors that may impede success. Analysing work processes will highlight the benefits (if any) of using the CIS, which can be imparted to users of and investors in the CIS, informing them of the actual – as opposed to the predicted – benefits of using the CIS.

Having described the model, its formulation, and hypothetical application, the derivation of each component of ISIM is now described and discussed, showing the data in which the model is grounded.

6.2 Derivation of ISIM

The derivation and discussion of each component of ISIM (work processes, Organisational Culture, Actual Usefulness, and CIS integration) is given in this section. The use of Role Activity Diagrams (RAD) to illustrate the ICU work processes is discussed in Section 6.2.1, while Sections 6.2.2, 6.2.3, and 6.2.4 present the derivation of the Organisational Culture, Actual Usefulness, and CIS integration elements of ISIM respectively.

6.2.1 Work Processes

This section describes how work process data were coded and the RADs developed; a comparative discussion of work processes at each site is given at the end of the section. Before the RADs are presented, a road map guiding their reading is given in Figure 6.9. A key describing the symbols used is shown in Figure 6.10.

Analysing the Work Processes

As described previously, the data on which ISIM is based were collected from three ICUs (Sites A, C, and D (Section 3.3); Site B was used as a validation site (Section 7.2)) by a combination of non-participant observation and interviews. The analysis of this qualitative data was performed using QSR[®]™ NVIVO. This enabled the coding of all the data that described work processes. Work process data were collected from observations and then participants were asked about their work in an ICU during interviews, so that anything that was observed was verified and anything missed or unclear could be clarified. Figure 6.8 shows an example of how QSR[®]™ NVIVO enabled the management, recording and analysis of data. In particular, this figure shows

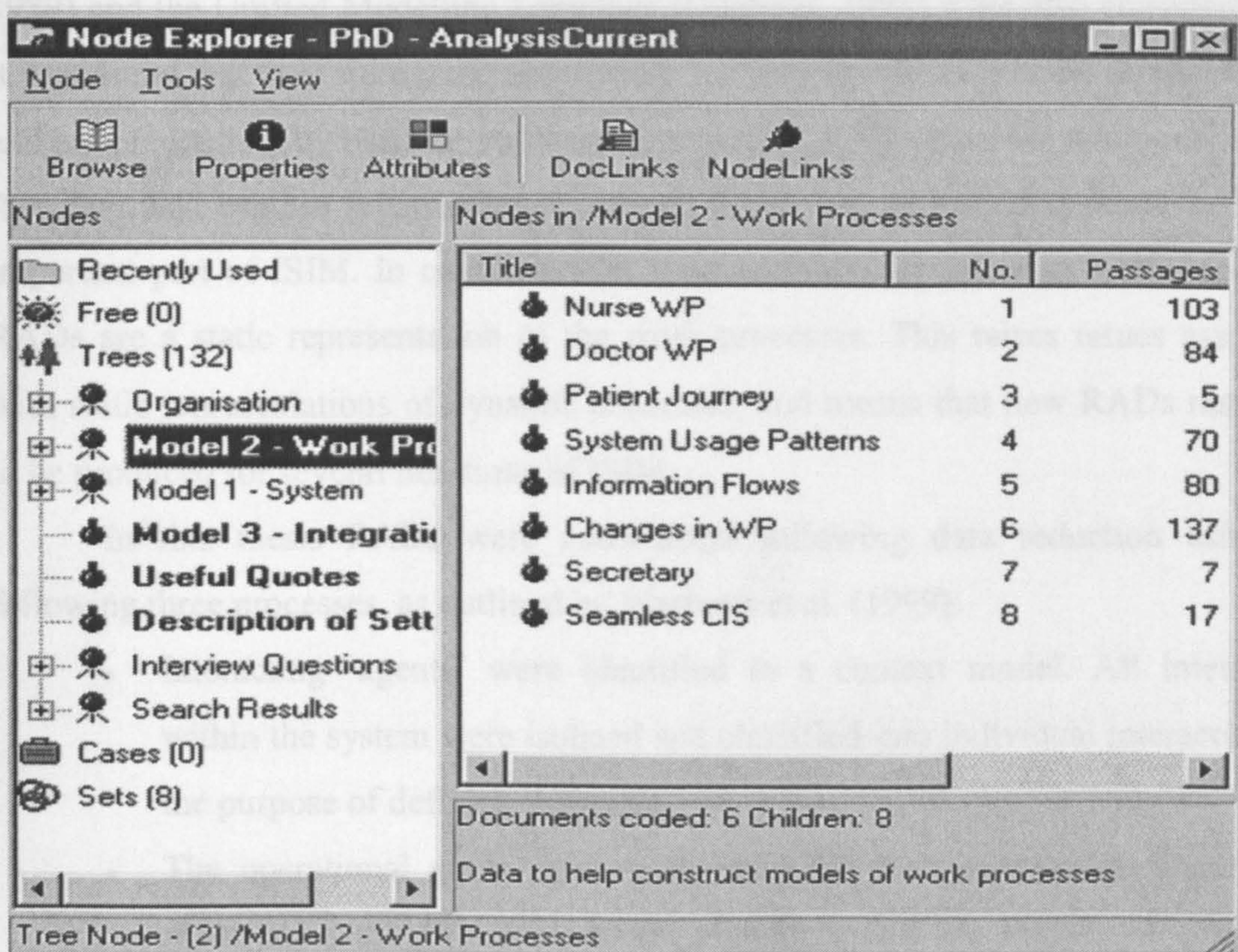


Figure 6.8: A screen dump of QSR[®]™ NVIVO showing the nodes at which data were coded for work process diagrams.

the nodes at which some of the observation and interview documents were coded for work processes. Observation data regarding work processes were separated into nodes, i.e., into clinician categories (nurses and doctors), as is shown in Figure 6.8. Each node was then coded under further categories such as information processes, flow of work, use of CIS etc. Using QSR®™ NVIVO it was possible to group all data about specific categories, so all data concerning information processes in all documents in which this was coded, could be searched for, and was presented in a document.

Once all relevant data had been coded, it was then re-read and compared with other categories within work processes. The methods outlined by Warboys et al. (1999) for constructing Role Activity Diagrams were then followed as is discussed next.

Formation of Role Activity Diagrams

Role Activity Diagrams (RADs) were used to illustrate nurse and physician work processes, first for three ICUs, and after the derivation of ISIM, for validation purposes at a fourth ICU (see Section 7.2). RADs were chosen for the purpose of this research because they can be adapted to look at higher-level pictures of processes and they have also been applied successfully in healthcare (Kay et al., 1998). Petri Nets (Murata, 1989) and the Unified Modelling Language (Quatrani, 1998) were also considered, but it was found that they were more appropriate for very low-level process representations and are predominantly used for software engineering. RADs have the additional benefit that they also capture organisational context, which can influence systems, and is an important part of ISIM. In common with most methods for mapping work processes, RADs are a static representation of the work processes. This raises issues associated with static representations of dynamic processes, and means that new RADs may need to be produced for several iterations of ISIM.

In this thesis RADs were constructed following data reduction using the following three processes, as outlined by Warboys et al. (1999):

- Interacting ‘agents’ were identified in a context model. All interactions within the system were isolated and classified into individual interactions for the purpose of defining the goals.
- The operational goals were established for each interaction. These goals represented the behaviour to be modelled, and are known as conceptual models; here involving clinical information between nurses/doctors/patients/other clinical staff and the information tools used.

- Method Models* illustrate how each goal is achieved through the use of RADs, which were developed for each site.

Work Process Road Map

In this thesis, the patient journey begins at the ICU; this is summarised in Figure 6.9, which is a guide to the order in which the RADs should be read. The focus of the work processes is predominantly on the information processes. It must be noted that the focus of this thesis is on 'Care' as it is the most information intensive; 'Admission' and 'Discharge' are described briefly in tables 6.1 and 6.4, for perspective.

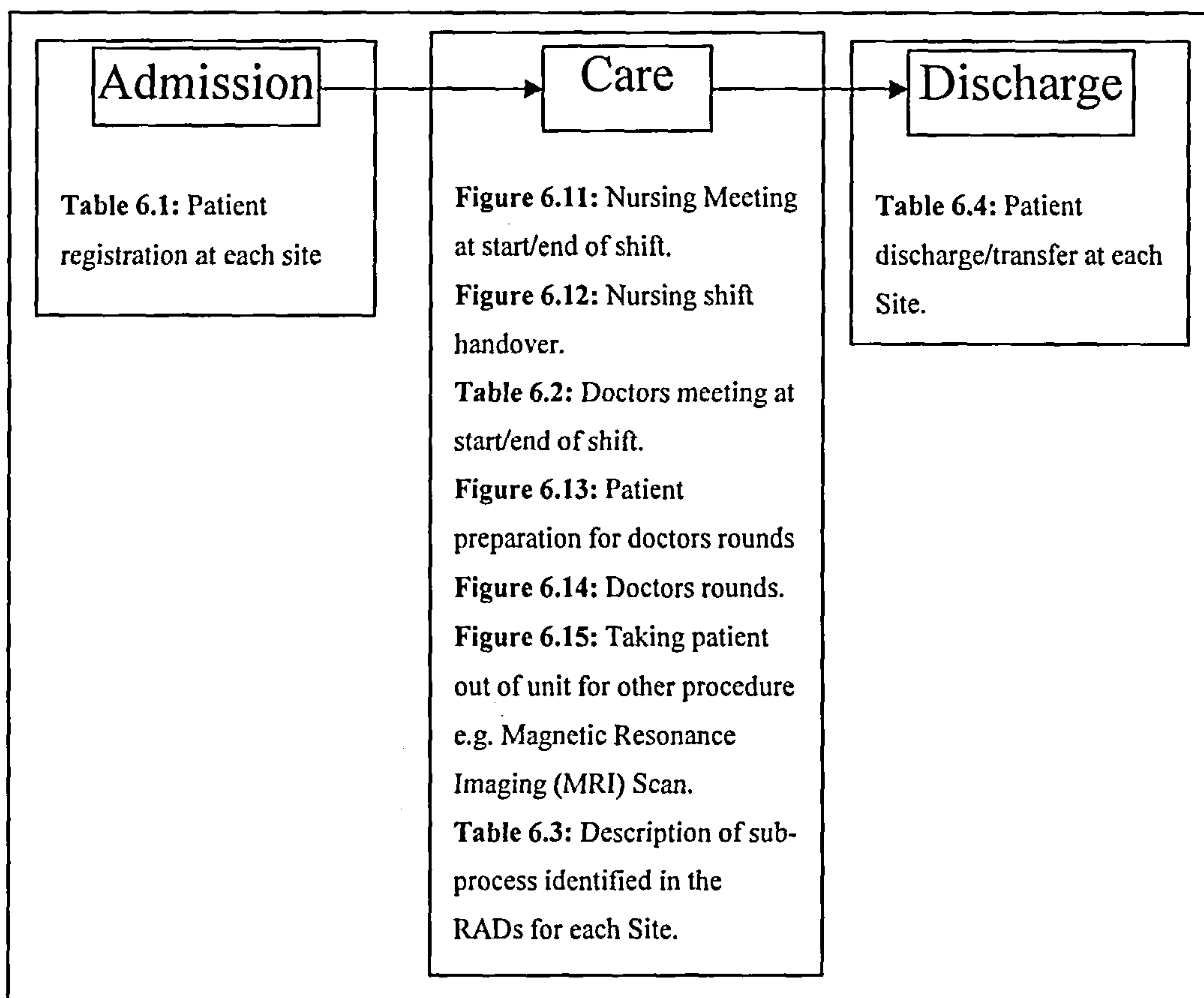


Figure 6.9: A guide for reading the ICU work processes

Having created the RADs for the ICU work processes, it was found that many of the work processes were identical at each site; the differences were in how sub-processes were conducted. Therefore, to make the RADs easier to read and follow, the figures show the common elements, the sub-processes at each ICU are given in Table 6.2, as

* Method Models are derived from contextual and conceptual models through the use of RADs, which show every role in the process or activity, and also every interaction within each role.

this immediately enables comparisons between the sites. A reference list of all tables and RADS developed to explain the work processes is given in Figure 6.9, and a key showing all the symbols used in the RADs is given in Figure 6.10.

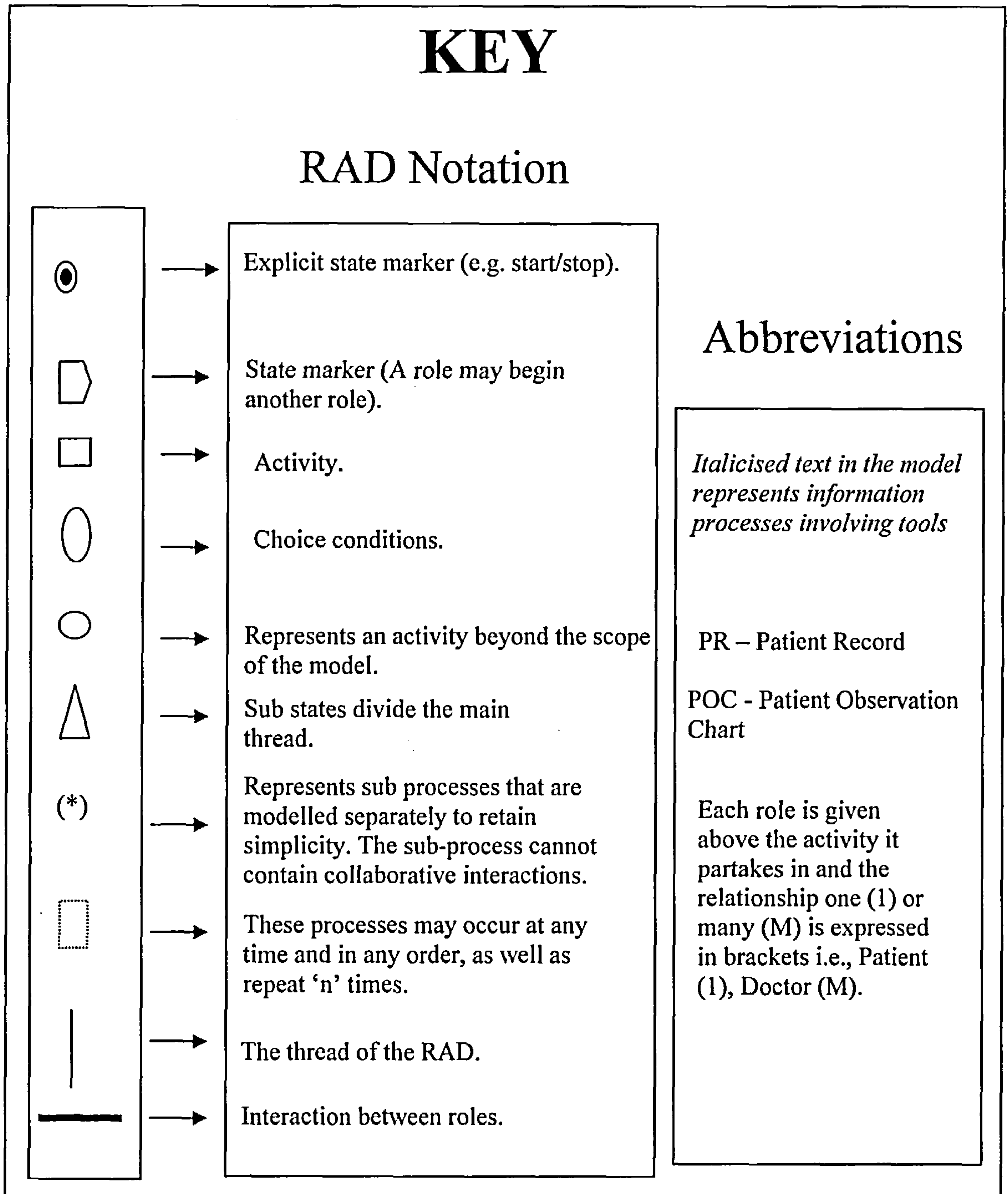


Figure 6.10: Key for reading RAD notation

Admit Patient to ICU:

Table 6.1 describes briefly, the information process of patient registration.

Table 6.1: Patient registration at each site.

<i>Site</i>	Registration Process
<i>A</i>	Patient details are sent with the patient. Details are given on printouts from the hospital information system and various registration forms. These details are then retyped into the ICU CIS.
<i>C</i>	Registration is handled by two ICU secretaries via the Green System, which was described in Section 3.3. Secretaries organise all patient data.
<i>D</i>	Registration is handled by a group of 5-6 ICU secretaries via the Green System, which was described in Section 3.3. Secretaries organise all patient data.

Care of Patient in the ICU

Nursing Meetings

Figure 6.11 illustrates the nursing meetings held at the start/end of each shift at the ICU. The meetings were conducted similarly at each site. The goal of the meetings was to update nurses beginning the new shift (sometimes nurses may be away from the unit for weeks, therefore this meeting is very important) about the situation at the ICU, and to assign patients to nurses.

All nurses on the previous shift (NoPS) and nurses on the current shift (NoCS) attended, as well as two clinical sisters. The aim was to inform all participants of the status of all patients on the ward. The meeting was conducted primarily by the clinical sister on the just-finished shift, who presented a verbal summary of all patients' status, although any NoPS could add details. The duration of the meetings varied between 15 and 30 minutes, depending upon the number of patients in the ICU and the severity of their conditions.

At all sites, nurses would mostly remember what was said, and only occasionally make notes. A more intense information exchange took place between the two nurses involved with each individual patient (one nurse coming onto the ward, and one finishing their shift). This exchange was conducted at shift handover (Figure 6.12), once the clinical sister had assigned nurses to patients, and is described next.

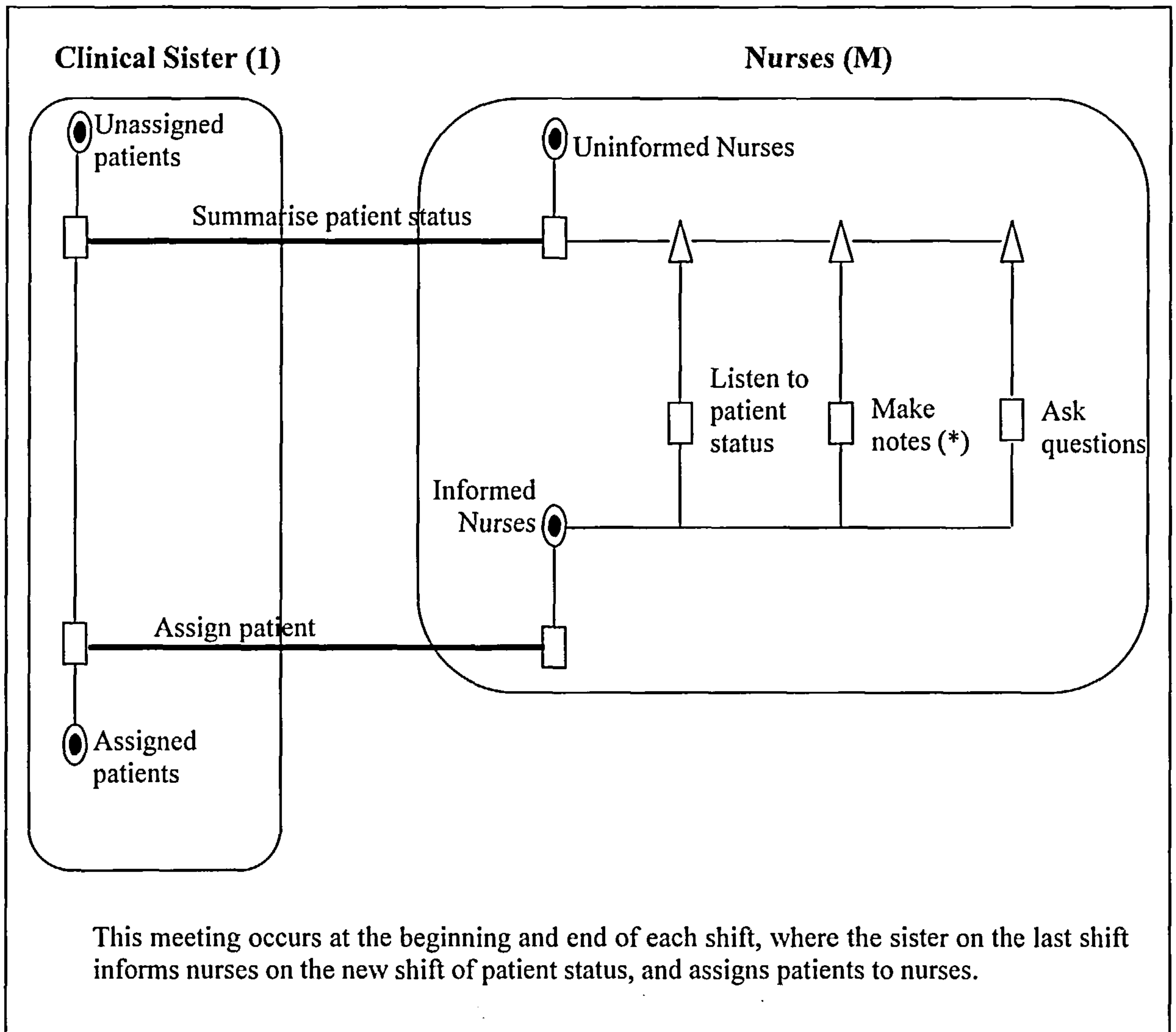


Figure 6.11: Nurse meetings at start/end of shift

Nursing Shift Handover

The shift handover is portrayed in Figure 6.12. This occurred by the patients' bedside between the nurse on the previous shift (NoPS) and the nurse on the current shift (NoCS). The goal of the meeting was for the NoPS to inform the NoCS about the patient and address particulars, for example the NoPS may not have had time to give the patient a bath, there may have been a change in the dosage of medication on that shift, or the patient may have to be positioned in a particular way, etc. This was also an opportunity for the NoCS to clear any queries they had. Any questions unanswerable by the NoPS were addressed to the clinical sister if she was available, or the nurse waited for the doctors' rounds, or tried to ask other nurses.

The information exchange was mostly verbal, however the NoCS would also watch the monitors and vital signs and observe the patient to verify what the NoPS was telling them; most of the nurses at each site confirmed the following quote:

“We look and feel, it is not just what is written...intuition..?” (Nurse, Site D).

The importance of the CIS in this exchange was minimised. However, this does not mean that a CIS was not capable of this task:

“Sometimes it’s just pure laziness, people ask you what you think, what have you done about that. There are a lot of things that we communicate verbally. But generally speaking you could get just about everything out of the CIS.” (Nurse, Site A).

The patient observation chart was also referred to frequently throughout the exchange between the nurses, as it was a summary of hourly nursing observations for the past 24 hours of nursing care. Once the shift had been handed over, the NoCS would check all the physiological equipment, as well as the patient. This is illustrated in Figure 6.12.

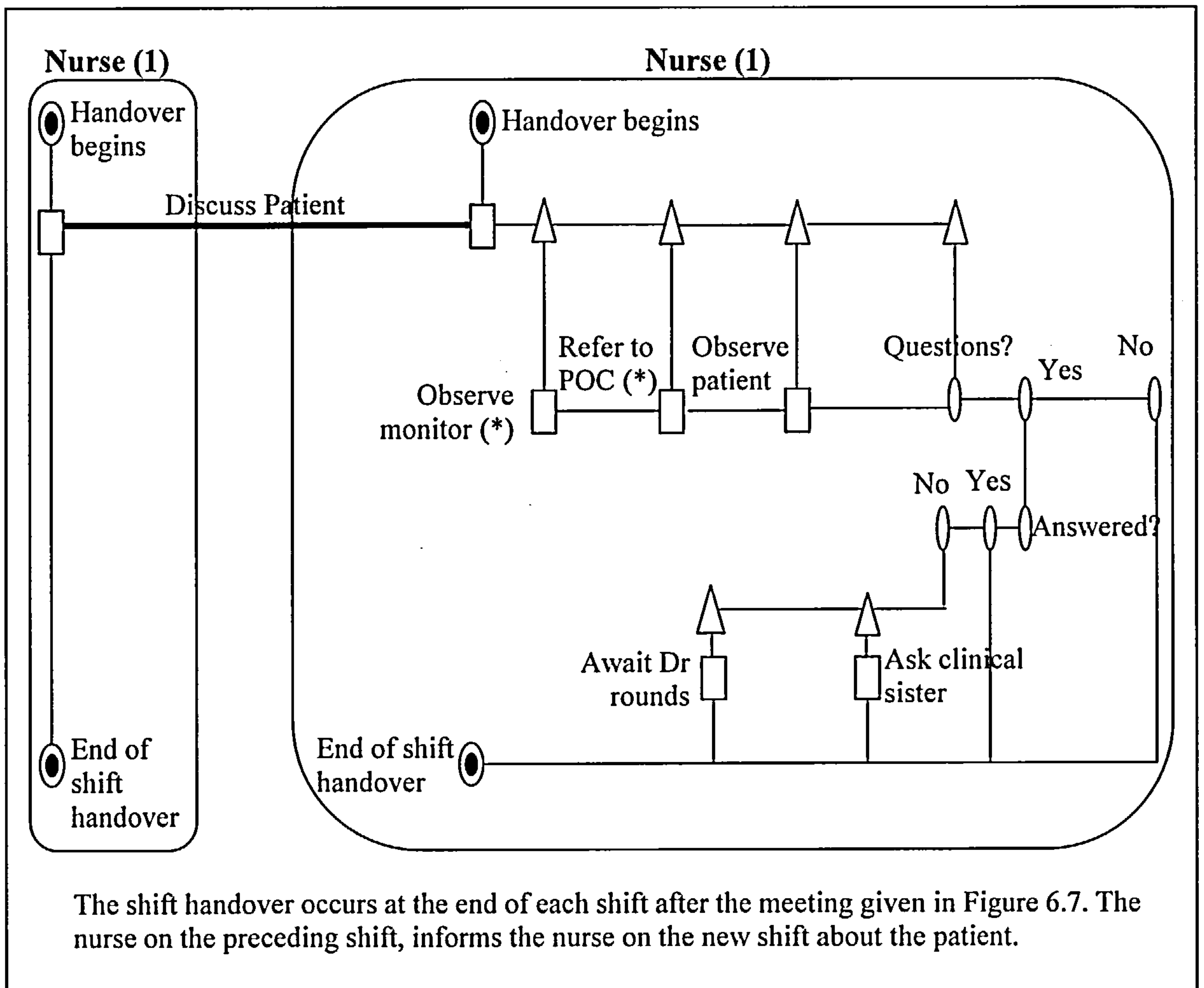


Figure 6.12: Nursing shift handover

Doctors' Meetings and Shift Handovers

A summary of the doctors' meetings and shift handovers for all three sites is given in Table 6.2.

Table 6.2: Summary of doctors meetings and shift handover

<i>Site</i>	Process	Information Processing
<i>A</i>	Consultant in charge leads attending doctors around each patient in ICU.	Use the CIS by the patient bedside to discuss patient and input any data.
<i>C</i> and <i>D</i>	Formal meeting where doctors on previous shift inform doctors on current shift of status of ICU. Patients are delegated between the doctors.	At the meeting, a sheet of paper with patient name and condition is given to each attending doctor. After the meeting doctors read the patient record to familiarise and prepare for the patient.

Although nursing meetings and shift handovers were very similar at all sites, the doctors' meetings differed between the Danish (Sites C and D) and the English (Site A) site. Where the Danish meetings were formal, and conducted in a separate room, the English meetings were less formal and conducted on the ICU by the patients' bedside. A visiting German doctor at Site C was quoted as saying:

"Meetings. You have to go to so many meetings here" (Doctor, Site C).

At both Danish Sites, doctors would meet during the shift handover, and doctors on the previous shift would summarise patient status and conditions. This was similar to the nursing meeting where questions were asked and the ICU status was discussed. All doctors participated in the meetings, and patients were shared out between them.

A sheet of paper with the name and condition of each patient was handed to all attending doctors, who made notes about the patients to be seen. Formal shift handover was not conducted in the same way as for nurses, as the meeting was considered sufficient. For details about a particular patient, the doctors referred to the patient record (see Table 6.3).

At the English site (Site A) formal meetings were not conducted, instead the consultant in charge and the doctors on duty went round each patient and discussed them by the patient bedside. Nurses in charge of the patient sometimes attended, and the clinical Sister would also attend. At the end of this process a doctor examined each patient, as in Figure 6.14.

Patient Preparation for Doctors Rounds

Figure 6.13 depicts the processes of preparing the patient for the doctor's rounds. Nurses at all sites, started their shift approximately an hour before the doctors; during this time the nursing meeting, shift handover, and some tending of the patient was conducted by the nurses. Once the nursing shift handover had occurred, the NoCS would check everything that the NoPS had told them, so the patient was observed, fed, and bathed, and physiological equipment was also inspected.

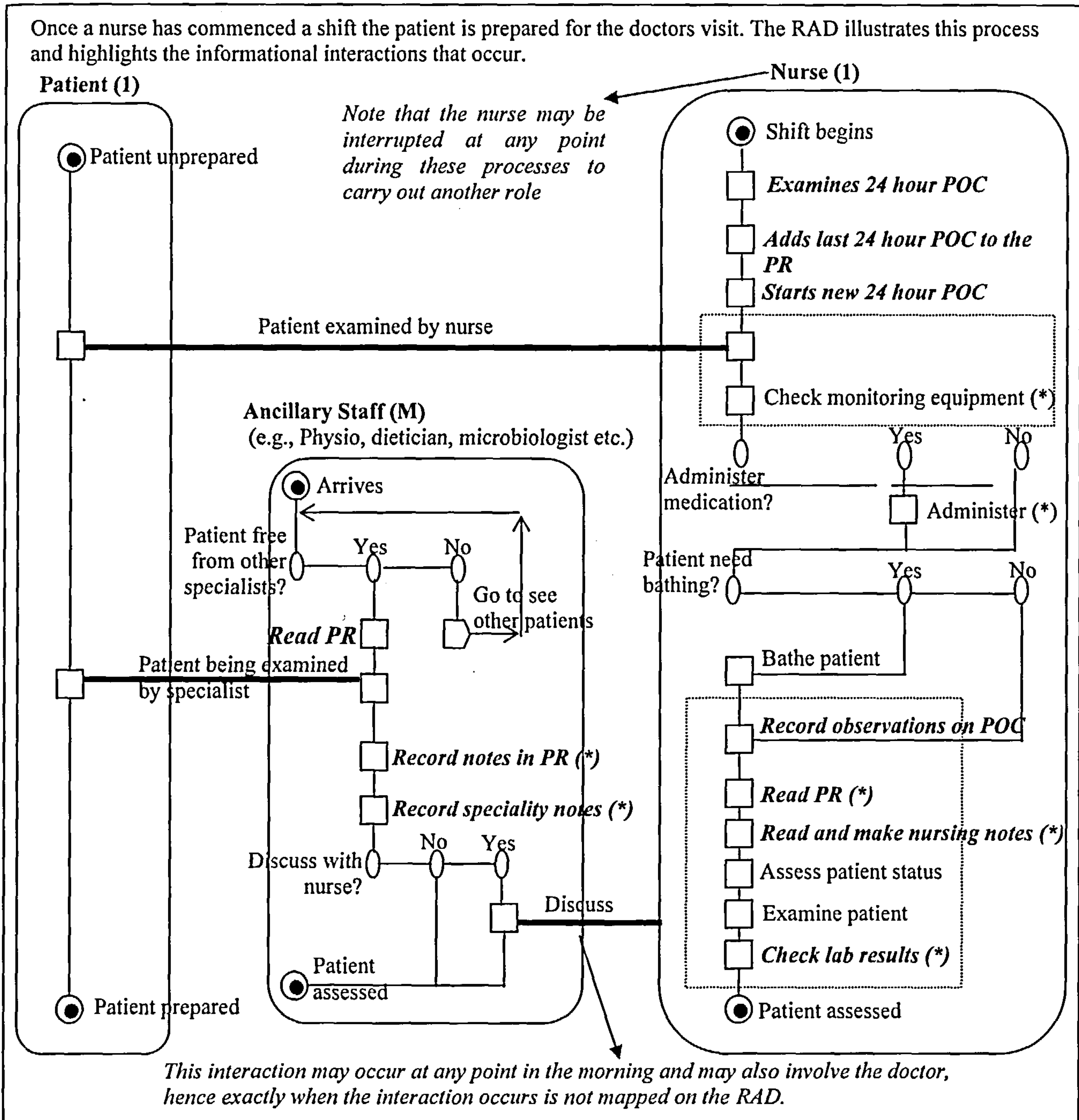


Figure 6.13: Preparing patient for doctors' rounds.

The nurse would constantly refer to the patient observation chart, which was the main source of up-to-date and summarised patient information. For more details the nurses generally referred to the nursing care plan, and the patient record was read occasionally – the patient record was predominantly read by doctors.

A number of ancillary clinical specialists, such as physiotherapists, microbiologists, and dieticians visited the patient at some point during the day. At all sites, they read a summary of the patient in the patient record, and they checked the patient observation chart. However, they mostly used their speciality notes, in which they recorded patient data. They would also write a brief entry about the patient in the patient record. At Site A physiotherapists also used the CIS to write their notes about the patient, as well as having their own notes. At Sites C and D, ancillary staff would write an entry in the patient record, and then complete their own notes. The nurse tending the patient was not always present when ancillary staff checked the patient. However, any information regarded as important was conveyed verbally between the two parties. Doctors may also have been consulted, depending on the situation.

Doctor's Ward Rounds

At Sites C and D, individual patient examinations were conducted after the doctors' meeting had finished, and doctors had read the patient record. In Site A the patient examination was conducted after a preliminary ward round with the consultant in charge. The patient examination was almost identical at each site, and is given in Figure 6.14. The differences between sites occurred at the sub-process level, and are described in Table 6.3.

In Figure 6.14 medical specialist interaction is also recorded. The exact process varied depending upon the speciality – some involved taking the patient off the unit for further tests. For example, in Figure 6.14, the 'take relevant action' entry is expanded in Figure 6.15, where a patient may be required to leave the ICU, e.g., for an MRI scan. The information exchange at this level is very interesting, as it varies depending upon how it is exchanged. Where sites had an electronic CIS that linked the departments, results were available much faster than where one was not available. This implied that it was possible to take more immediate action than if the results were obtained manually at some later time, and might affect overall patient outcome.

Doctors referred mainly to the patient record and the patient observation chart for their information needs; doctors rarely read the nursing notes. The patient

observation chart was the only common form of information that all clinical staff referred to on a regular basis. Table 6.3 describes the sub-processes at the sites.

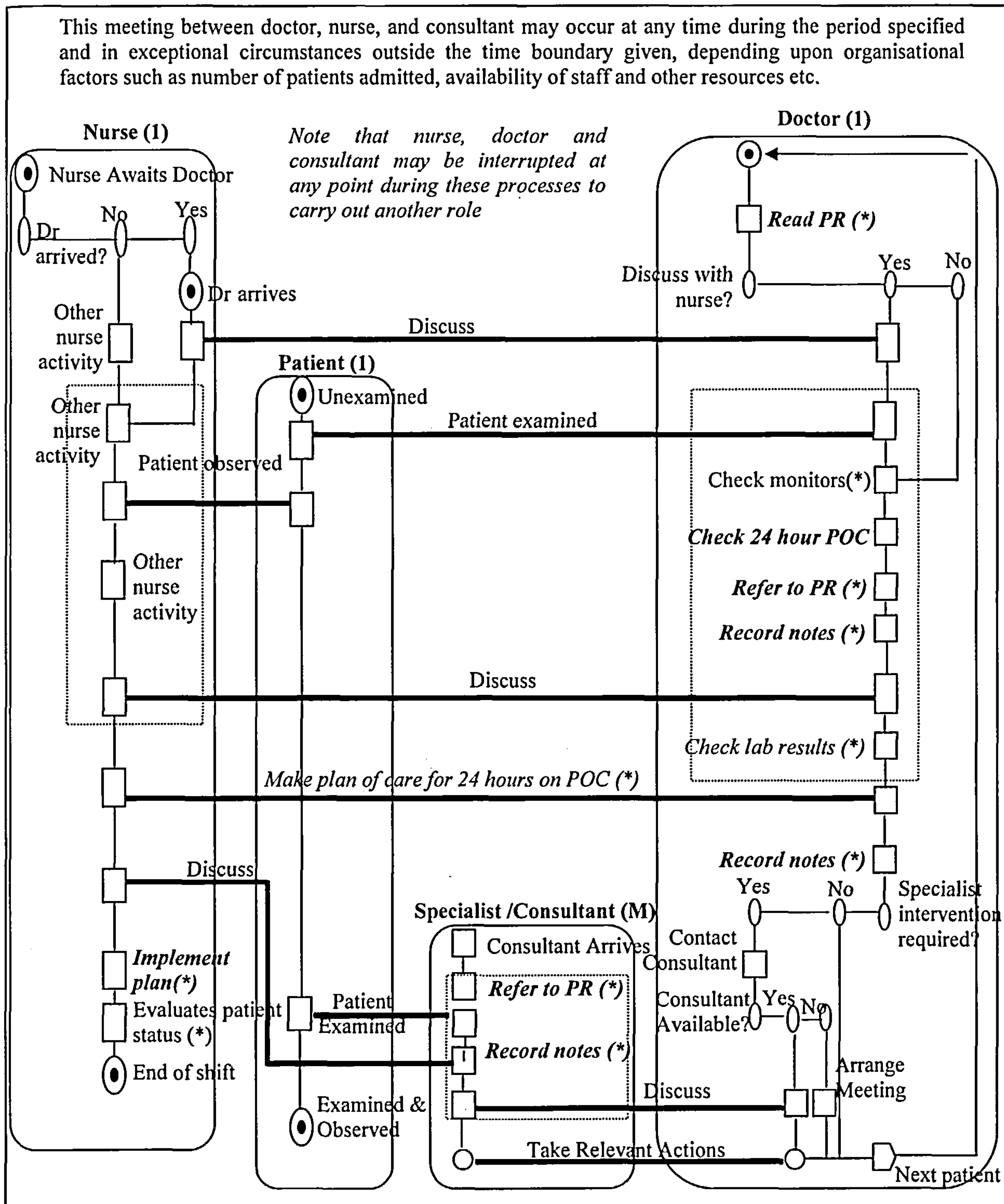
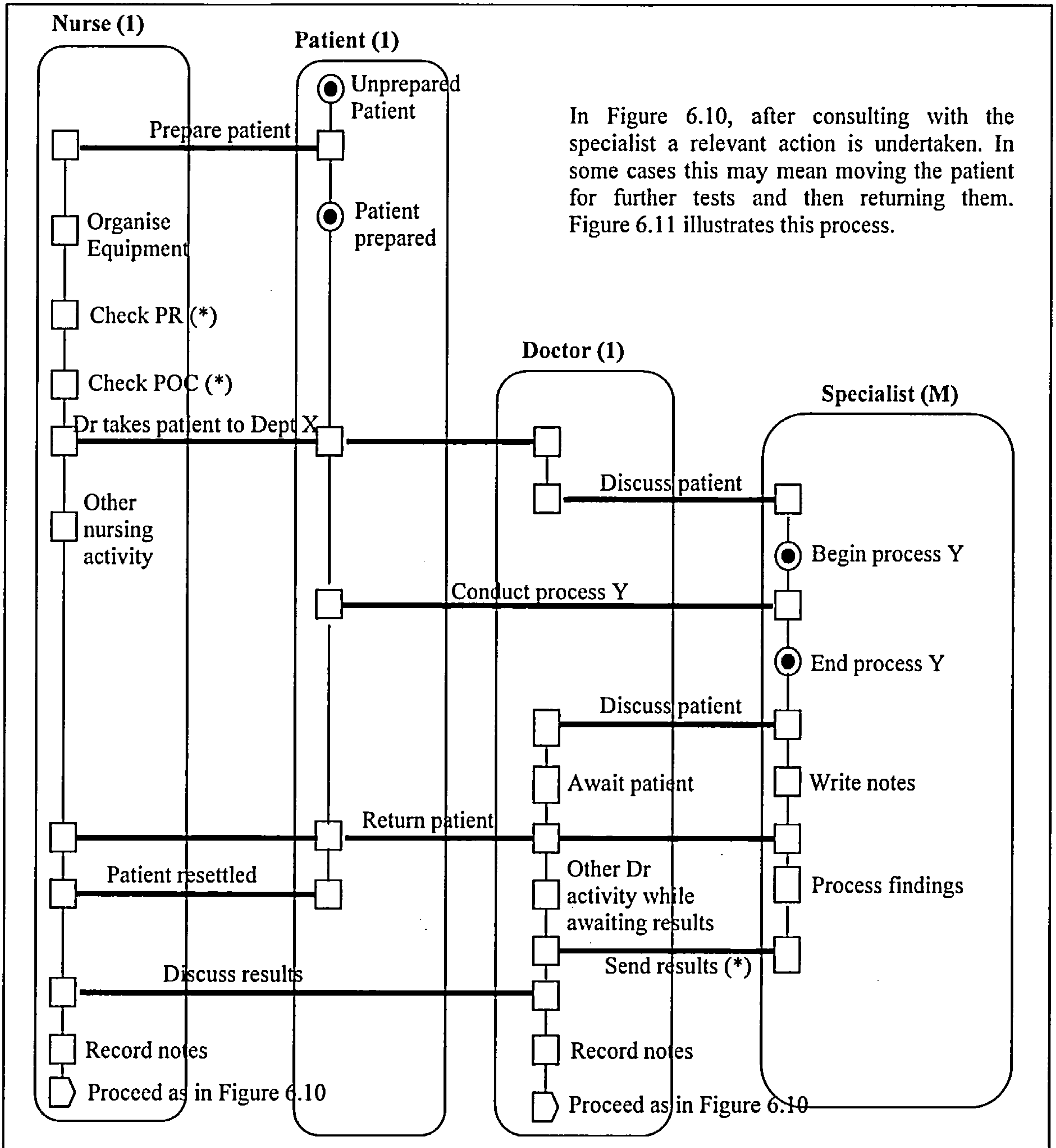


Figure 6.14: Doctors' ward rounds



In Figure 6.10, after consulting with the specialist a relevant action is undertaken. In some cases this may mean moving the patient for further tests and then returning them. Figure 6.11 illustrates this process.

Figure 6.15: Taking patient out of unit for other examination

Table 6.3: Summary of sub-processes at each ICU site.

<i>Sub-process</i>	<i>Site</i>		
	<i>A</i>	<i>C</i>	<i>D</i>
<i>Fig. 6.7: Make Notes</i>	Notes mostly remembered and sometimes written on paper.		
<i>Fig.6.8: Observe Monitor</i>	Physiological data is clearly presented via the CIS. However, the monitoring equipment is also used.	The CIS is used in conjunction with the monitoring equipment, but verbal exchange is preferred.	Monitoring equipment is observed and POC. Verbal exchange is preferred.
<i>Fig. 6.8: Refer to POC</i>	Typed in CIS by nurses. Accessible at the foot of patient bed or the nurses' workstation. Large colour monitors aid visibility. Can access observations for current and past 24 hours only. Observed by all clinicians who may need to see it.	Typed in CIS that replaces OC only. Input by nurses only. Patient plan no longer recorded. Instead, nurses memorise the plan and use their (paper) nursing notes more. Doctors use screen dumps that have increased the size of the patient record, as many computer screens have replaced one chart. Data extracted by management for quality control.	Recorded by hand on an A3 sheet of paper at the foot of patient bed. Observed by all clinicians who need to see it.
<i>Fig.6.9: Ancillary Staff notes recoded in PR and specialty specific notes.</i>	Physiotherapists use the ICU CIS to record their notes, and also record their own notes in paper form. Other ancillary staff do not use the ICU CIS.	Notes are recorded in the paper patient record by hand. Own notes are also recorded on paper.	
<i>Fig.6.9: Check Monitoring Equipment.</i>	As for Fig. 6.7		
<i>Fig.6.9: Administer Medication</i>	All data regarding patient medication is recorded in the ICU CIS. Decision Support is also available via the CIS, where a reference list of medications and dosage is also given.	Paper forms are completed for all medication given to the patient in the 'medicine kitchen' and nursing notes only. The CIS is used for POC records.	Paper forms are completed for all medication used and given to the patient: this is recorded by the 'medication kitchen' as part of an inventory. It is also recorded on separate medication charts and is recorded again on the POC and in the nursing notes.
<i>Fig.6.9: Record observation notes.</i>	As for Fig. 6.8 'record POC notes'.		

<i>Sub-process</i>	<i>Site</i>		
	A	C	D
<i>Fig.6.9: Read and record Patient Record</i>	Typed in the CIS by doctors only. Can be read by all clinicians authorised to do so. One CIS used for POC, PR and nursing notes. Clinical staff do not search for records. Very little paper is visible.	Dictated into an office-based dictation system that allows doctors to record their notes at any time, but only from a central office within the unit. These are then transcribed by a group of secretaries, who also print the notes and place them in the patient record.	Dictated into a hand-held Dictaphone carried by the doctors. Left with the secretaries, who transcribe them (0900-1600 on weekdays only). Often secretaries' desks are full of tapes, which can be scattered anywhere in the office. Notes printed and placed in patient record folder when found! Testing two of the Electronic Health Record Modules is causing problems, as they are not provided with the technical support that they require.
<i>Fig.6.9: Read and record nursing notes</i>	A section in the computer system written and read by nurses only.	Recorded on paper. Written and read by nurses only.	Recorded on paper. Written and read by nurses only.
<i>Fig.6.9: Read and record laboratory results.</i>	Arrive on a separate computer system. printed, and then typed into the ICU CIS.	Arrive on a separate computer system. Copied by hand into relevant notes.	Arrive on a separate computer system. Copied by hand into relevant notes.
<i>Fig.6.10: Evaluate Patient Status</i>	This is conducted using the POC and patient record as well as patient examination.		
<i>Fig.6.10: Refer to patient record and record notes.</i>	As for Fig.6.9, 'Ancillary Staff'		
<i>Fig.6.10: Check monitors/refer to POC/ Record Notes/ check Lab results</i>	As for Fig.6.9		
<i>Fig.6.11: Send Results. Example: Radiology</i>	Manual System. Wait for X-rays to be developed. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.

Discharge/Transfer Patient from ICU

Table 6.4 describes briefly, the information process of patient discharge/transfer.

Table 6.4: Description of patient discharge/transfer process

<i>Site</i>	Discharge/Transfer Process
<i>A</i>	Discharge: A summary of patient details are printed from the CIS and sent to the relevant bodies. However, as the High Dependency Unit is within the ICU, transfer of patient is more complicated, as patient information has to be retyped since the patient is discharged and in a sense, readmitted. A patient who has remained in the ICU will have accumulated much data. This process is also true the other way round. Data is electronically archived onto CD-ROM.
<i>C</i> and <i>D</i>	Details are re-entered on to paper forms and given to the relevant bodies.

Discussion of Work Processes

The RADs are representations of work processes concerning patient care. It becomes apparent that most processes are the same at each site, the only exceptions being those that involve input and extraction of patient information. From the diagrams it is also apparent that the patient care process is heavily dependent upon access to patient information, and that this patient information is obtained from a variety of sources. Although verbal exchange is highly valued in the ICU, other methods of information retrieval and input are essential for informing clinical staff, record keeping, clinical governance, and clinical care pathways, etc.

However the RADs, together with Table 6.3, show that the variety of sources used at each ICU are disparate, and that much information is duplicated. Site A is the only ICU of those observed with a collated system of patient information for the entire ICU. However, their system is unconnected to the rest of the hospital systems and other departments, which means that communication with them is conducted via paper; duplication of data is still unavoidable when dealing with other parts of the hospital, as patient information is re-typed into the ICU CIS.

At Site C it was found that introducing a CIS increased workload and exacerbated the stress on existing work processes. This was particularly true during the implementation phase. At Site C the CIS replaced one sheet of paper, but in turn it generated many. It altered the way in which information was stored and retrieved, and

clinical staff viewed CIS benefit as accruing only to management, since it was implemented to facilitate quality control and resource management.

Nurses and doctors missed the overview and instantaneity of a paper patient observation chart. The fact that the CIS was one of many information input and retrieval systems exacerbated the problem of searching for and the duplication of patient information, which was also visible at Site D.

Links to other departments within a hospital for example between the ICU and radiology, facilitated rapid availability of X-Rays at Sites C and D. At Site A this link was not in place, and so availability of X-Rays was not as immediate. This hindered timely decision-making.

Site A demonstrates that the CIS reduced the amount of paper used in the unit – as all patient information was contained in one system, it could be accessed with little effort from any workstation within the ICU. Yet as Site A could not communicate with other hospital CIS, it was not possible to eliminate paper entirely, and dissatisfaction about this was evident. It is clear that connected systems hospital-wide would eliminate this duplication and enable immediate access to patient information, the motivation behind ‘seamless’ CIS.

In this thesis, seamless CIS refers to:

- A mediating system that enables existing and new systems in ICU and hospitals to communicate and collate information for all clinical staff that need it.
- The development of a new system that is able to contain and allow the retrieval of all patient information required by clinical staff between departments and between hospitals.
- The development of new systems that are compatible with each other regardless of developer or supplier.

The interviews and observations revealed that the notion of seamless CIS within critical care was viewed as mythical by ICU directorates, especially by those that experienced negative interactions with suppliers and software developers. They were quite sceptical of the belief that all information requirements could be fulfilled by an electronic system. Yet at each site, when management approached various suppliers, CIS were sold to clinical staff as magical entities that would improve their work processes in a utopian manner. An illusion of actual usefulness was created, but the reality for users was nearly always very different. A paradox of myth and magic

therefore surrounds CIS. This paradox can be breached if the margin of the definition of magic is moved to include that which produces marvellous results, i.e., the CIS is able to satisfy a majority of users and their requirements.

Site A demonstrates this to some extent, as the CIS reduced the amount of paper used in the unit, and as all patient information was in one system it could be accessed with little effort from any workstation within the ICU. However, while the CIS fulfilled their information needs within the ICU, communication with other hospital departments remained a cause of much frustration. This impresses the urgency for seamless CIS and the significance of system compatibility and adaptability to suit users in complex organisations. These systems do not yet exist, as even at Site A communication with other departments lead to much duplication of information and many printouts from the CIS. Yet seamless CIS have the potential to draw together the diversity of systems within a hospital and even between hospitals.

Section 6.2.1 has emphasised that there is a great need for seamless CIS within healthcare. Although ICU work processes are complicated as they deal with uncertainty and unpredictable workloads, their information processes have the potential to become much simplified with the introduction of seamless CIS, thus creating 'simplified complexity'. Moreover, CIS that do not allow for changes or adaptations, as user needs change and develop will find it increasingly difficult to meet user demands and perpetuate the illusion of mythical and magical CIS. ISIM enables the organisation to examine the 'what' *and* the 'why' of their organisation. Sites C and D have both ignored the 'why' so far. The next sections (6.2.2 and 6.2.3) investigate more closely the two categories of Organisational Culture factors and Actual Usefulness factors that are defined in ISIM.

6.2.2 Organisational Culture Factors

Every Organisational Culture factor given in Figure 6.2 is defined and then discussed in terms of the three ICU sites A, C, and D. Section 6.1.2 described how the Organisational Culture data were arrived so this is not discussed here.

The concept of Organisational Culture as '*how we do things around here*' informed the categorisation of the eight factors (training and education, user knowledge and experience, users, organisational environment, management support, group attitudes, expectations, and CIS integration history) in this category. Note that the features

identified impact upon each other, and are not independent of one another. The order that the features are presented in does not imply any ranking. Some factors are discussed more than others as they were found to be of greater significance. Before discussing each factor, a map of Organisational Culture factors is given in Figure 6.16,

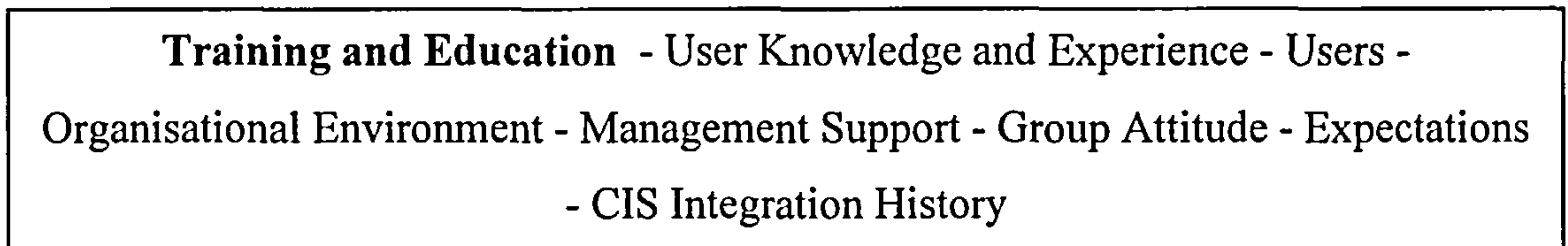


Figure 6.16: A map of the Organisational Culture factors to guide the reader.

to guide the reader. The bold factor in Figure 6.16 is the factor under discussion.

Training and Education

This factor concerns the type and amount of education about a CIS that is given to users, both before they begin to use the CIS, and as the system is changed and maintained. Training and education was found to be a particularly important aspect of Organisational Culture, and therefore it is discussed in greater detail. It also impinges on many of the other Organisational Culture and Actual Usefulness factors, such as leadership and group attitude. Table 6.5 summarises the training process at each ICU.

Table 6.5: Summary of CIS training at each site

<i>Site</i>	Training
<i>A</i>	<ul style="list-style-type: none"> ▪ Head of ICU and Head Nurse given training by CIS supplier. ▪ Training cascaded to all users while they worked. ▪ Full changeover from paper to computer took nine months.
<i>C</i>	<ul style="list-style-type: none"> ▪ One ICU Doctor and three ICU Nurses given training by suppliers. ▪ Invitation to 2, three-hour seminar sessions for nurses and doctors. ▪ Training then given by 3 nurses and 1 doctor to all staff while they worked. ▪ Parallel use of paper and CIS system for three months.
<i>D</i>	<ul style="list-style-type: none"> ▪ Initial training given to Head of ICU, who trained 3 nurses to cascade training down to all ICU nurses.

Site A

Two core leaders provided user support, and taught a team of nine nurses, who cascaded training throughout the unit. The full changeover took place over a period of nine months, during which parallel paper and computer use operated.

“There was also a big teaching initiative to make sure that everybody knew what he or she was doing. When I first started here I was still using paper but we were just moving into the computerised system then. And every member of staff gets training in it anyway.”

(Nurse, Site A)

Cascading training generally involved teaching users while they worked, and this system was still used for newcomers to the ICU:

“New staff get training. The people who it is cascaded down to, they are usually the ones that train people (sister or nurse). I’m not sure exactly what it involves. I presume they have an induction that we have initially, anyway.” (Nurse, Site A)

Cascading training had obvious benefits, such as the fact that nurses were not taken out of the ward, so that patient care interruptions were minimised, and that learning was not ‘brittle’ (i.e., learning was clearly relevant to the job and could be conducted on-the-job):

“You can sit in a room for however many days you want to do it for, but until you actually get here with the patient you won’t know what it’s like. It’s so much easier with the patient there. It’s much easier once they start using it.” (Nurse, Site A)

However, disadvantages to this method of training are also evident. This includes the fact that no extra time is available to practise using the CIS repeatedly, and when problems are encountered there is little or no time to resolve them. This is particularly true in an active environment such as an ICU, as observed at Site C and reported in Site D. For cascaded training to be successful and not a mere ‘Chinese whisper’ exercise, strong and supportive leaders who are prepared to invest time in training and facilitate problem solving are essential, as was demonstrated in Site A.

The use of parallel systems (i.e., both electronic and paper CIS) caused problems during the implementation phase at all sites. In particular, double data-entry exasperated users, confused existing work processes, and hindered learning the new CIS. When CIS training began, the teaching team at Site A also encountered resistance from some nurses, who found parallel operations time-consuming and demanding. However, these problems were overcome, in large part due to strong project leadership, the support mechanisms in place, and the realisation of perceived benefits into actual benefits of the CIS for all users.

A point of frustration at the ICU involved the fact that the CIS was stand-alone and that it was not linked to other hospital departments. As mentioned in the work processes section, the aim of achieving a paperless ICU was hindered only by this factor. Duplication of data regarding other areas of the hospital is still a problem.

The CIS was continuously evolving as it was improved and maintained by the suppliers, often in response to feedback from users at Site A, who were encouraged to suggest changes to the system, and report problems. Where these changes affected the way in which users interacted with the system, training was still cascaded through the unit from the leaders.

While nurses adapted to the CIS fairly rapidly, doctors still had to be strongly encouraged to use it:

“Doctors don’t put in as much stuff as they should and they don’t update, only when they are pushed. I think it is all the sections, with the paper notes they could just continue writing.”

(Nurse, Site A)

“I think the doctors would all like to blow it up and go back to paper.” (Nurse, Site A)

During training, checking for errors and mistakes by users is essential. At Site A this role was conducted by two project leaders, who were also clinical staff. This was an extremely time-consuming responsibility, and had the project leaders not been diligent and involved this task, it would not have been conducted. The leaders would check the system for inconsistencies and errors, and would follow-up users who had not used it correctly, or not at all, and would support users as they used the system. This was far beyond their chief roles as clinical staff members, and was not one that was budgeted for. An audit trail on the paper record was reported as being impossible.

The success of the system is related to how the project was lead and managed by two very enthusiastic leaders at the ICU. Whether or not this continues once these leaders are no longer able to manage the system and provide user support remains to be seen.

Site C

The computer system introduced at Site C replaced only the paper 24-hour observation sheet, and was implemented primarily for better management and use of data. When the system was introduced, all users were invited to a three-hour session showing them how to use the system. Attendees were mostly nurses, and only half of the doctors were present. Both nurses and doctors were very unimpressed with the training:

“We had one educator, she couldn’t go round and talk to all of them, so the way she did it was, this icon you can do this and blah blah blah, but none of the nurses were shown how to use it. So they were all yelling about it afterwards. So a few weeks later they took us down and gave us a case. It was much better, but not enough.” (Nurse, Site C)

“We could have some cases we could work on in the PDM instead of just having 3 hours of introduction. Which is really only an introduction. The rest we have to do it ourselves.”

(Doctor, Site C)

The trainers themselves also found that this method was unsuitable:

“They (nurses) would like to have more training, several days away from the unit because you can’t take care of the patient at the same time. It is not good nursing for nurses to have training on the unit.

“I think that nurses need more time without the patient. They would have more success with it if I could have four nurses for four hours...” (Nurse and CIS educator, Site C)

At this site, as at Site D, nurses would ideally have liked to be able to receive training away from the unit and the patient. They would have liked hands-on training where they could work with mock cases.

“It takes time putting it into such a big department with so many people and so little introduction. That is really too little. We could have some cases we could work on in the PDM instead of just having three hours of introduction, which is really only an introduction. The rest of it you have to do it yourself, which is not okay, you have to be better prepared, I think.”

(Doctor, Site C)

The implementation was also plagued with technical delays, and training was given a month before the system actually became operational, so that when it was introduced, staff claimed to have forgotten how to use the system:

“When we were introduced to the PDM we went home and it came in the ward three weeks later. So we had forgotten all about it. When we started up with it all the hardware didn’t work and we didn’t know what to do about it.” (Nurse, Site C)

Although the system was implemented in parallel to the paper system three months prior to full changeover, the CIS was ignored during this time. Once the paper observation sheets were phased out staff were left with no choice but to learn how to use the system by trial and error, but no further training was provided, although at least one trainer could always be contacted. However, a shortage of nursing staff meant that remaining focussed on the job of training was difficult:

“It is frustrating, because everyday I come in and say today I am a PDM person. Today I came in at 8 am and the first thing I was told to do was to help with the nursing. I have to find the time to teach them because they think I am a nurse everyday and want me to help with the nursing. I have to tell them that I can’t but they say how miserable they all are. So I help.”

(Nurse and CIS educator, Site C)

This resulted in many problems. Users were spending at least twice as long with the CIS than they had with the paper observation sheet, and nurses were waiting until the end of a shift, or until they had a spare moment, before they completed details on the computer. Nurses complained that staff from other shifts were not completing details as

they should, so they had to complete entries for others. They felt this was too much for them.

Site D

An implementer was employed who was responsible for the introduction of the EHR in the entire hospital. Prior to this study, a questionnaire had been sent out to ascertain the levels of computer literacy across the hospital, so that training could be organised accordingly. Of the 1,000 staff at this hospital, 300 had never used a computer. Teaching was underway, so that all staff had basic computer literacy, such as using spreadsheet and word-processing packages. The training plan involved pulling out a few users from different wards to avoid having to close down any individual ward; these users would then cascade the training in their unit by showing other staff how to use the system while they worked.

Although this sounds ideal for an ICU, it actually meant that the unit had to operate with fewer nurses for a time. The fact that the unit was having difficulties in retaining nurses and was under-staffed exacerbated the problem. One Intensivist was responsible for training three nurses at the ICU, and they then cascaded training down to other users. However, they found it difficult to obtain adequate support when problems arose. A help-line number for the EHR support team was available, but was considered useless:

“The IT support group is not very good. We have a number we can call, but no one answers it. There is a lack of ownership of responsibility; clinicians do not know who they may approach”.

(Consultant and CIS leader, Site D)

As the implementation had been subject to both political and technical delays, users were quite sceptical about it, but were generally willing to give it a go. This had more to do with the Organisational Culture of the unit than the pragmatics of having to use the system. There were strong concerns about losing the overview of patient data that the paper observation sheet had enabled:

“I won’t use it if I lose the overview.”(Nurse, Site D)

Training staff was also viewed as problematic:

“We have to push new technology with no help. We have to spend within the budget or we get less money next time round. I feel that if they were trained they would use the computer systems much more, they would feel more valued and morale would lift. It is an investment that would reap many benefits, but instead we get 0% on training.” **(Consultant and CIS leader, Site D)**

Much of this exasperation was expressed about a prior system that failed to be integrated in the unit, as nursing staff were not adequately trained and had to learn on the job; similar fears were arising about the Danish EHR.

Interruptions during training on-the-job, where nurses were constantly called away to either tend to their patient or help other staff, were also quite frequent. It was therefore not surprising that there were significant concerns about learning to use the system whilst caring for the patient, and losing time with the patient:

“At the same time they have to look after very complex patients, so they don’t always have the time to learn new things. I think that was the reason why many people are not positive.”

(Nurse, Site C)

When asked how they would like to be trained, most nurses and doctors wanted to have a few hours with the CIS and no patient, so that they could interact with the CIS; however this was not an option:

“It’s difficult. When I arrived here we got this PDA [Personal Digital Assistant] system and there were a few technical problems, and then someone said that you have to get acquainted to getting used to it. I found it rather difficult to just find the time and sit with it. So it took longer than it would have done than if we had more time and it wasn’t on the job.” (Doctor, Site D)

Overall

ICUs have a high turnover of clinical staff, and shortages of specialised ICU nursing staff are evident. Thus training is considerably more difficult, and teaching away from the ICU becomes particularly impractical. In addition, each new member of staff must be taught how to use the system. Furthermore, the ICU is rife with interruptions and distractions, which also makes on-the-job training difficult. Despite this, Site A succeeded with its implementation, and their CIS was integrated into the ICU and was well-used and liked, at least by the nurses.

Sites A and D both cascaded their training, whereas Site C did not, instead diverting three nurses and a doctor from healthcare to training. This was not as successful, and suggests that cascading training may be a better method depending on leadership, and the availability of experienced users who can be asked for help. However, it must be noted that both Sites A and D are much smaller than Site C, and it is not known whether or not cascading training would scale suitably.

At Site D, where CIS projects were ICU specific, positive outcomes were more readily visible. This system broke down at Site D once CIS project ownership and leadership extended beyond the ICU. For example, the EPR project was at county level;

although the Clinical Director was personally involved with training his staff, he did not have ultimate ownership or leadership of the project as in Site A.

User involvement and adequate feedback mechanisms were also essential. As user suggestions were considered at Site A, and users observed those suggestions being implemented, this lifted staff morale. However, this was not true at Site C. User attitude to training also proved to be a problem at Site C. Training programs were provided for all staff, but few doctors attended them, so the burden on nursing staff increased since they had to use the CIS on behalf of doctors.

“We had two days, about fourteen hours. When we were introduced to the PDM we went home and it came in the ward three weeks later. So we had forgotten all about it. When we started up with it all the hardware didn’t work and we didn’t know what to do about it.” (Nurse, Site C)

“Most of them are willing to learn and some of them have a block, they can’t learn because they think it is a stupid program, they are frustrated because they have to do the work around the patient. They also have to write everything down and at the same time have to learn how to use the system, which they don’t think is logical.” (Nurse (trainer), Site C)

Finally, it is important that the financial costs of training and education are included in the budget, not just initially, but throughout the lifetime of the CIS. This is often ignored. However, at Site C, as the effects of inadequate training became more obvious, the importance of training became clearer:

“If we don’t teach people good enough then they become frustrated and won’t like it.”
(EPR Module Leader, Site C)

<p>Training and Education - User Knowledge and Experience - Users - Organisational Environment - Management Support - Group Attitude - Expectations - CIS Integration History</p>
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Figure 6.16: A map of the Organisational Culture factors to guide the reader.

User Knowledge and Experience

This factor is concerned with how prior user knowledge and experience can affect CIS integration. This includes a wide variety of different facets, including previous CIS experience, IT competence, confidence in clinical procedures, and tacit knowledge.

It seems at first sight that prior IT experience would have a purely positive affect on CIS acceptance, and this is true in most cases:

“I think it was excellent. I have worked with computers before, after I had worked as a nurse I took a break in it and worked with computers for some years and then got back to nursing, so I had some experience with that kind of work.” (Nurse, Site C)

“But of course we are familiar with computers and windows and things in other settings so it is not new to us in every way, but it is a very different way of working (thinking?)”

(Doctor, Site D)

However on occasion, prior knowledge of one type of system can impede the use of a different type of system, as they raise false expectations and require more learning on the part of the user; for example, experience of using Windows-based systems is not necessarily beneficial for using Unix-based systems.

Where users do not have any IT experience, it can be a particular problem, especially among older staff, who often display some form of technophobia, and fear that it will take them longer to learn to use the system, because they also have to learn to use the computer itself:

“It would take some time for the skills to develop. It would take a lot of the time that we don’t really have if you are busy with other things.” (Doctor, Site D)

This lack of experience of IT systems was dealt with at Site D by their questionnaire about computer literacy, and subsequent training scheme. This seems to be a useful precursor to the introduction of any IT system.

Another very important facet of user experience ties in to Group Attitude and CIS Integration History. Users who have had negative experiences of previous CIS introductions will be much more resistant to change than those who have never used a previous system, or have had positive experiences:

“I had used a different system when I had worked in the south of England as a Midwife. I had used a system that was introduced then for obstetrics and gynaecology. So I have been using a computer system, for patient care, since about 1991/92.” (Nurse, Site A)

Evidence of confidence in clinical work can also positively affect how a system is used:

“I’ve worked in intensive care for eighteen years, I’ve worked in lots of different areas. I do have more experience and if you’re a bit more competent in practice it does makes life easier.”

(Nurse, Site A)

A principal reason for introducing a CIS is to help the users. Yet often their knowledge and experience is left as a huge untapped resource of tacit knowledge. This can aid in the selection of a suitable system, as here at Site C:

“This is not the most appropriate system for us. I have worked in other hospitals and know of other systems that are much better.” (Doctor, Site C)

It can also be useful for improving the system after implementation. At Site A this type of information is taken into account, and there are informal feedback procedures for all members of the ICU:

“Well, usually it is them telling us that we would like this, and that so we ring them and say can we have blah de blah de blah, and the system people will say fine, it might take one or two days.” (Doctor, Site A).

Training and Education - User Knowledge and Experience - Users -
 Organisational Environment - Management Support - Group Attitude -
 Expectations - CIS Integration History

Figure 6.16: A map of the Organisational Culture factors to guide the reader.

Users

Identifying the users of the system is essential. This may be an obvious point, but in reality it is often overlooked. In particular, nurses' needs often seem to be ignored; while doctors are often included in any plans, the input of nurses is not considered. An exception to this is the successful system at Site A:

“It was developed by the software people, and two intensive care nurses, which we thought was ideal. They demonstrated the system to us with a very thorough knowledge of ICU requirements. We felt that that was very helpful. The two nurses had a lot of input into that design. The development people and the ICU nurses were employed by the company.”

(Clinical Sister, Site A)

It is also important to identify benefits of using the system for primary users. In Site C the primary beneficiaries of the system were management, who received more data for quality control and resource management. The actual users, nurses and doctors, did not gain any benefit in terms of work processes from using the system, as it replaced only one paper chart, and altered a very simple method of data input and output to one that was much more complex. This was particularly true for nurses, since they also had to mediate between the CIS and the doctors, who refused to use the system.

An ICU houses many different specialities of clinical staff. The two most prominent groups are nurses and doctors, and these groups have very different needs and demands relating to patient information. The challenge arrives when these differences have to be reconciled for optimal CIS use. In the CIS at Site A, areas for both doctor and nursing notes were available, so that nurses could still use the system for their own notes, even if the doctors did not use it. In addition, because all patient

data was available from the system, including the patient record, all users had to interact with the system in order to use patient information. However, at Site C the system replaced a charting system that was used by both groups, and so it was much more difficult for nurses to use the system without physician input. At Site D the nurses did not feel particularly involved in the system, but did feel that they had to get on and use it:

“The other way round say there is something I would like to use but it is not here it is not part of the daily life so it would not be possible. So my influence on that part would be very small. You have to take what is there and use it I think.” (Nurse, Site D)

Overall, it seems that nurses are the mainstay of any CIS. If they do not like a system they will ignore it as far as possible, as at Site C. However, once they are involved and are happy with a system they will use it well, even taking on extra work to make up for the fact that doctors try to avoid using the system:

“Right now the doctors aren’t using the computer, only a few of them really know it.”

(Nurse, Site C)

“I hope they do [use the system] because we have too much to do here. We can’t do their typing and clicking for them.” (Nurse, Site C)

<p>Training and Education - User Knowledge and Experience - Users - Organisational Environment - Management Support - Group Attitude - Expectations - CIS Integration History</p>
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Figure 6.16: A map of the Organisational Culture factors to guide the reader.

Organisational Environment

This feature describes the working environment of the CIS, including staffing levels, type of work, and resource levels. All three sites were all under-staffed, under-resourced and had a high turnover of staff. A shortage of skilled ICU nurses, and low retention rates is apparent:

“We can’t get substitutes from other areas of the hospital because the nursing skills are so specialised for the ICU. So we have to make do without, i.e., the available nurses have to do extra shifts to make up for those who are off. A 1 nurse to 2 patients ratio is quite common in other hospitals.” (Doctor, Site A)

“We have enormous problems recruiting nurses to the ICU and that is really something. Seeing how often nurses are on call I am very sad about that. I think that more and more of the nurses are dropping out and doing other things.” (Doctor, Site D)

Nurses believed that they were forever teaching new staff, and the high turnover meant obtaining passwords was problematic – some nurses commented that obtaining passwords took a long time, with staff leaving before they obtained one. Until they had a password, other nurses were having to log in for them, which has ethico-legal implications, particularly in light of the current culture of litigation:

“There are a lot of legal problems now, if you sneeze near the patient they immediately want to sue you for this, that, and the other. The legal people of this department love it [the CIS], because all they have to do is just go in here and print it all out” (Clinical Director, Site A)

The ICU environment is also seen as being both physically and emotionally demanding, as well as being very unpredictable:

“You have to be an extrovert personality to survive in this environment, as it is both physically and emotionally demanding. You have to be able to stand up for yourself.”

(Clinical Director, Site A)

“It is a good mix, sometimes you have too work very fast and sometime it is slow and you have time to joke with your colleagues. I like that it is not the same every day.” (Doctor, Site C)

Planning for patients in an ICU is not possible, as in other hospital departments, since the type and severity of patient illness can vary considerably. Clinical staff need to be able to react quickly, and time is often at a premium. A CIS that impedes this is unwelcome:

“If it takes too much time to get all the necessary information I would hate it, to have more work when we are so busy out there. If it takes more time I will get furious, it is not using the system or the computer itself, but not getting the information that we need crucially.” (Doctor, Site C)

“I think that sometimes it can be a problem when you don’t have the time. I hate when I don’t have the time and I have to hurry and I have to talk with the patient but it isn’t good enough. Then you lose responsibility to finish anything and are asked to be everywhere. You have more problems than you can solve. Of course situations like that are always occurring in this field but it is a challenge. I don’t like the feeling of not being on top of it.” (Doctor, Site D)

The information needs of an ICU are also very important; ready access to data from a wide variety of sources is essential:

“Dr X is the man of the EPJ. He has been asked a lot. He has spent a lot of time with the manufacturers, programmers and things like that. Okay they have listened to what he says, but we have special demands here at the ICU and it’s not in the package, so they won’t fulfil.”

(Clinical Director, Site D)

ICUs are under increasing pressures to perform within budget and to reduce mortality rates, yet the type of patient ICUs deal with has changed over time as physiological and surgical equipment have advanced. ICUs are now able to treat patients with more severe

conditions than in the past, which means that a greater number of this category of patient is being admitted. This means that mortality rates are not necessarily reduced, despite the improvements in care. A CIS that will further distract and impede patient care will not be received positively.

The issue of where a CIS is placed is also significant. In Site A the CIS was procured as part of complete ICU renovation, so the layout was completely changed, with a central workstation for clinical staff so that all ICU beds could be observed, as well as a terminal at the foot of each bed dedicated to that bed. In Site C the computer terminals were placed at the head of the bed, meaning that users had their back to the patient when they were interacting with the CIS, and this meant that nurses would tend to use the CIS at the end of the shift when the new shift nurse would be able to observe the patient, or when another member of clinical staff was present.

Training and Education - User Knowledge and Experience - Users -
 Organisational Environment - **Management Support** - Group Attitude -
 Expectations - CIS Integration History

Figure 6.16: A map of the Organisational Culture factors to guide the reader.

Management Support

Two types of management support were identified at the ICU sites, both are very important – the direct management of the ICU i.e., a clinical director, and hospital management, who control resource allocation.

Although capital for CIS investment is obtained from hospital-level management, it is direct-level leadership that primarily influences CIS use once the system has been purchased. At Sites A and D direct leadership was outstanding – the clinical directors would go beyond their duties as clinical care providers and take full responsibility for the systems in their ICU. However, this should not be expected of clinical staff, as the role of project leader is not budgeted for. At these two sites CIS projects were considered a team effort, and the leaders would provide as much support to staff as they could. Both leaders were committed to, and motivated by, the CIS. However, at Site D, resources were a huge problem, and one area in which the clinical director could not support his staff, since it was beyond his control. The effects of under-investment were visible when considering teaching the CIS to staff – although

staff were very motivated and driven by challenges more resources may have enabled more satisfactory CIS results.

At Site C, this responsibility for the CIS was in effect delegated to an ICU consultant and three ICU nurses, who did not have the seniority to manage the implementation. The decision to implement the system came from higher up the management structure, but the actual task of implementing the system and training all the users was passed down to the four members of the ICU. In effect, the clinical director remained disconnected from the actual support and training that was essential to boost staff morale. Furthermore, ICU staff felt they were being forced to use the system by senior management, without any of their opinions being taken into account:

“You have to use it you have to. That’s it, if you don’t want to use it then you can’t stay here, that’s it. That is a decision they have made.” (Nurse, Site C)

The extent to which the size of the ICU affects this is unclear. Both Sites A and D had dynamic leaders who invested much time and effort into integrating the CIS, but both of these ICUs were also small. Whether a small number of people leading from the top could have the same effect in a larger ICU remains to be seen.

At Site A the clinical director took responsibility for the CIS and was the main decision maker regarding its procurement:

“I wanted the computer system because I think that paper notes are very space occupying, once they are on computer you can download them on to disk, and we have the notes permanently on the disk because very often paper notes go missing any way.” (Clinical Director, Site A)

“They [the doctors] said you’re the director if you want it you have it, but I said no, no I want to listen to your opinion. They said yes by and large.” (Clinical Director, Site A)

She also convinced senior management that it was worth the investment:

“Management first of all were very enthusiastic when I described it to them, then they had cold feet and said ‘oh, that’s a lot more money’, but eventually after some minor kaffuffles, they said ‘well there is no way you can go on writing all those notes’. We were having a new unit, you see, and we were going to buy all the monitors and equipment, and so in the end they did agree and suddenly they became all enthusiastic. By and large they are still supportive.”

(Clinical Director, Site A)

Finally, she took full responsibility for cascading the training to all users, auditing inputs to the system and being available for questions on a 24-hour basis while the system was introduced. One thing that they had not foreseen however was the amount of time, money and effort required to keep the CIS operational even after the CIS had been integrated:

“I think one of the biggest things is time, it takes time to maintain, like everything else it has to be maintained. You have to take data off it so that you have got space for the next patient coming along, so you’ve got to archive material. You have to check everything every day to make sure that it is okay. And that’s a time issue that was never budgeted for, we were given capital to fund it but there was no revenue, so that’s got to be done by us. In retrospect we would put a bid in for some body’s time to do that.” (Clinical Sister, Site A)

At Site D, as at Site C, the decision to introduce a CIS was taken by senior management, but it was left to the ICU leaders to implement the system. However, the Clinical Director was involved in the design of a module of the EPR, although he says that the needs of an ICU are not being taken into account:

“Dr X is the man of the EPJ [Danish EHR]. He has been asked a lot. He has spent a lot of time with the manufacturers, programmers and things like that. Okay, they have listened to what he says, but we have special demands here at the ICU and it’s not in the package, so they won’t fulfil.” (Clinical Director, Site D)

These problems are exacerbated by the fact that different suppliers are developing each module of the EHR. Therefore when problems occurred, users did not know who could help them. Although direct ICU management support was high, no one person had the time to provide support:

“The IT support group is not very good. We have a number we can call but no one answers it. There is lack of ownership of responsibility; clinicians do not know who they may approach.” (Clinical Director, Site D)

The unit also had problems with senior management, who did not support them in the development and implementation of the system:

“One could say that economical resources are very scarce to do these things. So you have to take time to do these developments and take the resources from patient care. I don’t think the management is that supportive in that manner. They have, I must admit, made some allowances that introducing the EPR could mean that our production goes down in a period.” (Clinical Director, Site D)

<p>Training and Education - User Knowledge and Experience - Users - Organisational Environment - Management Support - Group Attitude - Expectations - CIS Integration History</p>
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Figure 6.16: A map of the Organisational Culture factors to guide the reader.

Group Attitude

Group attitude concerns the attitude of individuals within the ICU towards CIS, as well as the group attitude that emerges from this. In all sites, a tug of war between nurses and

doctors was evident. This is where strong leadership can make a huge difference. At all sites, nurses were the predominant users of the system, yet it was designed for doctors and nurses, as well as other healthcare professionals. This created tension amongst nurses, as they felt that doctors should use the system too:

“We can’t do their typing and clicking for them.” (Nurse, Site C)

At Site A the clinical director made a point of following up those users, particularly doctors, who made sparse or no notes in the CIS. The nurses knew this and although they knew that this attitude change would take time, they also knew that the clinical director was supporting them, even though the problem was significant:

“If you had a consultant who came up here now, a consultant in medicine, a lot of them don’t record what they should in the system. That’s unfair, some do, but a vast majority of them don’t and won’t. They will just write it in their medical notes. Really it should all be entered into the computer system. We do our best and ask them to but they just say ‘no I won’t’.”

(Nurse, Site A)

At Site C this was not evident. Doctors felt that writing notes by hand was not something that they had to learn, and so it was less time-consuming compared to using the electronic CIS. They constantly referred to lack of time as a reason for not using CIS; this is further illustrated by the fact that many did not even turn up to training sessions:

“It is different from doctor to doctor. I think in the beginning they didn’t take any notice of it, all the nurses have been on the training for three hours. All the doctors were invited too but no more than half turned up. But they have to learn it now because it is the only way to get information now. Some of them, are positive but there are many who are not.” (Nurse, Site C)

Doctors are short of time; they have to manage many patients compared to nurses who mostly look after one.

Users that do not use the system can discourage those who do want to use it, as they have to correct colleague’s inputs, and input data for those who would not use the system:

“If I have to finish notes for lazy staff, If I have to log in and out, it all takes a long time.”
(Nurse, Site C)

By engaging those members of the ICU that are respected by others, they can act as delegates, rather than send negative signals about the system if they do not like it. In general, if the nurses can be encouraged to use the system, the likelihood of successful integration is much increased. This happened at Site A:

“The nurses here are very keen, they will say ‘oh, okay, we’ll give it a go’.”

(Clinical Director, Site A)

This is not to say that all nurses are positive about a new CIS. For example, at Site A, one nurse in particular was able to control how others used the CIS when it was first implemented. This nurse was in a position of authority and was very technophobic, and did not trust the computer system:

“It took us a long time to get it up and running because the staff sister then was very frightened of it, while opening her mouth and saying what a good idea, inside she was very frightened and she made them write paper notes all the time. These big sheets in which they wrote down all the pulses all the blood pressures, in case this didn’t record it on to it.” **(Clinical Director, Site A)**

Others were willing to try the system, even though they believed that they would not like it:

“I remember one of them said well I will use it as long as you want me to but I have to warn you that I am going to have all these post-it notes stuck all over the monitor... I don’t know if she still does but she did have a lot of post-it notes. She couldn’t stand not having paper.”

(Clinical Director, Site A)

“I will do my work as before. But I don’t know if I will be able to do things as fast if I can’t find the information.” **(Nurse, Site C)**

Common to all sites was the preference for verbal communication despite the fact that the CIS contained all the information that they could need, especially in the shift handover meetings:

“Sometimes it’s just pure laziness, people ask you what you think, what have you done about that. There are a lot of things that we communicate verbally. But generally speaking you could get just about everything out of the CIS.” **(Nurse, Site A)**

Sites A and D both had a positive attitude towards new ways of working and experimentation; at Site D they wanted their ICU to be the best in the county. These sites were also less bureaucratic than Site C in terms of relating to other staff. Sites A and D were much less formal. Again this could be related to the fact that these sites were much smaller and hence less complicated to manage, with everybody knowing everybody else:

“If you want to go for something then they say just go for it. It is more like a family department. It is a good atmosphere.” **(Nurse, Site D)**

This friendly environment has the benefit that those struggling have plenty of people to turn to for help, and that help is readily given. This means that cascading learning through the ICU is a practical proposition:

“It is allowed to ask and always to say I can’t manage this and nobody will look down on you if you ask for help. There will always be help.” **(Nurse, Site D)**

Training and Education - User Knowledge and Experience - Users -
 Organisational Environment - Management Support - Group Attitude -
Expectations - CIS Integration History

Figure 6.16: A map of the Organisational Culture factors to guide the reader.

Expectations

The differing expectations of different groups of users can also radically affect CIS integration. These expectations can be concerned with what the system will provide and how much effort will be involved in achieving those benefits. Of particular importance for CIS integration is a balance between user expectations and management expectations. This was seen at site C, where hospital management introduced the system so that they could make better use of collected data; the users saw themselves as a tool for inputting the data. Nurses and doctors could not see the benefit as it only replaced a single paper chart, and increased the size of the paper patient records two-fold due to printouts, significantly increasing the time taken to gain an overview of patient status.

Staff could therefore not perceive how it could possibly benefit them. All they saw was the parallel entry, which was increasing their workload, rather than decreasing it. Doctors tried to avoid using it, and relied on the nurses for their information. The patient record doubled in size due to all the printouts that they now needed to gain the same overview they previously attained from one sheet of paper.

At Site A nearly all of those interviewed believed that the CIS was much better than their expectations, finding the system both effective and easy to use:

“I think that my expectations were less than I’ve got. I was heavily surprised... I was extremely pleased with it. I’m still extremely pleased with it and I think it works for us. It is beginning to work better for us than I hoped.” (Nurse, Site A)

Users at Site C expected the CIS to integrate all the patient information in the ICU and to save time, but this did not happen; these expectations were unrealistic as the primary purpose of the system was to facilitate management decisions. Site D was still waiting to implement the EHR, and they had very positive expectations of the system, such as improved data quality, better archiving, no longer having missing notes, and having all patient information accessible via one system:

“I think it could improve the quality of the data being at hand for the people who are making decisions and not as now. Decision-makers are often without the correct data for these decisions.

It could help that. It could remove the problem about the journal [patient record] not being beside the patient.” (Doctor, Site D)

“I think it is the future and I don’t think we can go out from that. We need to have possibility to look through data and compare it. That is very difficult to do when you use paper work. But when you have a computer to do a lot of the work for you then, you can use it. But from now, maybe two three years from now we will have a use from it.” (Nurse, Site D)

However, they also had some negative expectations:

“I think computers are a necessary and obvious step but I of course have the concern, I get the impression, many shared concerns about reliability and the stableness and the speed of the system. Everything depends on that the computer system works and that everything is available on the system and that is a reliable system so we don’t find ourselves missing data because the system is down. That in many senses would be simply unacceptable.” (Doctor, Site D)

“I think you might lose time with the patient because you are going to sit by the computer to input the information. It is a problem. So you have to be careful not to lose the contact with the patient.” (Doctor, Site D)

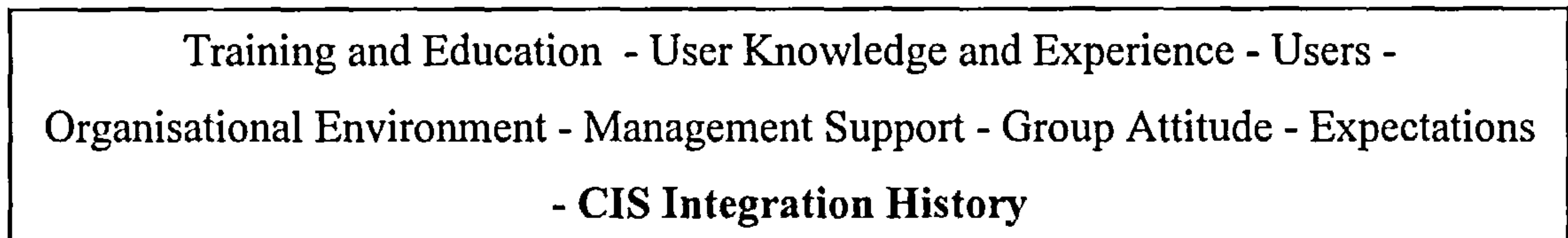


Figure 6.16: A map of the Organisational Culture factors to guide the reader.

CIS Integration History

This factor concerns past CIS implementations, and the effect that this has on current implementations. It is related to the User Knowledge and Experience factor discussed earlier. In essence, it seems obvious that where users have been involved in successful CIS implementations, they will be well disposed towards new systems, while where their experience has been negative, their expectations of any new system will also be negative, and so they will resist change. However, users may also resist change if they see their current system as adequate, believing that ‘if it isn’t broken, don’t fix it’.

At Site D the Clinical Director had been involved in an EPR project previously. The aim was to integrate all patient information so that it could be accessed from one system. However, that was almost a decade ago and the project was considered as over-ambitious and unrealistic by hospital management, so that research was conducted with minimal resources, and the project was eventually abandoned. The Danish Ministry of Health are now advocating the development of EHRs across Denmark, but the clinical director can see similar problems emerging, because there is not much investment for

implementation, CIS maintenance and user support. In Section 7.2 the validation of ISIM in Site B provided much more evidence for this factor.

6.2.3 Actual Usefulness Factors

As for Organisational Culture, each Actual Usefulness factor identified in Figure 6.2 is defined and discussed in terms of the three ICU Sites, A, C, and D. Actual Usefulness is the actual benefit of the CIS to clinical staff when it is in use. This will change over several iterations of ISIM, as when the system is first introduced it is novel, requiring more effort on the part of users, and while the old and new systems are operating in parallel, the full benefits of the system will not be seen. However, for a successful CIS integration, the old system will be phased out over time, and users will become more proficient at using the new system, provided the Organisational Culture factors discussed in Section 6.2.2 are given consideration.

Actual Usefulness examines what advantages and disadvantages arise from using the CIS, and how the actual experience of using the system differs from user expectations, as identified in the Organisational Culture category, where it was seen that the CIS at Site A had exceeded user expectations. Actual Usefulness enables the analysis of CIS use in practice.

It was found that factors for Actual Usefulness are functions of both the user and the system. For example, the *speed* of using a system is dependent upon *user knowledge* of the system, and typing skills, as well as *system* functionality. *Quality* of a system is dependent upon the quality of user input, and the functional quality of the system to be able to cope with the data.

The features within this category are very broad, i.e., there may be many levels of quality depending upon context. The factors also inform each other, as well as information input and output, the system, the user, and the Organisational Culture. The Actual Usefulness factors identified were: system suitability, quality, reliability, flexibility, speed, user friendliness, relevance to job, and system support. Before discussing each factor a map of Actual Usefulness factors is given in Figure 6.17, to guide the reader. The bold factor in Figure 6.17 is the factor of discussion.

**System Suitability - Human Computer Interaction Factors -
Relevance to Job - System Support**

Figure 6.17: A map of the Actual Usefulness factors to guide the reader.

System Suitability

This factor is concerned with how well the CIS procured matches user requirements in practise. Although this factor may be assessed before implementation to obtain an understanding of the Actual Usefulness of current CIS, the full evaluation of this factor for new CIS can only be conducted once the CIS is implemented, and will change during CIS integration.

The majority of clinical staff at Site A were pleased with the CIS that they used, and it exceeded user expectations. It proved to be of much value in practise, as all patient information was collated and accessible from one CIS. Users were also able to see the actual (as opposed to the purported) benefits of the system – it saved time, and directed attention to where it is most needed:

“It all shows up in colour so you can walk down this ward and without going anywhere near the bed you can say oh that ones looking a bit blue or I had better go to that bed first. It’s got lots of quick things and it’s got lots of links, it’s a bit like a filofax. So you can look at investigations and there are links that take you somewhere else. You can cross reference, look back at the previous hundred days or one day, you can expand your records.” (Doctor, Site A)

Both management and clinical staff found the system to be of benefit. The fact that the CIS was continuously evolving meant that changing user needs could be considered and the CIS adapted to reflect this. Much of this was due to the long procurement process, where the clinical director conducted much research, before a CIS that fulfilled requirements was procured. It was clear that much thought had been given to these requirements, so that the clinical director knew exactly what she wanted, rather than the system being pushed onto organisations by suppliers.

At Site C the CIS was procured on a recommendation from a Danish survey to senior management, without involving ICU staff. The survey that recommended the system was actually performed in 1999, three years before the system was purchased. The Clinical Director felt that it was the best system for the specific needs of management, i.e., for quality and resource management:

“Well the reason we needed it was a question of quality control and second to have a tool for computer decision making, are we using the right things for the right patients and so on and so forth.” (Clinical Director, Site C)

In addition, the Clinical Director did not consider evaluating the system, or observing it in use elsewhere:

“I would say that the procedure, buying a PDM system, actually you don’t know what you are buying.” (Clinical Director, Site C)

The system was not ideal, as even experienced users found that it did not work perfectly:

“I think it is good, but I have worked with it for a long time and I know all the details. Some things it doesn’t work quite good, but most of the things are good.” (Nurse (trainer), Site C)

Other users were concerned about not being able to adjust to using it:

“A few times I have tried but it is very difficult for me to get one view in a short time. So I am worried.” (Doctor, Site C)

At Site D the clinical director was involved with the development of one of the EHR modules. However, he felt that this module did not consider ICU needs. The co-clinical director also commented that ICU needs are not being captured in the EHR, which is focusing more on general parts of the hospital:

“Now we start the EPJ [EHR] it should be used on all the wards on all departments but we have special demands to make it work in our department. The first round, they won’t fulfil it, that’s okay, that’s a choice I can see that if you see the good things in others it is more easier to work with but it give out a problem and I don’t see a solution in the near future. For other departments and wards but we have special demands, they are not fulfilled.” (Clinical Director, Site D)

The CIS at Site A downloaded data from monitors automatically, and provided graphs on large monitors displaying the data clearly; this facility was not available at Site C. At Site A, although nursing observations were input into the CIS on an hourly basis, nursing and doctor notes were occasionally completed at the end of a shift, creating a backlog of people wanting to use the computer at the nurses’ workstation:

“Sometimes three people write and they say ‘come on, come on’. It’s not a great problem I don’t think. It depends if you come at the end of the nurses shift, at the end of the nurses shift they want to put a whole lot in, things that they may not have put in during the working day, they want to add in at the end.” (Clinical Director, Site A)

Compared to Sites C and D the overview of patient data at Site A was much better, and the system was much more user-friendly. When asked why they had not purchased the same system as Site C, one of the CIS leaders replied:

“[The Site C system] was not what we wanted, it was too complicated to use and did not computerise everything that we wanted” (Clinical director, Site A).

On introducing a new CIS, it will be compared with the previous system, and users accept it if the new CIS produces an improvement over the previous system. In general, the previous system will be the generic paper system that has been used for many years. The paper CIS can therefore be considered as a gold standard; it is a challenging task to find a suitable CIS that improves upon this without requiring too much effort for users to learn it.

**System Suitability - Human Computer Interaction Factors -
Relevance to Job - System Support**

Figure 6.17: A map of the Actual Usefulness factors to guide the reader.

Human Computer Interaction Factor

The Human Computer Interaction factors of quality, reliability, speed, flexibility, and user-friendliness were identified as important factors for CIS integration. The quality of the CIS can be evaluated in terms of the quality of the data within it, data downloaded directly from monitoring equipment (Site A) and data typed into the system, such as the Patient Record. Site A was able to comment on this aspect, as their CIS stored both data downloaded from monitoring equipment and that input by users, with the automatic recording of data being found particularly useful:

“The quality and accuracy have definitely changed. We are collecting data every minute. They don’t forget things like they used to because there is more structure” (Nurse, Site A)

The fact that the system prompts staff for various sorts of information that were not all previously recorded was also found to be useful:

“Pain scoring used to get missed but it is in front of them, so they just do it.” (Nurse, Site A)

Users at all sites felt that the quality of ‘hard’ data downloaded directly from monitoring and physiological equipment was more accurate, despite the initial scepticism from a nurse at Site A:

“These big sheets in which they wrote down all the pulses all the blood pressures, in case the system didn’t record it on to it. That was just totally mad, because it just automatically takes it down from the monitors and she managed to convince the administrators that this was the right thing to do. And they wanted to do backtrack and check that those blood pressures written down in the nurse’s notes matched the ones in the system. Well of course they did, they copied them off the monitors. That went on for months.” (Clinical Director, Site A)

Automatic fluid balance calculations were much appreciated, removing the need for mental arithmetic and also eliminating errors, as these calculations were usually conducted at the end of a shift when clinical staff can be particularly exhausted.

However, it was agreed that an electronic CIS could not do much for the quality of the subjective data: ‘the information is only as good as the person inputting the data’:

“You write a pack of lies here then it’s a pack of lies, you could write a pack of lies in written notes. It’s immutable. It is reliable and we haven’t had any such problems with it.”

(Doctor, Site A)

“I think the quality is better now, it is more visible it is less misinformation than when you write. It is electronic and more correct, you can do less things wrong.” **(Nurse, Site C)**

“You could say that the quality of the data in the journal is mostly dependent on the input and so it depends upon how it is input into the journal.” **(Doctor, Site D)**

“It varies but most of the time it is nothing to do with the system it has to do with the person who entered the information.” **(Doctor, Site D)**

The technical reliability of the CIS was not thought to be a particular issue at Site A, where they did not have many problems with this, and a strong relationship with suppliers meant that any problems were swiftly resolved. The same was not true of Sites C and D, where users were very aware of the problems:

“Well we have had a lot of technical problems. There was a technician yesterday and there is another one coming today because he wants to do something and they shut it down for 2-3 hours.” **(Nurse, Site C)**

“I prefer computer if the data is there and the system functions. A lot of the time we have problems with the functionality of the system, not the software but the hardware. You can’t turn on the computer, main problem.” **(Nurse, Site D)**

“No I think it is much easier to write in paper. The problem with the computer is that some programs don’t work or it takes a long time to log in and it doesn’t function.” **(Nurse, Site D)**

Problems regarding reliability of paper are also identified, i.e., the fact that it can be misplaced:

“Paper has its ups and downs. It is a stable and reliable format as long as the journal can be retrieved.” **(Doctor, Site D)**

Nor did users at Site A consider the computational speed of the system to be a problem, as their dedicated network was sufficient for their needs. However, the same was not necessarily true of time taken to interact with the system:

“It takes a lot of time, especially for paper. I’m not that good at typing so it takes a lot of time for me. It takes me more time typing then looking at the patient.” **(Doctor, Site A)**

At Site D speed of access to data was highlighted as being important, together with ease of access:

“If it improved my access to data, and it was a quick and accurate access to data, then I would probably use it more.” (Doctor, Site D)

However, this may be due to the fact that users found their system too slow:

“Staff think that the module is very slow and difficult. Many of them think that they won’t be able to learn it and that it is too slow for them.” (Nurse, Site D)

Again, at Site C they believe that speed of access was important, and were not convinced that an electronic CIS would facilitate their work:

“If it takes too much time to get all the necessary information I would hate it, to have more work when we are so busy out there. If it takes more time I will get furious, it is not using the system or the computer itself, but not getting the information that we need crucially.” (Doctor, Site C)

“I will do my work as before. But I don’t know if I will be able to do things as fast if I can’t find the information.” (Nurse, Site C)

The flexibility of a system examines how well the system can adapt to the needs of a multitude of users, how easy it is to change the system, and how well the system can be accessed from different places. The system at Site A had separate areas for nurses and doctors, making it flexible in that respect, and the strong relationship with suppliers implied that the second aspect was also strong:

“It’s very easy. You just go to the observation page and add the function you want to come up at any time you want. You can manipulate the system to do what you want.” (Nurse, Site A)

“Well usually it is them telling us that we would like this and that so we ring them and say can we have blah de blah de blah and the system people will say fine it might take on or two days.” (Doctor, Site A)

This was not seen to be a particular issue at the other sites, where the CIS was still in the process of implementation. However, the fact that paper records could be transported and completed anywhere was commented upon at Site C, although this can also result in paper records being misplaced.

The final aspect of Human Computer Interaction factors identified in this thesis is user-friendliness, which examines how quickly people can get to grips with the system and become proficient in using it, together with how easy it is to use. This was again felt to be a very strong feature of the CIS at Site A:

“We selected this particular system because it was very user-friendly, immediately user-friendly and you could see that people could begin to use it with very little training. You just needed to know how to use a mouse and a keyboard and you could do it. The front screen was very nice it was very easy to read, there was development potential in it and the content of the software was

what we felt we needed for our patients for information gathering. We liked the layout of the database as well; the actual ease at which you could find information was particularly nice.”
(Nurse, Site A)

Unfortunately, the same was not true of Site C, where users believed it was difficult to input data and to read it, and they were afraid of losing the patient focus:

“I have to scroll and scroll to get my information and I always have to explain.” (Nurse, Site C)

**System Suitability - Human Computer Interaction Factors -
Relevance to Job - System Support**

Figure 6.17: A map of the Actual Usefulness factors to guide the reader.

Relevance to Job

This factor is concerned with how well the CIS matches user work requirements, that is, whether it facilitates work processes, or requires users to work around the system. For example, at Site A, the CIS would remind nurses to input observations every hour, a feature impossible in a paper CIS:

“They don’t do a great deal of writing on it, and of course it reminds them, particularly in their observations. If it is time for the nurse to go and enter their observations then this is the reminder line. If they sent off blood investigations and the machine said it’s about time you picked up the results the yellow line starts flashing and they will go and look. So there are lots of nice things”.
(Clinical Director, Site A)

The system also performs calculations, relieving nursing staff from this task and improving accuracy. Nurses found that they no longer had to worry about losing the patient record or the different paper charts, as they were collated in one system, and could not be moved away from the patient, although they could also be accessed at the central computers. In addition, relevant information could be found more quickly than with a paper record:

“It does make life easier. You can check what drugs a person has had and how it is to be given if you are not sure. In that case it works very well”. (Nurse, Site A)

Those nurses who had been away from the ICU for a long period of time felt that the CIS gave them a good summary of the patients in a relatively short space of time.

At Site C the system replaced a single paper observation chart. However, it made the work processes much more difficult, because a holistic view of patient data was replaced with fragments of information across several screens. It took longer to input data, take data out, and to assimilate it, as the complete picture had been lost.

“I don’t want to say. It is difficult. I know the computer should be better. I know that, but I liked to have all the information together. I miss the overview.” (Nurse, Site C)

**System Suitability - Human Computer Interaction Factors -
Relevance to Job - System Support**

Figure 6.17: A map of the Actual Usefulness factors to guide the reader.

System Support

This factor was separated into two parts: hospital-level technical support and support from suppliers. The related area of management support has already been discussed.

At Site A technical support was mostly the responsibility of the supplier, who had provided 24 hour support since the CIS was first implemented, and continue to maintain a strong relationship with the ICU. A modem link connected the hospital directly to the suppliers, so that immediate communication was possible. Any upgrades are given free to Site A, in exchange for the site allowing potential buyers to view the system in operation. So far, Site A has had visitors from all over Europe.

“Site A approached us about a CIS. They worked together to tailor a system that met their requirements. Even now, if they want changes they will tell us what they want.” (System Supplier, Site A)

“Very helpful. The software people are very helpful and the service people are very helpful.” (Clinical Sister, Site A)

Non-technical problems were resolved via the clinical director and the clinical sister, who took responsibility for the system. The system has survived because it has changed continuously to meet the needs of its users; users and suppliers worked towards a mutual interest, with the clinical director and clinical sister acting as mediators between all users and the suppliers as well as helping with any problems with the system:

“Oh, we don’t get involved with that. We have a designated person. I think doctor Y usually takes care of all that. Between sister X and doctor Y they sort out all the glitches and pains.” (Nurse, Site A)

“Doctor Y still does a lot of work on it. We need input all the time from somebody like that, if we didn’t have somebody like that with input, keep the drugs updated, all the information correct, chase the junior doctors a bit and make sure they do the notes, the system would start to fall apart. It does need enthusiastic motivated people to keep it going.” (Nurse, Site A)

The systems used at Site C and D came from a wide variety of suppliers, this may become even more of a problem when the full EHR is implemented, as it was being

developed and implemented by six different suppliers, all working independently from each other. Problems of multiple suppliers are exemplified in Site D, where two of the EHR modules were being tested. The modules were developed by different companies, and many problems were encountered with enabling the modules to communicate with each other, and also in attaining an adequate level of support to enable them to test the modules fairly:

“They have been involved in the process of development, because most of the things we can’t do, so they have been in the process all the time. Not sufficient to our needs, but they have been there, and are still there.” (Doctor, Site C)

The problem of implementing disparate systems that are not compatible with each other heightens the burden on work processes and makes it difficult to balance existing and emerging work processes. Concerns about being locked-in by suppliers were also expressed. Suppliers need to build inter-operable systems; this is a complicated problem that requires common inter-operability software standards, and common hardware components.

With regard to the support from within the unit, at Site C it was felt that there was not enough help available, and that they were limited because they were not involved in system development, so they could not ask the suppliers to make major changes to the system:

“The super users are okay. They will tell you, but usually there is only one. Sometimes they tell you that it won’t work, or if you want it to do something they will say it is not going to happen. That is frustrating.” (Nurse, Site C)

“They usually come and tell it to me. Some things the smaller things I can do it right away. Some things are bigger, maybe we have to ask the manufacturer to make a change for the next program. I think so. I know I can call the software company when I need it but not all the problems they can handle. There is not everything that we would want to change that is possible to do.” (Nurse, Site C)

The same is true at Site D, where the time taken to get a response from the helpdesk was seen to be inadequate, and the fact that this would get worse as more and more of the CIS were moved onto the computer was highlighted:

“We have a department that takes care of it. But if it takes an hour or five hours then in ICU that is a big problem, especially when the total journal [patient record] is on the computer.” (Nurse, Site D)

Finally, the fact that all CIS are only there to facilitate patient care, and that all CIS therefore have to be reliable was further reiterated:

“Of course if the equipment breaks down your attention has to be on the patient.”

(Doctor, Site D)

6.2.4 CIS Integration

When introducing a new CIS, the ideal aim is to have a fully integrated CIS that is used effectively by all users. The extent to which this is true depends upon the changes to work processes, the Organisational Culture, and the Actual Usefulness of the CIS. ISIM identifies many features that affect the likelihood of the CIS being integrated into the ICU, or ignored. However, it is during the transition process that ISIM may be particularly useful. In general, a CIS will go through several iterations towards eventual acceptance or rejection.

For example, when the new CIS is first introduced, it will generally be used in parallel with the old system. This means increased workload for all users – not only are they having to get used to a new system, and to be trained in the use of that system, but in addition, they are still having to use the old system:

“For a while we were using half the computerised system and half the paper system, which was quite frustrating. But once we moved over....it’s been quite a smooth transition. Because we were using half and half once we moved over we accepted that we weren’t doing everything twice, which made quite a difference”. (Clinical Sister, Site A)

“I didn’t like working with the paper and the PDM. It was too much.” (Nurse, Site C)

At this stage it seems that strong leadership within the group is important to encourage people to persevere with the new system and to ensure that users are getting it right. This can be achieved, but it takes time:

“The first thing that we did was we checked everything very thoroughly because it is clinical information. We wanted to make sure that whatever information we had on the computer was retrievable, so we had to go through every little bit to make sure we could retrieve every bit of information the day after the week after three months after etc. etc. So we had to do that first and then we did lots of training and we withdrew one chart at a time. So we started off with really simple things, so for quite a long time all the nurses were doing written observations and the stuff on the computer. Once they started to see the charts disappear they accepted it. All the time they were doing two lots of work it was really horrid to get them to accept it. But once we started taking paper work away they accepted it quite readily. There were very few people who had problems with it, very few. The new staff that arrived who never used paper work just got on with it and had no trouble with it at all.” (Clinical Sister, Site A)

While the system is implemented, users start to want to do more with it, and it is important that leadership is strong and reliable, to facilitate users when they need help.

This is more likely in cases like Site A, where there are strong links with suppliers, and so changes to the system are relatively easy to achieve. However, even in Site A problems are still evident, since communicating with other hospital departments is conducted via paper:

“I’d like the blood results from the lab to be directly linked into it as well. I think there is a plan for it to be in the loop, but it is not there at the moment.” (Nurse, Site A)

The timescale for CIS integration is also important. While parallel implementation is taking place, the workload of the users is significantly increased, which is unpopular, and the staff may just ignore the computer CIS, as in Site C. However, once the paper system has been phased out, it may still take a long duration of time before the CIS is considered to be fully implemented, when all users are using the system effectively:

“I think if I look at the staff and the introduction, I think it will take the nurses and the doctors a lot of time all the time they use now. But if I look ten years from now it will be easier, a lot easier. I think they will be happier to use that. But today they see it as making them work more.” (Nurse, Site D)

6.3 Summary and Conclusions

This chapter has described the heart of this thesis, the Iterative Systems Integration Model, ISIM. The model was derived using observations and interview data collected from three ICUs, two in Denmark and one in England. ISIM was described and then each of the four categories of ISIM, Work Processes, Organisational Culture, Actual Usefulness, and CIS Integration were defined. The formulation of ISIM in terms of Grounded Theory was also discussed. Hypothetical applications of ISIM were presented, to clarify how and when it may be applied.

Role Activity Diagrams were utilised to illustrate and describe a set of information intensive work processes at the three ICUs. These processes were: nursing meetings and the nursing shift handover, doctors meetings and shift handover, patient preparation for doctor’s rounds, and the doctors rounds. It was found that these processes were virtually identical at each site, regardless of country. However, they differed at the information processing level, which were summarised in tables, so that comparisons across the three ICUs could be clearly seen.

It was found that clinical staff are heavily dependent upon patient information, and yet accessibility of this information is not always easy, and is often hindered by the

wide variety of disparate systems, both internal and external to the ICU, which can delay decision-making, and hence impact patient outcomes. The notion of seamless CIS was introduced as a means of uniting disparate systems in the ICUs.

Finally, each factor of the Organisational Culture and Actual Usefulness categories were presented in a discussion comparing these factors across the three sites. It was found that:

In Site A it took nine months to integrate the system to a standard where it was being used. Links with suppliers were strong, as was leadership, which meant that the CIS itself was continually evolving with the environment, i.e., users would report their actual experience with the system to the Clinical Director, who would ask the suppliers to make changes to the CIS, so that the system was better integrated. However, because their Organisational Culture was such that it embraced the technology, the fact that the CIS was not networked to the rest of the hospital was a cause of unrest.

At Site C a new system for better management of data quality and resources was implemented. This CIS only replaced the patient observation chart, and was implemented for management benefit only, and users were not consulted in its implementation. This caused much frustration as it complicated their current work processes, since it replaced one sheet of paper with many printouts, increasing the size of the patient record two-fold. Users also felt that they lost the ability to assimilate information and attain a rapid overview, which the paper chart enabled and the CIS hindered, as data were spread across many screens. As well as initial apprehension, users could not realise the benefit of the CIS to them, and the actual usefulness of the system did not ease their perceived apprehension of it. Nurses were tired of using the system on behalf of physicians as well as for their own purposes.

Site D experienced many problems with their suppliers and project managers. A doctor stated that ICU needs are very different to other areas of a hospital, and that those needs were not met. Despite user involvement in the development of the EHR, those involved felt that their needs were not being addressed because the developers had no idea what these needs were.

Talking to clinical staff and examining the organisational environment in which a system is implemented, over a period of time, should be a prerequisite to systems developments. Simply reading specifications and talking to a few members of management leaves a huge gap between what is desired and the system that is delivered.

Moreover, 'ancient' problems of CIS integration, as discussed in the literature review (Chapter 2), were still found to be dominant at these ICUs. Some of the causal factors identified from these sites are given below:

- Inadequate understanding of current work processes (Sites C and D).
- Poor leadership and lack of ownership and responsibility for CIS implementations (Site C).
- Inadequate and inappropriate training (Site C).
- Unconsidered context of the organisational environment and the structure and layout of the organisation (Sites C and D).
- No way of communicating with existing systems (Sites A, B, and C).
- No potential for change and adaptation so that the system can be altered to suit the characteristics of the organisation (Sites C and D).
- Poor system suitability (Site C).
- Unclear 'actual' benefit of the system to the user (Site C).
- Weak relationship with suppliers (Sites C and D).

The next chapter provides a validation of ISIM using a fourth independent site and questionnaire data, and discusses the model in terms of the Technology Acceptance Models (TAM and TAM 2).

Chapter 7

Evaluation of ISIM

The aim of this chapter is to present an evaluation of ISIM, the model developed in this thesis. This is conducted using a fourth ICU site and by examining the results of questionnaires undertaken at all four sites. None of this data was used in the development of the model. The relationship between ISIM and the Technology Acceptance Model (TAM) and its successor (TAM 2) are also discussed.

7.1 Introduction

Section 7.2, and Section 7.3 are concerned with validating ISIM, the model introduced in Chapter 6 through consideration of data collected in three ICUs. Section 7.2 validates the results of the model by considering data collected in the fourth site, Site B, the second English site. Following this, Section 7.3 considers the results of a questionnaire undertaken in all four sites. In Section 7.4, ISIM is compared to TAM and TAM 2, as some concepts in ISIM and the earlier models appear to be similar.

7.2 Validation of ISIM – Site B

Data collection and analysis methods employed at Sites A, C, and D were replicated at Site B, with data collection being conducted after ISIM had been created, so that it was a fully independent validation. A report of the findings was given to each

site so that participants could provide feedback. Some of the comments received by email are given in Section 8.2.5.

Site B was selected prior to data collection at all sites, rather than selecting a site after the model had been developed so that the results would fit the model. The results at this site were arrived at independently from the other sites and from ISIM development.

The results and discussion of the findings at Site B are given in a similar structure to that presented in Section 6.2, although the individual Organisational Culture and Actual Usefulness factors are not discussed separately, as in Chapter 6, but presented as a discussion since this is more appropriate for a single site.

Work Processes are discussed in Section 7.2.1, and then each factor of the Organisational Culture (Section 7.2.2) and Actual Usefulness (Section 7.2.3) categories of ISIM are discussed, finishing with the CIS integration category (Section 7.2.4) and a summary and conclusions of the validation.

7.2.1 Work Processes

On analysing the work process data, it was again apparent that the clinical work processes remained identical, but the patient information processes differed. It could be seen from the RADs that the information processes had the potential to become much simplified with the introduction of seamless CIS, thus creating 'simplified complexity' i.e., systems connected hospital-wide could eliminate patient data duplication and enable immediate access to patient information (this is discussed in more detail in Section 6.2.1).

Since the RADs have already been given in Section 6.2.1, they will not be repeated here. However, the tables comparing Sites A, C, and D are reproduced with Site B being added to facilitate comparisons. The basic work processes of Admit, Care, and Discharge, as given in Figure 6.5, structure the presentation of the validation.

Admit Patient to ICU:

Table 7.1 describes briefly, the information process of patient registration.

Table 7.1: Patient registration at each Site.

<i>Site</i>	Registration Process
<i>A</i>	Patient details are sent with the patient. Details are given on printouts from the hospital information system and various registration forms. These details are then retyped into the ICU CIS.
<i>B</i>	All registration is handled via the hospital information system, and dealt with on paper registration forms in the ICU
<i>C</i>	Registration is handled by the ICU secretaries via the Green System, which was described in Section 3.3. Secretaries organise all patient data.
<i>D</i>	Registration is handled by the ICU secretaries via the Green System, which was described in Section 3.3. Secretaries organise all patient data.

Care of Patient in the ICU - Site B

Nursing Meetings

Similar process to Sites A, C, and D were observed.

Nursing Shift Handover

Similar process to Sites A, C, and D were observed.

Doctors' Meetings and Shift Handovers

Although nursing meetings and shift handovers were very similar at all sites, doctors' meetings differed between the Danish and the English sites. Neither English site had formal morning meetings as described for the Danish ICUs in Chapter 6.

Patient Preparation for Doctors Rounds

This was similar to the other sites (see Table 7.2).

Doctors' Ward Rounds

The work processes at Site B were virtually identical to those at Site A, except for the information processes (see Table 7.2). However, as Site B was a university hospital it also meant that junior doctors accompanied the consultant and doctors on ward rounds. Junior doctors are assigned a patient after a briefing round of all the patients, and would convene at the end of the IPE to discuss the treatment plan with the consultant. This process varied between consultants, with some simply assigning patients at the beginning, eliminating the briefing round.

An interesting observation is that consultants did not necessarily sit down and discuss the patient with the nurse tending the patient, as was noted at Sites A, C, and D. Instead, they spoke only of things they deemed noteworthy, so that the interaction

between these groups was more limited at this site. A possible reason for this may be that Site B is a university hospital, as noted before, and so consultants were busy teaching junior doctors, and therefore did not have much time to sit down and discuss the patient with the nurse. Alternatively doctors may have preferred to work this way

Table 7.2: Summary of doctors meetings and shift handover

<i>Site</i>	Process	Information Processing
<i>A</i>	Consultant in charge leads attending doctors around each patient in ICU.	Use the CIS by the patient bedside to discuss patient and input any data.
<i>B</i>	As this is also a university hospital, junior doctors are also present. Similar process as for Site A, with question and answer session conducted by Consultant to educate junior doctors after patients have been examined as in Figure 6.10.	Paper patient record, and paper observation chart. Monitoring equipment observed.
<i>C</i> and <i>D</i>	Formal meeting where doctors on previous shift inform doctors on current shift of status of ICU. Patients are delegated between the doctors.	At the meeting, a sheet of paper with patient name and condition is given to each attending doctor. After the meeting doctors read the patient record to familiarise and prepare for the patient.

Table 7.3: Summary of sub-processes at each ICU site.

<i>Sub-process</i>	Site			
	A	B	C	D
<i>Fig. 6.7: Make Notes</i>	Notes mostly remembered and sometimes written on paper.			
<i>Fig.6.8: Observe Monitor</i>	Physiological data is clearly presented via the CIS. However, the monitoring equipment is also used.	The nurse observes the monitoring equipment for vital signs, etc., but mostly refers to the POC.	The CIS is used in conjunction with the monitoring equipment, but verbal exchange is preferred.	Monitoring equipment is observed and POC. Verbal exchange is preferred.

<i>Sub-process</i>	<i>Site</i>			
	A	B	C	D
<i>Fig. 6.8: Refer to POC</i>	<p>Typed in CIS by nurses. Accessible at the foot of patient bed or the nurses' workstation. Large colour monitors aid visibility. Can access observations for current and past 24 hours only. Observed by all clinicians who may need to see it.</p>	<p>All data are hand written on an A3 sheet of paper at the foot of patient bed. Observed by all clinicians who need to see it.</p>	<p>Typed in CIS that replaces the POC only. Input by nurses only. Patient plan no longer recorded. Instead, nurses memorise the plan and use their (paper) nursing notes more. Doctors use screen dumps that have increased the size of the patient record, as many computer screens have replaced one chart. Data extracted by management for quality control.</p>	<p>Recorded by hand on an A3 sheet of paper at the foot of patient bed. Observed by all clinicians who need to see it.</p>
<i>Fig.6.9: Ancillary Staff notes recoded in PR and specialty specific notes.</i>	<p>Physiotherapists use the ICU CIS to record their notes, and also record their own notes in paper form. Other ancillary staff do not use the ICU CIS.</p>	<p>Notes are recorded in the paper patient record by hand. Own notes are also recorded on paper.</p>		
<i>Fig.6.9: Check Monitoring Equipment.</i>	<p>As for Fig. 6.7</p>			
<i>Fig.6.9: Administer Medication</i>	<p>All data regarding patient medication is recorded in the ICU CIS. Decision Support is also available via the CIS, where a reference list of medications and dosage is also given.</p>	<p>Paper forms are completed for all medication used and given to the patient: this is recorded by the 'medication kitchen' as part of an inventory. It is also recorded on separate medication charts, and is recorded again on the POC and in the nursing notes.</p>	<p>Paper forms are completed for all medication used and given to the patient in the 'medication kitchen' and nursing notes only. The CIS is used for POC records.</p>	<p>Paper forms are completed for all medication used and given to the patient: this is recorded by the 'medication kitchen' as part of an inventory. It is also recorded on separate medication charts and is recorded again on the POC and in the nursing notes.</p>

<i>Sub-process</i>	<i>Site</i>			
	A	B	C	D
<i>Fig.6.9: Record observation notes.</i>	As for Fig. 6.8 'record POC notes'.			
<i>Fig.6.9: Read and record Patient Record</i>	<p>Typed in the CIS by doctors only. Can be read by all clinicians authorised to do so. One CIS used for OC, PR and nursing notes. Clinical staff do not search for records. Very little paper is visible.</p>	<p>Format is similar to a diary and is placed at the foot of the patient bed. All clinical staff except nurses record notes in it. Can be read by all clinicians.</p>	<p>Dictated into an office-based dictation system that allows doctors to record their notes at any time, but only from a central office within the unit. These are then transcribed by a group of secretaries, who also print the notes and place them in the patient record.</p>	<p>Dictated into a hand-held Dictaphone carried by the doctors. Left with the secretaries, who transcribe them (0900-1600 on weekdays only). Often secretaries' desks are full of tapes, which can be scattered anywhere in the office. Notes printed and placed in patient record folder when found! Testing two of the Electronic Health Record Modules is causing problems, as they are not provided with the technical support that they require.</p>
<i>Fig.6.9: Read and record nursing notes</i>	<p>A section in the computer system written and read by nurses only.</p>	<p>Recorded on paper. Written and read by nurses only.</p>	<p>Recorded on paper. Written and read by nurses only.</p>	<p>Recorded on paper. Written and read by nurses only.</p>
<i>Fig.6.9: Read and record laboratory results.</i>	<p>Arrive on a separate computer system. Printed, and then typed into the ICU CIS.</p>	<p>Arrive on a separate computer system. Copied by hand into relevant notes.</p>	<p>Arrive on a separate computer system. Copied by hand into relevant notes.</p>	<p>Arrive on a separate computer system. Copied by hand into relevant notes.</p>
<i>Fig.6.10: Evaluate Patient Status</i>	This is conducted using the POC and patient record as well as patient examination.			
<i>Fig.6.10: Refer to patient record and record notes.</i>	As for Fig.6.9, 'Ancillary Staff'			

<i>Sub-process</i>	<i>Site</i>			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
<i>Fig.6.10: Check monitors/refer to POC/ Record Notes/ check Lab results</i>	As for Fig.6.9			
<i>Fig.6.11: Send Results. Example: Radiology</i>	Manual System. Wait for X-rays to be developed. Used by doctors only.	Local computer system, X-rays arrive electronically. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.	Remote computer system, X-rays arrive electronically. Used by doctors only.

Discharge/Transfer Patient from ICU

Table 7.4 describes briefly, the information process of patient discharge/transfer.

Table 7.4: Description of patient discharge/transfer process

<i>Site</i>	<i>Discharge/Transfer Process</i>
<i>A</i>	Discharge: A summary of patient details are printed from the CIS and sent to the relevant bodies. However, as the High Dependency Unit is within the ICU, transfer of patient is more complicated, as patient information has to be retyped since the patient is discharged and in a sense, readmitted. A patient who has remained in the ICU will have accumulated much data. This process is also true the other way round. Data is electronically archived onto CD-ROM.
<i>B</i>	Details are re-entered on to paper forms and given to the relevant bodies.
<i>C</i> and <i>D</i>	Details are re-entered on to paper forms and given to the relevant bodies.

Discussion of Work Processes

Apart from the doctor's ward rounds, nothing new was identified. However, it is interesting to note that neither English hospital has formal doctors' meetings before and after a shift changeover, as at the Danish sites. The nursing meetings, though, were standard at all sites.

Once again, it is apparent that the patient care process is heavily dependent upon access to patient information. Verbal exchange was the preferred method of information exchange as at the other sites. This may be due to medical culture and the nature of medical work.

At Site B, the disparate nature of information retrieval mechanisms was apparent, and duplication of data was also obvious between CIS within the ICU and other hospital departments. Site A was the only site with a complete ICU information CIS i.e., inclusive of nursing and doctors notes, observation charts, automatic download of physiological information, etc. The discussion about the importance of seamless CIS given in Chapter 6 is also applicable to this site.

A discussion of the Organisational Culture and Actual Usefulness factors at Site B is given in Sections 7.2.2 and 7.2.3 respectively. This is followed by a discussion of the overall validation of ISIM in Section 7.2.5.

Table 7.5: Summary of CIS training at each site

<i>Site</i>	Training
<i>A</i>	<ul style="list-style-type: none"> ▪ Head of ICU and Head Nurse given training by CIS supplier. ▪ Training cascaded to all users while they worked. ▪ Full changeover from paper to computer took nine months.
<i>B</i>	<ul style="list-style-type: none"> ▪ Two technicians responsible for physiological equipment and CIS. ▪ All ICU and cardiology staff invited to a seminar. ▪ Training given to all ICU and Cardiology staff by two technicians.
<i>C</i>	<ul style="list-style-type: none"> ▪ One ICU Doctor and three ICU Nurses given training by suppliers. ▪ Invitation to 2, three hour seminar sessions for nurses and doctors. ▪ Training then given by 3 nurses and 1 doctor to all staff while they worked. ▪ Parallel use of paper and CIS system for three months.
<i>D</i>	<ul style="list-style-type: none"> ▪ Initial training given to Head of ICU, who trained 3 nurses to cascade training down to all ICU nurses.

7.2.2 Organisational Culture Factors

The CIS employed at Site B was abandoned in the late 1990s. The CIS was introduced primarily for management use, and was driven by the clinical director of the ICU at the time, as at Site C. Within the ICU two full-time technicians were employed to maintain, and teach all clinical staff about, physiological equipment and CIS. These technicians were also shared by the cardiology ICU and the cardiology HDU. The technicians were responsible for implementing the CIS and for training all staff to use it. Table 7.5 summarises the status of training at Site B given at the time of the implementation of the CIS. This was unrealistic given the size of the unit:

“There are 150 staff, and that’s just the nurses. There are about 25 medical staff, to teach them how to use over 80 pieces of medical equipment, not just in number but 80 different types. It’s a full time job just in training. We try to keep on top of that but we also tend the trouble shooting because we don’t have enough time to teach them, so it is a bit like the chicken and egg. There is no chance that we could keep up with it all – we need more help. There are only two of us for the ICU. It’s really hard.” (Technician, Site B)

“At the time we probably did have four technicians around but there was one who was really responsible for it. I think it was a really unrealistic expectation to put a heavy workload on one technician, to teach all the medical staff.” (Nurse, Site B)

A set of training programs were devised, these featured a mixture of classroom training and on-the-job training, with sessions for approximately 20 nurses at a time, during the shift handover period, or three to five doctors. The lessons were designed to be interactive, with the emphasis on teaching basic IT competence, as well as experience of using the CIS:

“We set out a training plan which you can imagine was huge for them, at the time it was all new technology. Some of the staff couldn’t even use a mouse they couldn’t work the keyboard. So we had to start from the bottom and teach people how to use computers and then show them how to use the system. It was a huge concept at the time. So we had to sell the concept of this change first. We had to learn the system our selves and then teach them what we knew.”

(Technician, Site B)

“The people who are afraid of new technology are afraid of change, which is the way it is. They found it a bit hard to take it in because they weren’t familiar with this mouse thing, or this keyboard thing. Where as once they were up to speed with the computer they embraced it much more readily. So the concept was more readily accepted by the people who where more up to speed with the technology.” (Technician, Site B)

However, as at Site C, few doctors attended the sessions, increasing the burden on nursing staff:

“I think it is 8 of us are all getting our training the next audit day. Whether we all turn up or not is another question. They tend not to train doctors, they tend to assume you know things.”

(Doctor, Site B)

The CIS at Site B was an early development, and staff had little or no experience with computers when it was first implemented, something that is generally different now. However, even now previous experience can work against the user, as a quote from a doctor using the hospital laboratory CIS shows:

“I tend to try and treat it like a windows system, it doesn’t work, and it doesn’t like to be treated like a Windows system.” (Doctor, Site B)

Negative impact of previous experience was also a factor that was identified in Sites A, C, and D.

The main problems with the CIS introduced at Site B were similar to those that were found at Site C – a major imbalance between the actual users of the CIS – the nurses – and the principal beneficiaries, management, was reported. The CIS was implemented in a very top-down manner, and the nurses were not consulted:

“It was something that wasn’t really used and it was something that was imposed on us. We weren’t asked what we wanted before they put it in.” (Nurse, Site B)

“We weren’t involved in the design of it at all; it was just like here it is. It was imposed and it was the director of the unit at the time who had some grand ideas lots of visions of the future that just didn’t involve the people who were going to be using that system day in day out.”

(Nurse, Site B)

“I know from previous experience that when we had a computer system before we weren’t involved in the setting up of it from the word go. It was something that was imposed on us really, very top down approach.” (Nurse, Site B)

The CIS is a charting tool, something that is used by both nurses and doctors, although the nurses carried out most of the input:

“We rely really on the nurses to fill in the charts, so a lot of nursing time is taken up with filling the chart. So if some of that information can be captured electronically that that would be fine, but it all depends upon typing.” (Doctor, Site B)

However, nurses did rely upon physician input, and this was not forthcoming, in common with Sites A, C, and D. Even where doctors would contribute, staff at Site B were very aware that the information needs of nurses and doctors were different, as was their desire to record information on the charts:

“Of course I would read the nurses notes. Nurse are very useful and usually much more punctilious then doctors are.” (Doctor, Site B)

“The problems we had, the nurses tend to document information in a better way than the medical staff.” (Nurse, Site B)

“The doctors just don’t record information that we would consider quite important.”

(Nurse, Site B)

“The nursing culture is that you document everything, you cover your back.”

(Technician, Site B)

Similar to Sites A, C and D, Site B is an active and complex environment with very specific information needs:

“One would hope that we would be asked and be able to trial it first. It is a complex area in intensive care, there are lots of people having inputs to things and so it is quite difficult to design

something that a number of people would be able to access. You have to have a system that is robust at each stage. You can't have a system that breaks down half way." (Doctor, Site B)

"A lot of it is monitoring the patient, a critically ill patient; we record their vital signs really. That's the main thing, so obviously drugs, medical care that is documented, a lot of it is to do with the actual patient. Clinical details really." (Nurse, Site B)

"Intensive Care patient data that tells you how ill the patient is from day to day, how many organs are working etc?" (Technician, Site B)

One particular problem concerning the CIS at Site B involved the placement of terminals. As at Site C, these were placed at the head of the bed, meaning that while nurses interacted with the CIS, they had their backs to the patient:

"The workstations were all located behind the beds so you couldn't see patients when you were working on the computer, by the time people were going for their break or to the lab, there were very few nurses around who could keep an eye on things. There were patient safety issues there really. It was very worrying. The foot of the bed might have been more practical."

(Nurse, Site B)

"The nurses were very enthusiastic to start with, but soon realised it had problems with it. So every time they went to put anything in it would take forever. Its location was wrong it was behind the patient. It took them away from the patient." (Doctor, Site B)

In addition to placing the CIS in a location that was not thought to be conducive to patient care, a nurse in Site B mentioned that the layout of the ICU was also poor, and sometimes a patient hidden away in a room would be forgotten and not seen by the doctors:

"We have found on occasion because of the geographical layout of the unit, where we have an individual side room and a three bedded room – a step-down room, that sometimes patients aren't being seen by the doctors although those areas are with intensive care. But because they are out of sight they tend to be a bit out of mind. So things aren't getting documented, as they should on a daily basis." (Nurse, Site B)

The issue of implementing CIS without consultation with the actual users has already been discussed in Chapter 6, and was clearly evident in Site B. The following quote exemplifies the general opinion of hospital management at Site B:

"[They are] pretty hopeless really, I think that they probably themselves don't have a clear direction of what they want in terms of management systems until they are reactive to the needs that are coming in from external sources so the commissioning would drive their needs and the clinical needs are always put down to one big pile, and yet for the patient it is the most important thing." (Doctor, Site B)

Another problem that seems to be common across all sites, is the different attitudes of nurses and doctors, and particularly the attitude of doctors to nurses:

“I think that more recently the consultants have realised that the senior nursing staff have an important part to play on the unit because we bring continuity to the unit. We are here day in day out and they are not. Also we are very experienced, so I think we are being valued more now. I don’t think they regarded us as being professionally as equal to them. If anybody had an idea it had to come from them, so there were control issues there really.” (Nurse, Site B)

This difference can be seen in the way that clinical staff approached the CIS, with nurses being much more prepared to use it than the doctors:

“The nurses were very enthusiastic to start with, but soon realised it had problems with it.” (Doctor, Site B)

“The doctors didn’t really have much to do with it, and if we had stopped writing the observations down then the doctors wouldn’t have accessed the computers.” (Nurse, Site B)

This may have been because nurses were told that the CIS would integrate all of the patient information in the ICU, thus saving much nursing time, although this was immediately found to be incorrect. The consultant and technicians involved with the CIS implementation held unrealistic expectations of the CIS and were described, as ahead of their time, computer technology was not yet that advanced. However, the CIS was advocated as a panacea and this did not match up in reality:

“I think maybe our expectations of it were too high, I remember seeing a sheet of A4 used by the sales rep that had all the requirements, which is absurd.” (Technician, Site B)

“The salespeople sold ‘futures’ to the Clinical Director/Technical Manager, and their primary product was monitoring. They regarded the CIS as a marketing tool. There was only one person within the suppliers European division who was responsible for information systems, and his concern was at a technical installation/support level”. (Information Officer, Site B)

This previous experience of an unsuccessful CIS implementation has left most members of staff very sceptical about any future CIS implementations:

“We wouldn’t want anything introduced now, I don’t know what the medical staff think but from a nursing point of view if it is not going to help us it will take more time and take time away from the patient. From the nursing perspective we aren’t very keen.” (Nurse, Site B)

“Obviously the people, who have worked here a lot longer, will remember the bad times and it will take something exceptional to overcome that. If it did ever happen again I would like to think from the word go that we would be involved in implementing and designing it. We are the users and we weren’t consulted last time. That was a major downfall really.” (Nurse, Site B)

This negative feeling is a very serious problem that could impede successful integration of any future electronic CIS, and even cause it to fail. However, it does appear that at least some of those involved in the previous implementation have learned lessons from its failure, realising that it is crucial to involve users in the choice of CIS and its implementation, and to change teaching methods. Unfortunately, this takes time and

much effort on the part of those responsible for implementation, especially for the technicians:

“I suppose over the years that we have learned you can’t just put a system in, you have to be able to learn to use it. We have also learned that you can’t just put a system in and use all facets of it, you would have to do a bit at a time. If you were moving over to the paper system you would have to run the two together. So it has to be a very structured program of introduction. And the teaching would have to be done, first with the senior nurses and doctors and then the junior doctors and nurses. To access data, to be able to put stuff in and be able to get stuff out. It would have to happen very early on and would be a very long process.” (Doctor, Site B)

“We really want to get the nurses involved. We would most certainly do it differently now.” (Technician, Site B)

Some nurses suggested that they would like to see and talk to users of a CIS in ‘actual’ use at another ICU, before it was implemented in their own ICU, i.e., they would like to evaluate the Actual Usefulness of the CIS:

“I would now like to maybe go to a unit where it is up and running before we committed ourselves again.” (Nurse, Site B)

7.2.3 Actual Usefulness Factors

As in Site C, the CIS implemented at Site B was predominantly employed for management benefit, i.e., for quality and resource management. However, unlike Sites A and C, where a CIS was sought to meet particular requirements, the CIS at Site B was given free with monitoring equipment that had been bought. Although CIS implementation and training was clearly not sufficient, there were also many faults with the CIS itself, which impeded the AU of the CIS. However, it is worth remembering that this was a very early CIS, and this may well have been a large part of the problem, as technology has improved considerably since the 1980s. That said, it is clear that, even for its time, the CIS – or at least, Site B’s implementation of the CIS – was inadequate, and was certainly not relevant to the work of its actual users, nurses and doctors:

“All the things you would think as being basic you couldn’t get.” (Doctor, Site B)

“All it did was a very crude job of replacing the paper-based chart. It did nothing for Care Plans, for drugs etc. A bit more interfacing might have helped. And although we stored everything electronically we would print everything out at the end of the day, purely then for litigation purposes if nothing else. It was effectively useless. I think the thing that put the nail in the coffin was its poor archiving ability.” (Information Officer, Site B)

“From a nursing point of view it didn’t really help us. It was very good for collecting information but we were still writing down on the chart and it didn’t cut down on the nurse’s time at all.” (Nurse, Site B)

“The work it took for the nurses to put it in was not worth what we got out of it of it. We put a lot of work into getting the information in and we didn’t get much out of the system.” (Technician, Site B)

As well as the fact that the CIS contributed negatively to nursing activity, one criticism has strong echoes of that at Site C – it was very difficult to obtain a quick overview of the state of the patient, something that both doctors and nurses relied heavily upon in the ICUs:

“The big advantage with paper is that if you get a big enough piece of paper you get all the information on it. With electronic things, so far, they haven’t managed to get an electronic system that is big enough to get it all on.” (Doctor, Site B)

“It’s very important in critical care to be able to go to a patient and very quickly assess what is wrong with the patient and what we can do for them. With the chart we can see all that, but on the monitor we didn’t have that.” (Nurse, Site B)

While this is mostly a question of effective CIS design, staff also had problems interpreting data as it appeared on the monitors. This was not found in Site A, where the monitors are much larger than at Site C, and the CIS produced clear and colourful graphs that were easy to interpret. This is a HCI issue and may be an issue for training; for example, teaching people to understand different forms of data display. However, a large part of the problem was caused by the small size of monitors and the clarity of data display:

“I think we do have experiences with our previous system and I think patient care definitely suffered with that system. And maybe that was because our interpretation of what we were looking at on the monitor was poor. And didn’t seem to be able to assimilate the data together in the same way that we would assimilate data from a sheet of paper. I guess the acquisition of data and the use of it in terms of the individual, relies on you making a set contact. So if the blood pressure dropped you would automatically look at the heart rate and drugs and infusion. Unless you have system that allows you to visualise that at the same time, you would only see a part of the jigsaw” (Doctor, Site B)

Similar issues concerning data quality were found as at the other ICU sites; quantitative data from monitors were reliable, but the subjective data in the notes were of a lower quality overall:

“We have just finished a reliability audit in the network looking at the quality of data. And what we have found is that the hard data, the facts like cardiovascular data are very reliable. The diagnosis, subjective data, is often quite inaccurate compared to the other type of data.”

(Doctor, Site B)

Even when the CIS was being used for its particular purposes, it was still found to be unsuitable. The implementation did not seem to be stable, it was slow when used across the whole ICU and nurses who were originally keen to try the CIS found that it took much time to input data into the CIS:

“There were numerous bugs in the system. It had a number of design issues as well; you could just see that it wasn’t being well received by the users.” **(Technician, Site B)**

“I think there were so many problems with that system in terms of its speed which wasn’t apparent until you looked at a number of data points on the system and then it would slow right down.” **(Doctor, Site B)**

“I think the first reason was that we lost enthusiasm for it because it took so much effort to get anything done.” **(Doctor, Site B)**

Furthermore, it was not possible for Site B to customise the CIS or to improve its functionality:

“I think the defining moment was when we tried to add prescribing into the CIS, up until then it had been collecting data, but then the issue came up of having to prescribe drugs and prescribing drugs was a much more complex process than we realized and it was just far too cumbersome. It was actually open to errors.” **(Doctor, Site B)**

This last issue of flexibility might have been less of a problem had a good relationship with suppliers been evident. Unfortunately, this was not the case:

“They did promise to work with us and develop it into a reporting tool to give us more information and that didn’t come off. That was a shame, we bought promises and futures and I’m not blaming the suppliers for that, they had a good system in America, and it still does work well in America. But we wanted something different. The Americans were quite happy with it, and obviously we are only a small island, it was not worth changing for two hospitals in the UK. The company that was developing the stuff wasn’t pushing the suppliers into what we wanted them to. It was only us, pushing for this system, driving them to, but it is now what everybody is talking about, we were just ahead of our time.” **(Technician, Site B)**

Suppliers were not very keen on being involved with the development of the CIS, they had a larger market in the US and so were not very approachable when changes to the CIS, and CIS support, were requested. This meant that two technicians were responsible for maintaining the CIS, as well as being responsible for the physiological equipment, yet CIS maintenance, as at Sites A, C, and D, was not budgeted for. Where technicians were unable to rectify problems, the CIS suppliers had to be approached, but it soon became apparent to Site B that many of the promises negotiated with the suppliers would not be delivered, deflating Site B’s confidence in them.

Users at Site B found that frequent changes to the CIS impeded their efforts to learn to use it. While Site A did not find this to be a problem, the same was not true here. However, the CIS at Site B was never as fully developed as at Site A – the technicians at Site B made large changes frequently, and early on in the CIS implementation, rather than small incremental changes that were executed at Site A. Furthermore, changes at Site A were driven by suggestions from users as to how to improve a working CIS, rather than desperate attempts to make the CIS work. In addition, users at Site A were basically happy with their CIS, whereas those at Site B were not, which may have decreased their tolerance to changes.

Similarly to Site C, as management focus was applied to their own access to overview data about clinical quality, they were not concerned with user aspects of the CIS, and did not provide any resources for dealing with user complaints or improving the user interface. At present, users still find problems with the information services that are present in the hospital, including difficulties in gaining access:

“And as of yet, in terms of the patient information service we have got in this hospital, I haven’t got a password, they won’t give me one. So at the moment, I don’t use any patient electronic services and use only paper notes etc.” (Doctor, Site B)

This implies that user support was not forthcoming at this site.

Overall, the CIS introduced at Site B failed to be integrated. The system was abandoned in 1999. It was found that the CIS made existing work processes much more difficult, it created extra workload for nurses, and became very time consuming. It took time away from the patient without giving anything back to its actual users, who felt that it had been forced upon them without consultation. The extent to which this biases the ICU against future implementations of CIS remains to be seen:

“I don’t remember it very well because it never worked very well. We certainly never got the system up and running to level with its ability.” (Doctor, Site B)

7.2.4 CIS Integration

The discussion of CIS integration given in Section 6.2.4 is also applicable to Site B.

7.2.5 Summary and Conclusions of Validation at Site B

Sites B and C, which are in different countries, have many factors in common; many of the problems could be accrued to the large size of the two ICUs (attributed to Organisational Environment in the Organisational Culture category), but much is also related to the fact that both sites failed to engage users in the integration process, and they did not account for user needs and requirements.

CIS requirements were not adequately identified – at Site B, this was an ad hoc process, whereas at Site C an external survey informed the CIS procurement decision. Another interesting point is the fact that neither site used the cascade method of teaching, while the successful implementations at Site A and D did. However, leadership is not as strong in Sites B and C, so whether or not cascading teaching would have worked would be interesting to investigate. Furthermore, the cascade method was one that the users actively decided not to use as it involved teaching users while they worked. Despite this, the method appears to have been successful at Sites A and D, and this is certainly related to the Organisational Culture of the ICU and the Actual Usefulness of the CIS, as has been discussed in the previous chapter.

The factors identified in ISIM as important for CIS integration have been identified again in this independent evaluation, and no additional factors were found. The comparative discussions given above have shown that ISIM is not only applicable to Sites A, C, and D, where it was developed, but also to a further site that had a history of a failed implementation. Factors identified in the other sites were encountered again. The reasons for CIS discontent in Site C are very similar to the factors that led to the downfall of the CIS at Site B, but as Site C is still trying to integrate its CIS, the outcome of this integration remains to be seen. Site B further validated the CIS Integration History factor, which is part of Organisational Culture. Furthermore, the findings of this validation show that ISIM has empirical worth, and has much potential for use in ICUs.

7.3 Further Validation of ISIM – Questionnaires

Section 7.2 has shown that ISIM is a valid model for informing CIS integration. All the factors identified in the three data collection sites, and used in the ISIM model, were also found at Site B. However, as described in Section 5.1.3, a questionnaire was also distributed in each of the four sites, and this enabled further validation of the results. Although these were distributed at the same time that observation and interview data were collected, analysis was not performed until after ISIM was derived. This enabled a further check on ISIM, utilising a different method of data collection. Section 7.3.1 describes the questionnaire response rates at each site, while Section 7.3.2 presents the results.

7.3.1 Response Rates

The questionnaire response rates were

- Site A: 41%
- Site B: 19%
- Site C: 9 %
- Site D: 16%.

It can be seen that, apart from Site A, the response rates were low, especially Site C. This meant that the questionnaires were not used for the derivation of the model, but were used instead as a secondary method of validating the components of ISIM.

At the end of the data collection period it was discovered that all sites found the questionnaire too long. This was not foreseen as a problem during evaluation of the questionnaire conducted by two researchers at the University of Manchester who are experienced in survey research, nor during piloting with nurses and doctors before distribution.

A second criticism was received from the Danish Site C – respondents found it difficult to reply in English despite a comment on the questionnaire cover sheet stating that respondents were very welcome to reply in Danish; however no respondents did so. This may be due to respondents feeling that their confidentiality may be compromised, as the questionnaires were not to be translated by independent professionals. It was impossible to do this, since the cost of translation services is high and one that PhD research does not budget for. The following section presents the questionnaire results.

More detailed information, including the responses for all questions and any free text answers and comments, are given in Appendix R.

7.3.2 Questionnaire Results and Discussion

Questionnaire Topics

As the questionnaire was developed before data collection began, and distributed during data collection, it was not possible to focus the questions towards any particular area; rather the questions attempted to discover as much information as possible about CIS usage and opinions, so that these data could be used later, after the results from other methods of data collection had 'emerged' from data.

The questionnaire was divided into six generic areas:

1. The CIS used in the ICU – Questions 1-5
2. Ease of using the CIS – Questions 6-12
3. Comparison of Paper and electronic CIS – Questions 13-18
4. ICU staff information requirements – Questions 19-27
5. Organisational Issues – Questions 28-32
6. Demographics – Questions 33-38

After ISIM had emerged, and was validated at the fourth site, the questionnaire questions were grouped under the factors of the Organisational Culture and Actual Usefulness categories within ISIM. This can be seen in Table 7.6, which shows that each factor in ISIM is covered by questions from the questionnaire. Descriptive statistics in the form of frequency analyses were conducted, and were compared across the sites; these are given in Appendix R, and are described next. More complex statistical analyses were not conducted. The reasons for this are identified at the end of this section.

Table 7.6: List showing which questionnaire questions correlate with ISIM factors

<i>Organisational Culture Factors</i>	<i>Questions</i>	<i>Actual Usefulness Factors</i>	<i>Questions</i>
Training and Education	6, 7, 8	System Suitability	5, 12, 12a, 13, 14, 16, 17, 20, 21, 23, 24
User Knowledge and Experience	1, 15, 17, 38	Reliability	5, 10, 11, 16, 18, 18a
Users	12, 12a, 17, 20, 30	Quality	5, 11, 16, 18, 18a, 21
Organisational Environment	3b, 3d, 9, 12, 12a, 17, 22, 23, 28, 29, 31, 32	Flexibility	5, 11, 18, 18a, 21
Expectations	1, 4	Speed	5, 11, 16, 18, 18a
Management Support	9, 28, 29	User Friendliness	5, 11, 18, 18a
Group Attitude	1, 17, 23	Job Relevance	5, 12, 13, 14, 16, 20, 23, 24
Integration History	1	System Support	5, 9, 10a,

Frequency Analysis

This section describes the questionnaire results, focussing on questions that contribute to an understanding of ISIM. As mentioned above, the low response rate, particularly at Sites C and D, mean that statistically valid conclusions cannot always be drawn.

All respondents believed that a computerised CIS was useful to some extent (Q1), although respondents at Sites A and B, the English sites, were generally more positive. The results of the first open question (Q4) showed that only Site A reported negative expectations before the CIS was introduced. This may be because a greater number of respondents completed the questionnaires at this site. In general, CIS expectations were similar across all sites.

Only at Site B did the majority of respondents feel that their CIS performed below their expectations, although some respondents from Sites C and D also reported this; only 1 person at Site A did so. The comments from Site C show that users anticipate the system to improve over time.

The importance of training for CIS integration was made clear in Q6, Q7, and Q8, although respondents at Site D did not believe that training was very important. The fact that this site has not yet implemented a system may have affected this. Of the training provided, Site A found it to be the most useful; this site also trained its staff

most often, cascading training through the ICU whenever substantial changes were made to the CIS.

Satisfaction with the CIS at Site A was heightened from the response to Q9, an open question that asked how respondents would deal with CIS failure— a respondent stated that it was unexpected. This was further validated by Q10, where fewer users than at the other sites had experienced problems with the CIS, where the support they received was deemed to be adequate by all respondents, in contrast to Sites B and D.

In Q11 respondents were asked whether their current system was better (in a HCI sense) for viewing and entering data. Electronic CIS were faster, easier to use, and more flexible than paper for entering data. Overall, each site expressed a preference for computerised CIS in Q13, with Sites A, B, and C expressing a strong preference. In the case of Site C this is counter-balanced with the fact that a respondent also expressed a strong preference for paper. As responses from this site were low, respondents might well have been those who held extreme views about the CIS.

In general, all respondents agreed that an electronic CIS is more flexible in that it can be used for a variety of tasks in a variety of ways (Q14), but respondents were mostly neutral when asked which system provided more trustworthy data (Q15). This is in line with responses from the interviews when qualitative data such as care plans are considered, i.e the information is only as reliable as the person who enters it. A country split in the results of Q16 is evident, with Sites A and B (England) agreeing that electronic CIS provide more care time for the patient, while Sites C and D thought that both electronic and paper CIS were both about the same. This was unexpected in the case of Site B, with a history of a failed CIS.

An electronic CIS was mostly preferred to inform all healthcare groups (Q17), except at Site C, where no preference was given. Less consensus was evident where respondents were asked to rate electronic and paper CIS for a range of HCI factors (Q18). Those at Site A preferred electronic CIS mostly, although they believed that both systems were equally reliable. Site B agreed, but Sites C and D believed that electronic and paper CIS were about the same for all factors. This probably reflects the electronic systems that were used at Sites C and D.

The majority of respondents agreed that their information requirements (Q20) were met most of the time, although many respondents from Site B believed that they were met only some of the time. The information content of the CIS was considered to

be about the same for both paper and electronic systems by Sites B and C, with Sites A and D showing a slight preference for electronic systems.

At Sites B and C, which have had negative experiences with CIS integration, respondents believed that the introduction of an electronic CIS caused major changes (Q22); at Sites A and D responses suggested that CIS cause only minor changes. Only respondents at Site A believed that they had a fully integrated CIS (Q23).

In Chapter 6 it was reported that many nurses felt that doctors were not sufficiently involved with the CIS and relied upon the nurses to do that part of their job for them. In Q26 this was stated to be favoured least by five respondents at Site A. Q27 asked whether respondents would recommend their system to other ICUs. Only respondents from Site A would definitely recommend their system.

The findings about Organisational Environment in Chapter 6 were borne out by Q28, where staff at Site A felt involved with the CIS, as did some at Site D, while those at Sites B and C did not. This is slightly different than responses to Q29, where respondents from English hospitals thought their inputs were considered to be of more value by management than respondents at the Danish sites.

Further Statistical Analysis

Further statistical analysis, including correlation analysis between variables, and linear regression was not possible due to the peculiarities of the questionnaire data:

- The number of respondents from Site A far outnumbered the other sites.
- There were very few respondents from Site C.
- No doctors responded at Site A, although questionnaires were distributed to them.
- The majority of respondents at Site D were doctors.
- Almost all respondents at Site A were female.

These points mean that any cross-analysis performed on the data would be very biased, and would mostly reflect the situation at Site A.

7.4 ISIM, TAM, and TAM 2

ISIM has some similar features to the Technology Acceptance Model (TAM), developed by Davies in the late 1980s. This section shows that the similarities are slight and that the differences between the models are more important. Evidence is provided to show that ISIM may be better suited to healthcare.

TAM (Figure 7.1) was developed for analysing factors that influenced user perceptions of, and attitudes towards, information systems. TAM is based on data collected about MBA student's uptake of email, using a survey study (Davies, 1989). Although TAM has been used extensively in industry, it is consistently reported to explain only 40% of system use (Legris and Collette, 2001). Chismar and Wiley-Patton (2002) assert that only two applications of TAM have been found in healthcare, those being Hu et al. (1999) and Dixon and Stewart (2001); the former were concerned with analysing CIS adoption by family physicians adoption, while the latter investigated physician acceptance of tele-medicine applications. Both found that TAM did not fit with physicians and that the model did not 'work' (Chismar and Wiley-Patton, 2002). Chismar and Wiley-Patton's claim that only two applied studies of TAM in healthcare exist is incorrect – a further study was found, that of Handy et al. (2001).

Handy et al. investigated the attitudes of primary care physicians towards a proposed system for maternity patients. They found that TAM was not appropriate, and so it was modified to include the categories of 'perceived system acceptability', 'organisational characteristics', and 'individual characteristics' before being applied. Handy et al. (2001) criticize TAM for *'simply investigating user perceptions of CIS exclusive of contextual and organisational issues'*.

Venkatesh and Davies (2000) extend TAM to include cognitive instrumental processes (perceived usefulness, job relevance, output quality, result demonstrability, and perceived ease of use) and social forces (subjective norm, image, and 'voluntariness'). The outcome of this extension was TAM2 (Figure 7.2). Chismar and Wiley-Patton (2002) claim that TAM2 has not been tested in healthcare, and so they apply the model in a pediatric setting, to investigate the adoption of Internet and Internet-based health applications. The authors found that their results partly confirmed TAM2 although *'significant parts of the model were not confirmed'*.

7.4.1 Criticisms of TAM and TAM2

The original TAM model is shown in Figure 7.1. It can be seen that Perceived Usefulness and Perceived Ease of Use are independent of each other, and that they are about the *system* only. All the relationships in the model are expressed as one-way, which implies that IS are perceived in a linear fashion; however considering the

empirical evidence given in Chapter 6, ISIM shows, this is not always the case. Note also that TAM considers perceived factors only.

Although it appears that Actual System Use is similar to Actual Usefulness in ISIM, it can be seen quite clearly that Actual Usefulness in ISIM does not just refer to the *system*, but states that a relationship between the context (work processes) and the Organisational Culture impact CIS integration. Unlike TAM, ISIM considers the evolving state of systems integration through iterations of the model, while TAM appears to be static.

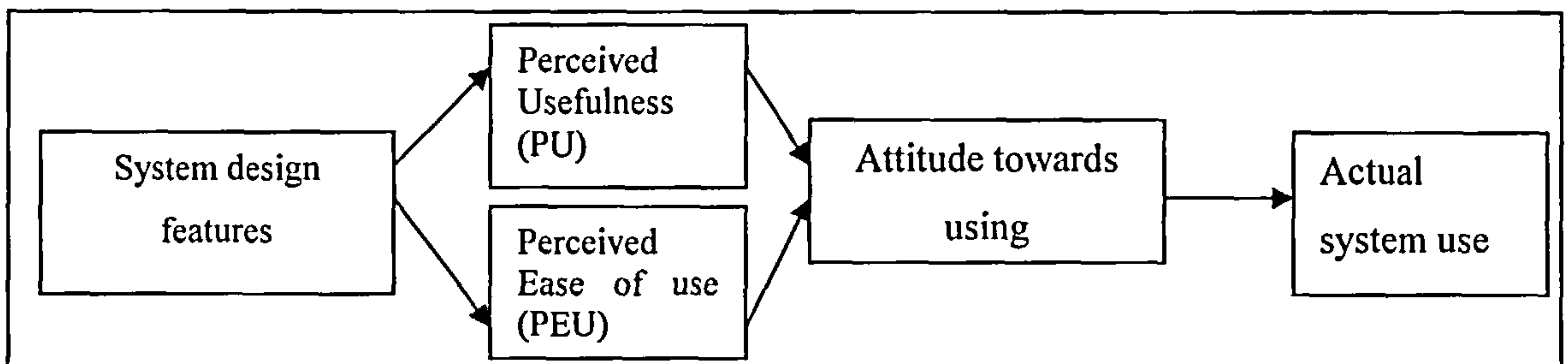


Figure 7.1: TAM (Davies, 1989)

In the revised model, TAM2, shown in Figure 7.2, the iterative links between the work processes and Actual Usefulness and organisational factors is still missing, so that TAM2 is only suitable for assessing technology acceptance after the system has been fully implemented. It misses completely the contextual factors, and does not allow for inter-relationships between factors; all of the factors that affect technology usage are independent of one another. In reality this is unlikely. TAM and TAM 2 are quantitative models that use pre-developed and prescriptive questionnaires to quantify each aspect of the models.

ISIM is derived from 'real clinical users' in 'real clinical environments'. It is not static, and considers the evolving nature of organisations and the complex web of interactions that take place within those organisations. Whether or not ISIM is applicable in other areas of healthcare, and even areas outside healthcare is an interesting question that remains to be tested.

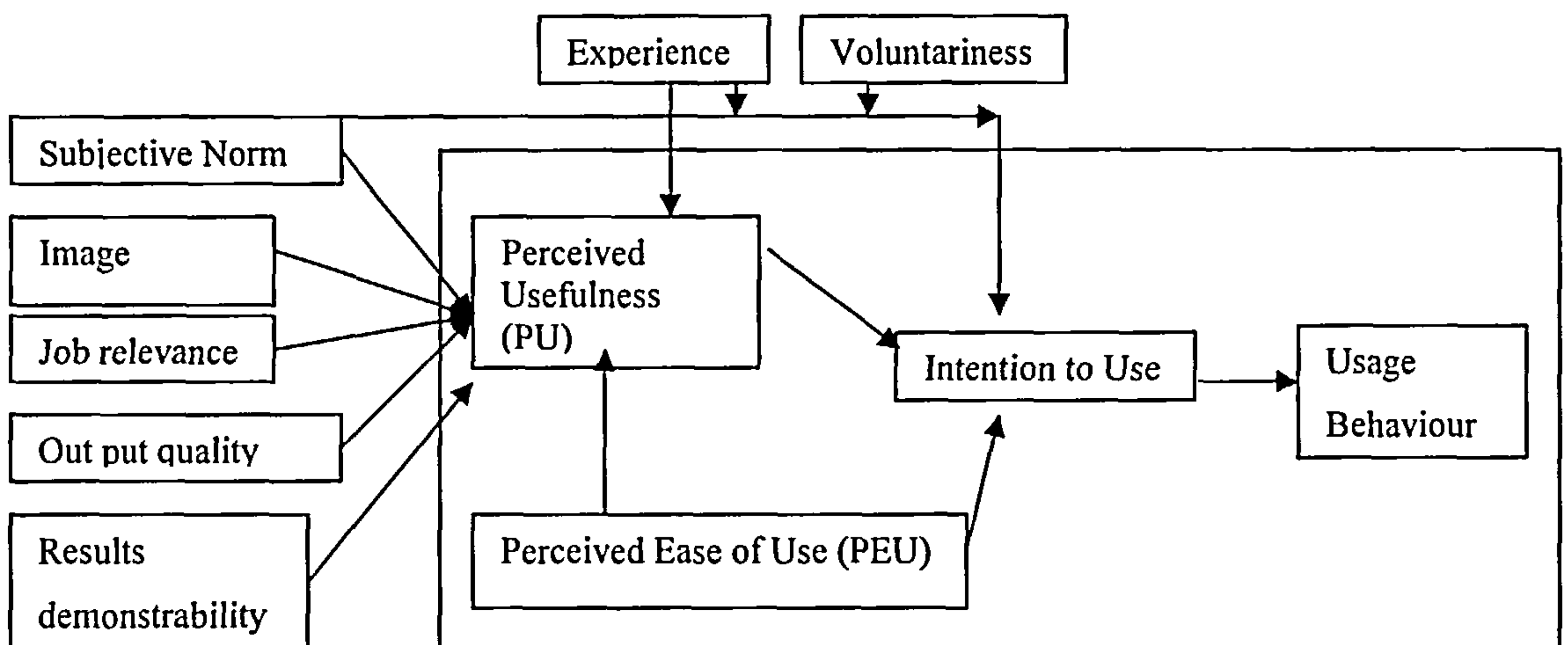


Figure 7.2: TAM2 (Venkatesh and Davies, 2000)

7.5 Summary

This chapter has presented a validation of ISIM in a fourth ICU – Site B, has presented the results from questionnaires distributed at all four sites during the data collection process, and has highlighted the differences between ISIM , TAM and TAM 2.

During the validation of ISIM in Site B, it was shown that the factors in the ISIM model were repeated in this site; this ICU has a history of a failed CIS implementation, which provided a stronger indication of the importance of the ‘CIS Integration History’ factor in Organisational Culture. Similar characteristics between Sites B and C were identified, in particular the factors that contributed to CIS failure in Site B were evident in Site C; as the CIS in Site C is still being integrated the outcome of CIS integration is yet to become apparent there.

ISIM was further validated using questionnaires distributed at each site. The questionnaires were analysed independently of ISIM. Despite low response rates in Sites B, C, and D, the questionnaires were useful for further validating ISIM. It was found that no new categories emerged, however the results of the questionnaire did confirm the existing factors in ISIM. Further, they emphasised the inter-dependencies of these factors, as some questions could be used to inform more than one factor (see Table 7.6).

Finally, ISIM was compared to TAM and TAM 2, models considered to be most similar to ISIM. However, the discussion in Section 7.4 revealed that the similarities are superficial, and evidence that TAM and TAM 2 have been found to be unsuitable for

evaluating CIS in healthcare settings, was presented. As ISIM has been developed from empirical data collected from ICUs it should be more applicable to healthcare settings.

Chapter 8, the concluding chapter, will present a critical evaluation of this thesis, where the achievement of the aim and objectives will be discussed, together with the validity and reliability of the study. A discussion of this thesis, compared to the conclusions drawn from the literature in Section 2.8, is also given, and the thesis conclusions are presented.

Chapter 8

Summary and Conclusions

The aim of this chapter is to present the summary of this thesis and to critically evaluate the work that it contains, so that an assessment of the achievement of the thesis aim and objectives can be made. The contributions of this thesis are outlined, and conclusions about the research are drawn.

8.1 Thesis Summary

This thesis began with the question of whether or not Organisational Culture informs CIS implementation and integration. Chapter 2 was concerned with reviewing the salient literature. It covered the areas of Clinical Information Systems, Intensive Care Units, and Organisational Culture, and confirmed that ICUs were an under-investigated area in Health Informatics, specifically with regard to Organisational Culture. It was found that the literature recognises the importance of organisational issues. It supported the view that organisational factors, although researched for over 50 years, had only recently gained any standing within Medical and Health Informatics, and yet could greatly affect CIS implementations such as an EHR. There are few studies of Organisational Culture in Health Informatics, and those that exist are often conducted under the broader subject heading of organisational issues/factors. Further, few empirically derived and validated organisational culture models were found in healthcare.

Having introduced the thesis and reviewed the literature, it was important to present the context of this research, so Chapter 3 was concerned with presenting the ‘bigger picture’ surrounding each of the four ICUs, two each in Denmark and England, before describing the individual situation at each site.

Chapters 4 and 5 presented the methodological underpinnings of the thesis. Where Chapter 4 focussed on presenting the theoretical aspects of the research methodology, Chapter 5 concentrated on presenting the actual data collection methods used. The research adheres to the phenomenological paradigm, and in particular it used both case study and ethnography as its methodologies. In Chapter 5, the data collection methods of non-participant observation, shadowing of clinical staff, and semi-structured interviews were given as the chief data collection methods, with the approach to analysing the resulting qualitative data being given as grounded theory. Questionnaires were used to further verify the research findings but were not used to derive the Iterative Systems Integration Model (ISIM).

Chapter 6 is the ‘heart’ of the thesis. The chapter develops ISIM, and also its components (work processes, Actual Usefulness, Organisational Culture, and CIS Integration). To enable a better understanding of the model, hypothetical cases of when and how it may be applied were presented, before the details of ISIM and its derivation were discussed. The formulation of ISIM in terms of grounded theory was discussed in terms of each component of the model.

Work processes are an important part of ISIM. They were illustrated and described using Role Activity Diagrams i.e., the diagrams illustrated: nursing meetings, the nursing shift handover, doctors meetings and shift handover, patient preparation for doctor’s rounds, and the doctors rounds. It was found that these processes were virtually identical at each site, regardless of country. However, they differed at the information processing level, which were summarised in tables, so that comparisons across the three ICUs (labelled A, C, and D) used to develop ISIM could be clearly seen. These tables were extended in Chapter 7, when a fourth ICU (Site B) was used to validate the model.

Finally in Chapter 6, each factor of the Organisational Culture and Actual Usefulness categories were presented in a discussion comparing these factors across the three sites. The validation of ISIM was presented in Chapter 7, where it was shown that the factors in the ISIM model were repeated in a fourth site that had a history of a failed CIS implementation. This site provided a stronger indication of the importance of the

‘CIS Integration History’ factor in the Organisational Culture category. Similar characteristics were identified between Sites B and C, in particular, the factors that contributed to CIS failure in Site B were evident in Site C; as the CIS in Site C is still being integrated the outcome of CIS integration was yet to become apparent there, as was discussed in Chapter 7.

Despite low response rates from Sites B, C, and D, questionnaires were useful for further validating ISIM. It was found that no new categories emerged, however the results of the questionnaire confirmed the existing factors in ISIM. Chapter 7 also highlighted the differences between ISIM and the Technology Acceptance Models (TAM and TAM 2), commonly-used models for measuring system use. The discussion revealed that the similarities were superficial, and evidence that TAM and TAM 2 had been found unsuitable for evaluating CIS in healthcare settings was presented. As ISIM had been developed from empirical data collected from ICUs, it should be more applicable to healthcare settings but requires testing.

8.2 Critical Evaluation

A critical evaluation of this research is presented in this Section. It evaluates the aim and objectives of this research (Section 8.2.1), the validity and reliability of this research (Section 8.2.2) and the limitations of this research (Section 8.2.3). The research evaluation in terms of the literature review given in Chapter 2 is given in Section 8.2.4. The contributions of the thesis are outlined in Section 8.2.5, and finally for this section, future work is given in Section 8.2.6. For the thesis conclusions, see Section 8.3.

8.2.1 Assessment of the Research Aim and Objectives

In Section 1.2 the aim and objectives of this thesis were presented. These are given again for convenience.

Aim

The aim of this thesis was:

To develop a declarative model of clinical information systems integration based on empirical evidence from intensive care settings.

Objectives

The objectives of this thesis were:

1. *To investigate the significance of Organisational Culture for explaining actual CIS deployment in intensive care.*
 - a. To determine the Organisational Culture characteristics that affect CIS integration into intensive care settings.
 - b. To determine the relationship between Organisational Culture characteristics found and CIS as they are used in practise.
2. *To investigate the interactions between clinical staff and CIS, so that it is possible to determine the effect of these interactions on intensive care clinical work processes.*
 - a. To determine the interactions that take place between clinical staff and their work processes.
 - b. To model the above interactions.
 - c. To explore the relationship between Organisational Culture, actual CIS use, and clinical work processes.
3. *To develop a theoretical model of CIS integration.*
 - a. To conduct a comparison of the findings from each site
 - b. To apply the knowledge and understanding drawn from primary empirical evidence to develop a model for CIS integration.
 - c. To validate the model using an investigation at another site.

Table 8.2 outlines these objectives and provides a reference to where they were demonstrated within the thesis. Each primary objective is then discussed.

Table 8.1: References for the Achievement of the Research Objectives

Primary Objective	Sub-Objective	Section	Page
1	a	6.2.2	110
	b	6.2.3	129
2	a	6.2.1	94
	b	6.2.1	94
	c	6.1.2	89
3	a	6.2	93
	b	6.1	85
	c	7.2	142

Evaluation of the Achievement of the Research Aim and Objectives

Each primary objective is discussed first, followed by the achievement of the thesis aim.

1. *To investigate the significance of Organisational Culture for explaining actual CIS deployment in intensive care.*

In order that the role of Organisational Culture for determining CIS interaction in ICUs could be investigated, it was important to be able to obtain data in the context within which it occurred. Therefore, non-participant observation and interviews with clinical staff enabled the collection of data, which were analysed using grounded theory to determine the Organisational Culture factors that affect how CIS are integrated; a second category, the Actual Usefulness within ISIM, emerged from the data. Organisational Culture was shown to have a very significant role for CIS integration, and eight Organisational Culture factors were identified from the data (see Section 6.1 in Table 8.1).

2. *To investigate the interactions between clinical staff and CIS, so that it is possible to determine the effect of these interactions on intensive care clinical work processes.*

Data collected from observations and interviews with clinical staff enabled the development of Role Activity Diagrams, which were analysed across all sites, so that the interactions between the CIS and clinical staff could be recorded with consideration to ICU work processes. These work processes only differed between ICUs at the information processes level.

3. *To develop a theoretical model of CIS integration.*

Having achieved the first two primary objectives, it was possible to develop a model of CIS integration using the findings from Actual Usefulness, Organisational Culture and Work Process analysis. This was presented in the form of the Iterative Systems Integration Model (ISIM), which was evaluated in Site B. ISIM was further validated using the results from the questionnaires. All sites were given feedback of the results and they too confirmed the findings.

It can be seen that the achievement of the research objectives ultimately enabled the achievement of the research aim, i.e., the development of a declarative model of clinical information systems integration based on empirical data from ICUs. The trustworthiness of this research is discussed next.

8.2.2 Validity, Reliability, and Generalisability

In Section 5.2.4 the concept of triangulation was discussed. It was found that triangulation of different methods can enhance the validity and reliability of the research findings (Denzine, 1970). This research employed three of the five types of triangulation: data triangulation (i.e., a variety of informants (nurses and doctors)), method triangulation (i.e., a variety of data collection methods (interviews, observations and questionnaires)), and environmental triangulation (different locations/settings (four ICUs, two each in England and Denmark)).

Most studies attempt to adopt two types of triangulation (Hussey and Hussey, 1996; Robson, 1993), it can be seen that this work adopts three types of triangulation so that the research findings can be accepted with more confidence. The reliability, validity, and generalisability factors of this research are now discussed in greater detail.

Reliability

In positivist research, it is generally accepted that if findings are repeatable by other researchers, then they are reliable (Hussey and Hussey, 1997; Robson, 1993). However, this thesis is a phenomenological study and it is common knowledge that the replication of qualitative studies is a more complex matter, due to the subjective nature of this type of research. This does not, however, imply that qualitative research cannot be reliable since *“it is not important whether qualitative measures are reliable in the positivistic sense, but whether similar observations and interpretations can be made on different occasions and or by different observers”* (Hussey and Hussey, 1997).

For pragmatic reasons it was not feasible to work with other researchers at the time, so that the findings could be tested. Collaborations with other researchers may enable this work to be tested at other sites in the future. In terms of similar observations and interpretations being attained on different occasions, Section 7.2 presents the results of an evaluation of the research findings conducted in a fourth site. Similar observations and interpretations to those at the original three sites were found.

Validity

Validity is defined as the *“extent to which the research findings accurately represent what is really happening in a situation.”* (Hussey and Hussey, 1997). Validity is often very high in qualitative research, since it aims to capture the real meaning of the phenomena by collecting data rich in context and explanations (Robson, 1993). This thesis aimed to achieve this by using observations conducted at the location of the phenomenon being investigated, rather than conducting observations in a laboratory, away from the natural context of clinical staff. This enabled understanding of clinical work processes in context and situation, with regard to CIS interaction. Further, interviews were conducted and these verified observations i.e., were observations consistent with ‘that’, being told, and vice-versa?

Generalisability

In positivistic research, generalisability is defined as the *“application of research results to cases or situations beyond those examined in the study”* (Hussey and Hussey, 1997). Gummerson (1991), in Hussey and Hussey (1997), states that *“using statistics to generalise from a sample to a population is just one type of generalisation: in phenomenology it is feasible to generalise from one setting to another.... i.e., can patterns, theories, and concepts generated in one environment be applied in another?”* Statistical generalisations were not possible in this thesis. However, conducting research in a number of ICUs confirmed that similar conclusions could be drawn across four ICUs; ISIM was applicable in all the sites investigated. Future research could investigate the applicability of ISIM in ICUs in other countries, and even in other areas of the healthcare sector (this is discussed in more detail in Section 8.2.6).

Having discussed the credibility of this thesis, it is also important that the thesis limitations are reported, these are presented next.

8.2.3 Thesis Limitations

The paucity of questionnaire responses was quite disappointing. Although both academics and clinical staff at each site piloted the questionnaires, the Danish respondents felt that the questionnaires were too long and took too much time to interpret and complete. As only a small sample of nurses and doctors tested the questionnaire, it appears that the sample was not very representative.

Translating the complete questionnaire into Danish was considered before distribution, but as feedback was positive this was not thought to be necessary. Translation costs for a minority language such as Danish are also very high, and were not within budget. However, had this been a positivist study, relying solely on survey data, greater emphasis would have been placed upon the questionnaires, which would have been translated; future research in this area will consider this option in more detail, and it may also be possible to budget for this in post-doctoral research. As the questionnaire was also not the focal source of data from which ISIM was derived, this is not a major limitation to this thesis.

A focussed and directed research team may be better suited to this type of study than a sole researcher, as was found by Kay et al (1996); as discussion of findings and interpretations may lead to more reliable and generalisable findings, if a number of independent researchers arrived at similar conclusions.

ISIM is not a static model, but describes the iterative nature of CIS integration in ICUs. Although the Role Activity Diagrams used to model the work processes are static, since process models are snapshots of work processes at a particular point in time, the importance of remodelling work processes during different iterations of CIS integration was stressed in Chapter 6. ISIM is not prescriptive; rather, it acknowledges the dynamic nature of ICU organisations, operating in 'real' time with 'real' people. It is advocated as useful for *guiding* CIS integration, rather than prescribing exactly how it should be conducted, since each organisation is complete with its own set of norms, values and idiosyncrasies. Section 8.2.4 presents a discussion of the thesis in terms of the literature review presented in Chapter 2.

8.2.4 The Thesis in Terms of the Literature

This section discusses ISIM in terms of the issues that arose from the literature review (Section 2.8). The general points identified in Section 2.8 are discussed and then ISIM is discussed with regard to a paper by Kaplan and Shaw (2002), which reviews models used to assess CIS implementations.

The conclusions drawn from the literature review in Section 2.8 are given below, with each point being followed by a discussion of how this thesis addresses the issues raised.

1. Since the introduction of CIS in healthcare in the 1960s, little has changed in terms of organisational problems when implementing CIS (Richards, 2001).

The paper by Richards (ibid) found that organisational issues, such as user perceptions of CIS, were causes of unsuccessful CIS implementation as early as the 1960s; this is still being found today (Kaplan and Shaw, 2002). In this thesis the Organisational Culture and Actual Usefulness factors of ISIM identified show that there are many significant features that affect CIS implementation and integration; these features can inform understanding of CIS integration issues. Furthermore, human and organisational issues were found to be at least as important as the technical issues as causes of failure (at Site B) and unrest regarding CIS at Site C. However, this thesis has also shown that while poor organisational factors can contribute to failure, they can also be significant factors for successful CIS, as exemplified at Site A.

2. Despite decades of research in Health Informatics, implementing and integrating a CIS into secondary care remains a major problem (Benson, 2002a and 2002b; Schoeffel, 1998).

This thesis has shown that this is true in all four ICU settings examined, and has investigated many of the reasons why this is so.

3. The issue of integrating CIS successfully into complex areas, with equally complex information needs, becomes much more salient with government-imposed deadlines for EHR developments across the globe (AMIA, 2003; Iakovidis, 1998; Moorman and Van der Lei, 1999).

This is a very important issue, especially for ICUs. Section 6.2.1 highlighted the complexity of an ICU environment and the dependency on the availability and access to patient information. Furthermore, the participants of this environment, such as clinical staff, have been quoted as saying that their needs are not being addressed in large scale

EHR projects, where the focus remains on more general hospital departments. If an EHR is to be successfully integrated in all areas of patient care, then every area needs to be considered, and complex areas like ICUs must not be ignored.

4. *ICU information requirements differ substantially from other areas of a hospital, and this will affect the design and development of CIS (Hagland, 1998; Campbell et al., 2001; Randolph and Kane, 1998).*

Section 6.2 draws similar conclusions from observations at three of the four ICU settings (A, C, and D) discussed in this thesis.

5. *The issue of transferability of CIS developed in one setting to other healthcare departments and institutions is challenging (Heathfield et al. (1994)). However, it has been demonstrated that CIS developed in complex areas such as ICU are more likely to succeed in other less complex areas of healthcare, rather than vice-versa (Junger et al., 2001; Hagland, 1998).*

This thesis has not examined this question, focussing on implementation of CIS in ICUs. However, Section 6.2.1 has shown that the ICU work processes are very similar across all sites, regardless of country and size of unit. This is an interesting finding that implies that, at least at the English and Danish level, these countries could collaborate and inform each other's EHR developments. Whether this would be true for other countries and other areas on healthcare is something in need of investigation.

6. *Few large-scale studies of ICU exist (Bennet and Bion, 1999), and very few tackle the issue of Organisational Culture and CIS in intensive care.*

This thesis investigates four ICUs in two different countries, each at a different stage of CIS implementation. The particular focus of the thesis has been the investigation of human and organisational issues with regard to the CIS implementation.

7. *Few organisational models developed for informing CIS implementations are based on empirical evidence (Iles and Sutherland, 2001).*

ISIM is grounded in empirical data collected from three ICU settings, and was validated in a fourth. In terms of the literature, this thesis contributes original work, based on empirical evidence, to the existing academic literature; specifically, the thesis investigates Organisational Culture issues with regard to CIS integration in intensive care.

ISIM and other Models

Many CIS evaluation models and methodologies exist; a very comprehensive and thorough review of a large number of these models is given by Kaplan and Shaw (2002), and those of relevance to this thesis were discussed in Section 2.4.1.

Kaplan and Shaw's paper highlighted the fact that a majority of research focuses on system success and highlights the importance of not only the technical aspects of a system, but also the organisational, behavioural, and human factors. Further, they state that contextual issues are also important, so that evaluations consider not only the system, but also the users and the setting in which the system is implemented.

The authors found that, despite the vast amount of research in this area, a number of issues remain under-investigated. These issues are addressed below in terms of this thesis and ISIM:

- *“Many evaluations focus on practitioners, primarily physicians... more evaluations are needed that address the concerns of the many individuals involved in, or affected by, informatics applications”.*

This thesis has addressed this issue through the research at the four ICUs. ISIM was developed in consideration of nurses and doctors, and also acknowledged the input of other clinical staff, as shown in the RADs given in Section 6.2.1.

- *“Attention is needed not only to successes, but also to failures, partial successes, and changes in project definition...publication bias in Medical Informatics provides little opportunity to learn from studies in which technological interventions resulted in null, negative, or disappointing results”.*

ISIM was informed by not only successful CIS implementation (Site A) and ongoing implementations (Sites C and D), but validated in Site B, where a CIS had failed. The thesis discusses all four sites, which were at different stages of CIS development. These different stages helped ground ISIM not just in one context of successful system integration, but in three other contexts, which demonstrate failure (Site B), partial failure (Site C) and partial success (Site D).

- *“Comparative studies, while exceedingly difficult, are important for illuminating contextual issues.”*

This thesis investigates four sites, and compares the findings at each of them.

- *“More work is needed to develop both evaluation methods and theory, and to bring together understanding developed through these studies.”*

The three issues highlighted above by Kaplan and Shaw (2002) have been discussed in the context of this thesis. It has been shown that this thesis has considered the factors that were reported as being under-investigated by the authors in the development of ISIM.

Section 7.4 discussed the relationship between ISIM, TAM and TAM 2, and highlighted the differences between the three models. The precise contributions of this thesis are given next, in Section 8.2.5.

8.2.5 Contributions

This thesis makes a number of useful contributions to Health Informatics, and its practitioners. These are listed in order of significance below:

- Develops an empirically validated model of CIS integration – The Iterative Systems Integration Model (ISIM) – for informing CIS integration into ICU, (Chapter 6).
- Contributes original work – based on empirical evidence – that investigates the significance of Organisational Culture for integrating CIS in intensive care to the academic discipline of Health Informatics (Section 2.7).
- Provides process maps of intensive care work processes, based on empirical observations from intensive care settings, to illustrate the interactions that occur between clinical staff, CIS, and intensive care work processes (Section 6.2.1).
- Provides insights into the interactions that occur between clinical staff, CIS, and intensive care work processes.
- Enables the dissemination of empirical evidence from four separate intensive care sites that support theory, and contribute to knowledge and the academic literature about Organisational Culture, clinical information systems, and the interactions between these in intensive care.

The findings may be of particular interest to those involved with the introduction of the integrated care record service (ICRS) in the UK National Health Service (NHS) (DOH, 2002b), and those involved in national Electronic Health Record (EHR) initiatives in Denmark, as data were collected from sites in these countries. Global EHR initiatives may also find this thesis of some use, for its insights into the context of clinical work and CIS integration.

Responses from three correspondents at Sites B, C and D illustrate a specific and practical contribution to the ICUs in Sites B, C and D (Site A did not provide written feedback therefore it is not quoted):

“I think it’s an accurate reflection of what went wrong at [Site B]. I feel that we will struggle to re-introduce a CIS until we can offer more automated data collection to the staff (e.g. labs), in addition to the points you’ve raised. As our Trust doesn’t have an interface engine that could be some time off. I’ve love to have a look at the finished thesis as it will no doubt help us second time round (whenever that is)”. (Contact, Site B)

“I’ve read your excellent paper again today. And my answer will be a bit different from the first time I read it. I remember feeling that it all seemed ages ago, all the things concerning the implementation of CIS, when I first read it. And I couldn’t remember the doctors not being interested in using the system, as I was more concerned with the nursing staffs reaction to the system.

Now – almost a year after – I can suddenly see what you are referring to in your paper. And I have to agree with your findings completely. I suddenly also understand the questions you’ve asked me about the ward better. So what do I think about your paper? I think you’ve pointed out some very important factors in implementing CIS into a clinical setting. And I wish your paper – or findings – had existed prior to implementing CIS to our ward. Now all I hope is that they – the management – will consider your findings before they start implementing the doctors and the nurses EPR. Have you sent the paper to them? And are you planning to send your doctoral thesis to them? I really think it’s an excellent paper. And it’s only gotten better after reading it again now almost a year after we started implementing the CIS into the ward” (Nurse, Site C).

“Concerning the paper [...] I have reread it now and find it well describing the actual situations in Denmark and setting up good conclusions” (Contact, Site D).

8.2.6 Future Work

- Investigate ISIM in more ICU settings, to improve its generalisability. Academics at Massey University in New Zealand have already expressed an interest in testing ISIM in New Zealand ICUs, and further investigations can only add to the results.
- To consider the question of whether ISIM is applicable in the private healthcare sector. While it seems unlikely that there would be any difficulties, the Organisational Culture of private hospitals, in terms of governance, finance, and motivation, is radically different. It would be interesting to compare these findings with public health services, both within a country, and trans-nationally.
- Examine the applicability of ISIM in practice as a guide for informing CIS integration in ICUs. This would have to be a longitudinal study that follows an ICU throughout the process of CIS procurement, implementation, and integration, and would require a long-term relationship with the ICU site.

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- Investigate the applicability of ISIM in other areas of healthcare. ISIM was developed from data exclusively captured in ICUs, and may therefore not be directly applicable to other healthcare settings, such as other hospital units, and primary care. This requires further investigation, but would be of great interest, both because it would provide a useful model to those settings, but also because this investigation would highlight differences between the work processes in the different settings, and hence the information processes.
 - Examine the applicability of ISIM in other sectors. TAM and TAM 2 have been used with varying success in many sectors, but they were originally developed from just one set of data. While it is unlikely that any one generic model can capture the complexities of all information system integrations, ISIM, and variants of it, may be useful in other sectors.

8.3 Conclusions

It is evident that despite the purported benefits of CIS, and decades of research in Health Informatics, users in this study were still experiencing CIS problems that were prevalent in the 1960s. Many studies have emphasised the difficult nature of CIS implementation, and the increasing number of failed CIS implementations. Much evidence suggests that CIS are often greeted with scepticism and uncertainty as to their capabilities and integration with existing clinical activities. Many systems remain unused, or are used far below their potential. The care of the patient is paramount, and unsuccessful implementations detract from patient care. In addition, the pressures on management to reap returns on their investment are great, as the public healthcare sector is renowned for its shortage of resources, so justification of every investment becomes imperative, and successful outcomes a necessity.

Although many randomised controlled trials and economic analysis studies have been conducted for evaluating CIS use in healthcare, it has become increasingly apparent that these methods alone are not sufficient. The study of organisational and human factors has only recently gained momentum, despite decades of research. The question of whether or not Organisational Culture could inform CIS implementation and integration is under-investigated. Further, no empirically derived and validated Organisational Culture models in healthcare were found.

This thesis aimed to develop a declarative model of CIS integration grounded in empirical data from ICUs, a healthcare area under-investigated in Health Informatics, despite the intensity of its information needs. ISIM, a model to guide CIS integration in Intensive Care Units, was developed. ISIM was derived from empirical data (observations, shadowing, and interviews) collected from three ICUs in England and Denmark, and it was validated in a fourth ICU. ISIM consists of four elements, Organisational Culture, Actual Usefulness, work processes, and CIS Integration. The model suggests that CIS integration is an iterative process, and one that is dependent upon the extent of changes required to existing work process, the Organisational Culture and Actual Usefulness of the CIS.

In this study it was found that although a CIS is budgeted for in terms of its software and hardware constituents, investments in maintenance and education are often non-existent. Yet as ISIM shows, this is a prerequisite to successful Actual Usefulness. Further, where the relationship with suppliers was found to be weak, system support was impeded further, causing unrest and disillusionment with the capabilities of the CIS. Strong leadership was found to be essential, to ensure that CIS capabilities and user requirements are adequately considered before procurement, and that staff are motivated to use the CIS. The factors identified as impeding CIS integration were:

- Inadequate understanding of current work processes (Sites C and D).
- Poor leadership and lack of ownership and responsibility for CIS implementations (Site C).
- Inadequate and inappropriate training (Site C).
- Unconsidered context of the organisational environment and the structure and layout of the organisation (Sites C and D).
- No way of communicating with existing systems (Sites A, B, and C).
- No potential for change and adaptation so that the system can be altered to suit the characteristics of the organisation (Sites C and D).
- Poor system suitability (Site C).
- Unclear 'actual' benefit of the system to the user (Site C).
- Weak relationship with suppliers (Sites C and D).

The need for seamless CIS within healthcare was also emphasised. From the RADs it became obvious that ICUs are complex organisations, with complex needs and work processes. Upon closer examination, ICU information processes were found to have the potential to become much simplified with the introduction of seamless CIS, thus

creating 'simplified complexity' in dynamic organisations. Moreover, CIS that did not allow for changes or adaptations as user needs changed and grew found it increasingly difficult to meet user demands and be integrated.

To conclude, at present, the approach to CIS implementations is haphazard, and isolated from those that use the systems, and those that develop them. There is poor communication between the groups that are involved, such as suppliers, management, and users. CIS integration involves many different parties, who need to communicate with each other; each group is equally important, and they all influence CIS integration. CIS are often viewed as a cure-all; to be effective they depend not only on what they have been engineered to do, but also on how they are implemented and used. It is hoped that ISIM will contribute positively to CIS integration in intensive care and, with further testing, beyond.

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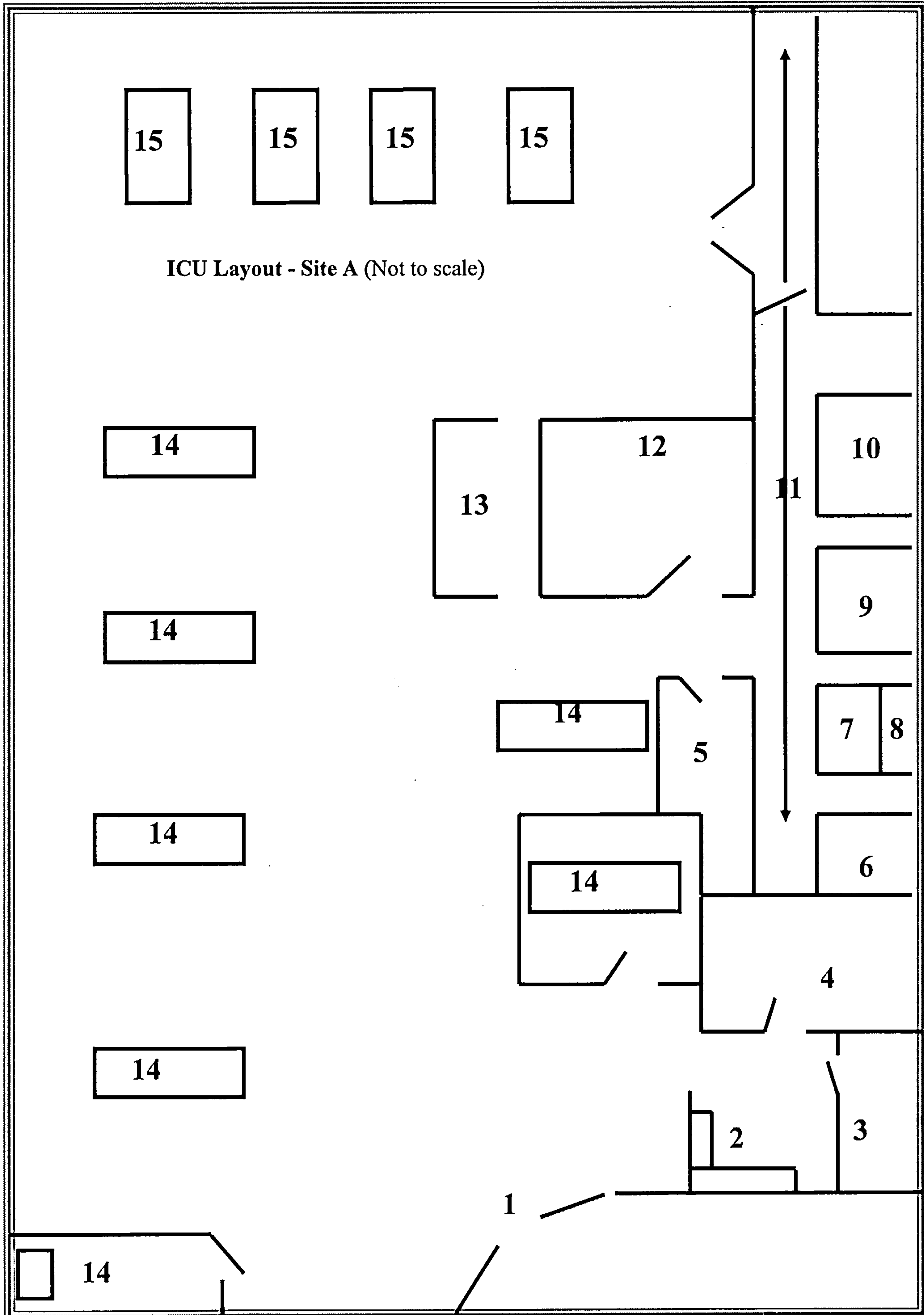
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Appendices

Appendix A



ICU Layout - Site A (Not to scale)

Key for ICU Site A

<i>Code</i>	<i>Name</i>	<i>Description</i>
1	Entrance and Exit	Not Applicable to this thesis (N/A)
2	Open plan work area	Desks/computer/chairs used by pharmacist
3	Computer Room	One computer
4	Office	Three computers –used by nurse manager and clinical sisters
5	Dirty Room	Contains linen
6	Kitchen	N/A
7	Staff Room	Notice board/ TV/ fridge, tables and chairs
8	Toilet	N/A
9	Server Room	Houses server for CIS and CIS workstation, notice board with contact details for S/W company and documentation for the CIS
10	Staff Changing Room	N/A
11	Corridor	N/A
12	Medicine Room	Fridge's and cabinets for drugs
13	Nurses Work Station	Three printers, computer connected to laboratory computer. Computer with access to the internet and for general use such as word processing. Tea and coffee area, notice board, paper and clinical books and folders for reference etc.
14	ICU Beds	CIS by bedside
15	HDU Beds	CIS shared by two beds

Appendix B

CIS Functionality, Site A – This Appendix refers to Site A alone, as it is the only site with a fully computerized ICU.

The Central CIS

For each shift the CIS recorded the name of the shift nurse, duty doctor, date and time. The following list gives a description of its functions:

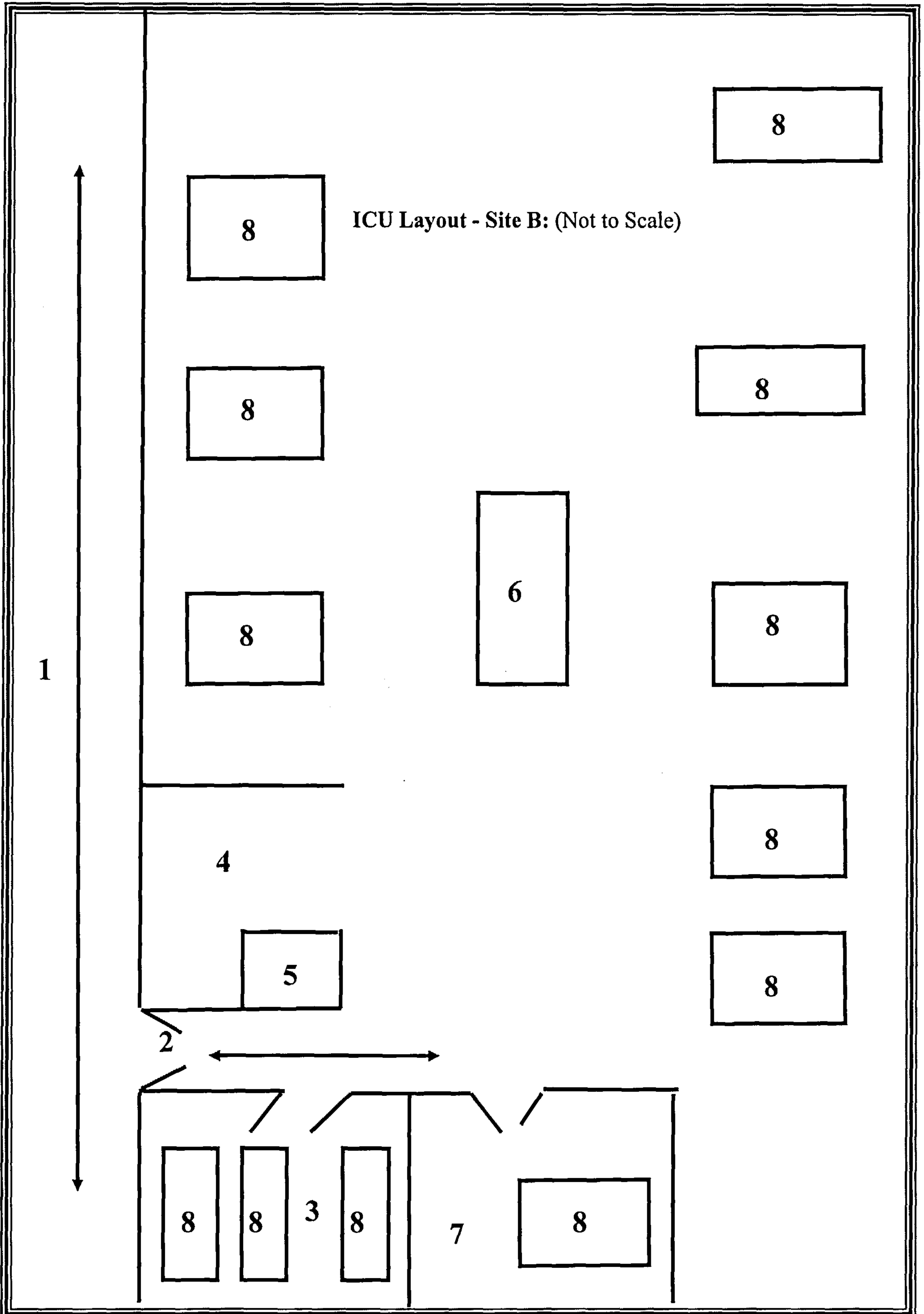
- Enables access to a list of all current patients.
- Allows screen dumps only i.e., printing one page at a time.
- Patient administration – demographic details from the hospital administration system are retyped into the CIS:
 - * Admission and contact details.
 - * Primary clinical information and clinical history.
 - * List of shift nurses.
 - * List of duty doctors.
 - * ICU discharge details - summary - details about patient status.
 - Observations – list of observations recorded at selected intervals - informs when they are due to be recorded.
 - Investigations – list of investigations e.g. blood clotting - profile of blood - blood/gas analysis etc.
 - Therapy's – drugs input manually - allows selection from a list – able to add to list if item not available.
 - Review – possible to review different care areas – enables comparisons with historical data.
 - Nurse care plan.
 - Reporting - provides weekly report facility - daily continuation notes: History.
 - Help.
 - Information to inform users about particular areas of care.
 - Physiological details such as: Breathing, weight and fluids etc.

Nurses were able to write their care plans using free text, while the facility for entries by doctors required structured data entry.

Bedside CIS

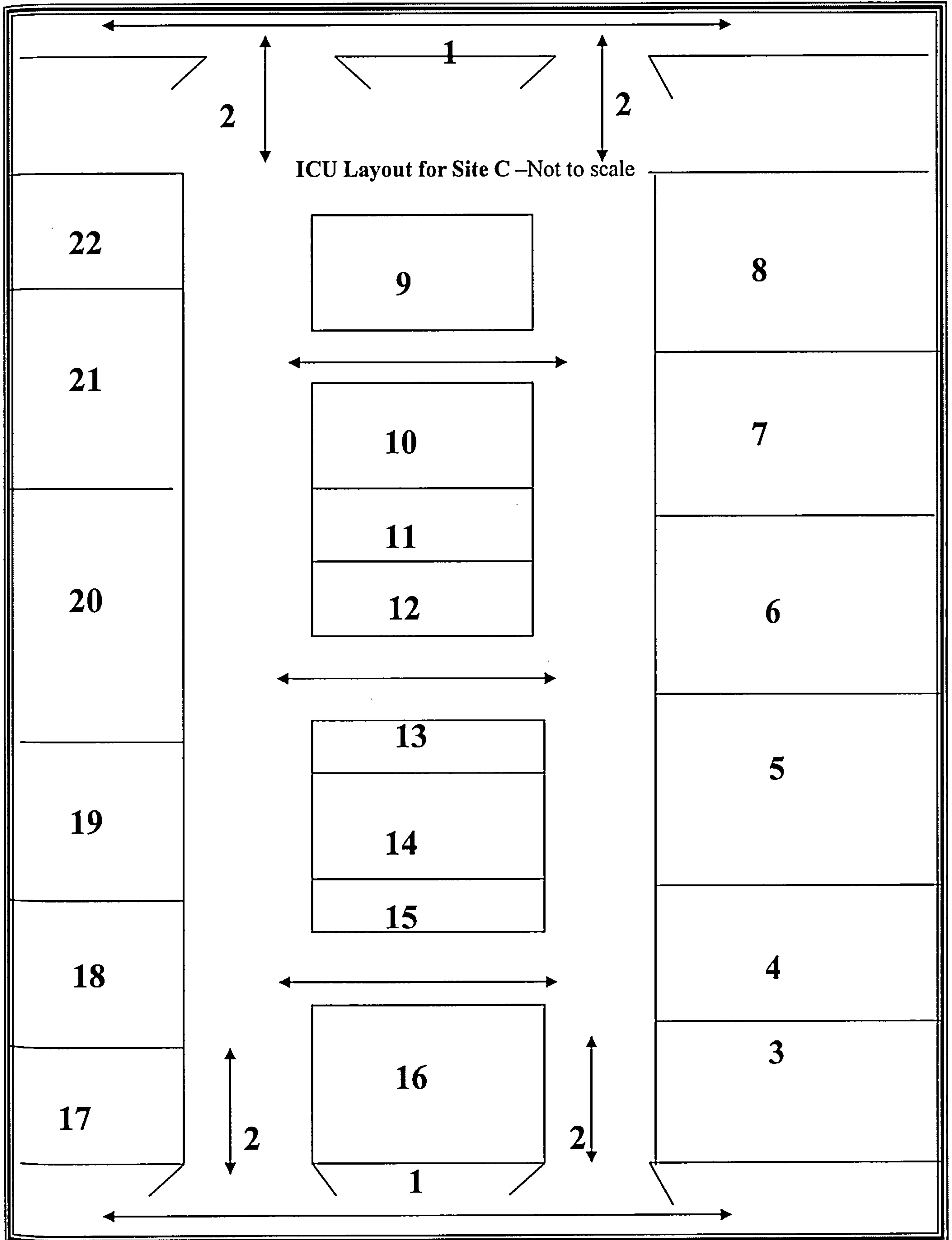
Downloads information from the monitoring systems, such as respiratory system. It can select a particular view, though the nurses prefer the graphical display since it highlights different types of patient data so that it is easier to distinguish between them. The graphical display shows all vital signs and fluids. Due to the colour coding system and visibility of graphs and charts it is immediately possible to see any vital changes that require attention. Finally it is possible to write the care plan and doctors notes for the patient whom the bedside CIS refers to.

Appendix C



Key for ICU -Site B		
<i>Code</i>	<i>Name</i>	<i>Description</i>
1	Corridor	N/A
2	Entrance and Exit	N/A
3	HDU	High Dependency beds only
4	Work Station	This is where nurses and doctors congregate. Radiology computer and Lab computer is located here. Computer with access to internet and for general use such as word processing. Tea and coffee area, notice board, paper and clinical books and folders for reference etc.
5	Medicine 'Kitchen'	Medicines, and medicine apparatus are stored here
6	Nursing Equipment	Trolley holds items such as medicine trays, tissue paper, aprons...etc.
7	Patient Room	For patients who are deemed unrecoverable.
8	ICU Beds	Monitoring CIS at the head of beds.
These rooms are off the corridor labelled 1 on the picture.	Kitchen	N/A
	Staff Room	Notice board/ TV/ fridge/tables and chairs, notices about team-working workshops.
	Server Room	Houses server for auditing equipment and also all the ICU technicians responsible for all equipment on this unit and two other units.

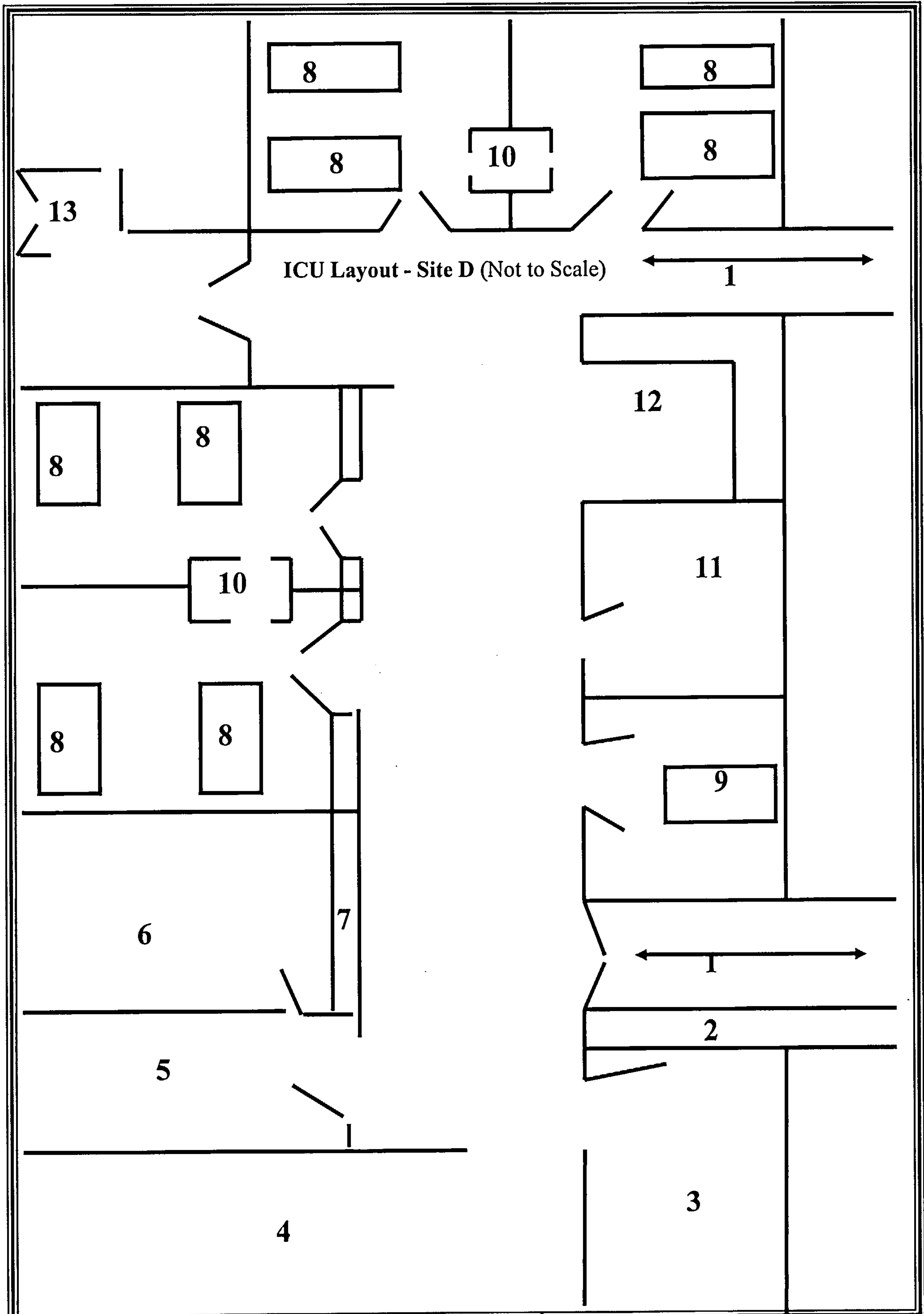
Appendix D



Key for ICU - Site C

<i>Code</i>	<i>Name</i>	<i>Description</i>
1	Corridors	N/A
2	Entrance/Exit	N/A
3	Secretaries Office	A large office with at least four secretaries for sorting patient information and records. Access to the Green System. Computers giving access to general windows packages and the internet.
4	Room for Head Nurses	Each group in the ICU (Cardiology, Paediatric, Lungs and Brain) has it's own head nurse synonymous with nurse manager in England. Each of these nurses is responsible for managing their group of nurses, scheduling staff duty rotas etc. Each leader has a computer with windows applications and the internet.
5	Children's ICU	Four beds with CIS by each bed and at clinician work station. Medical reference books and forms etc. Computer with access to ordering system, internet and word processing packages.
6	Chest and Lungs ICU	As for Children's ICU
7	Heart ICU	As for Children's ICU
8	Kidney ICU	As for Children's ICU
9	Equipment	N/A
10	Medicine Kitchen	A fridge is available to hold patient medications, bloods, foods etc. The room also holds basic medical apparatus as well as reference books and folders.
11	Kitchen	N/A
12	Online X-rays	This room contains photocopiers and an online link to radiology, so that Drs and nurses may access patient x-rays on line. Two large monitors are placed side by side so that before and after x-rays can be compared easily.
13	Linen	N/A
14	Linen	N/A
15	Toilets	N/A
16	Coat hanging space and changing room	Used to store clothes and shoes when on duty. A separate changing room is also available.
17	Offices	N/A
18	Offices	N/A
19	Offices	N/A
20	Changing Rooms	N/A
21	Staff Room	Two sets of tables and a coffee area. TV, lockers and fridge.
22	Vacant Room	Will be refurbished to make more room for the heart patients.

Appendix E



Key for ICU - Site D

<i>Code</i>	<i>Name</i>	<i>Description</i>
1	Entrance and Exit	N/A
2	Staff Changing Rooms	N/A
3	Head Nurse and Staff Educator	Three computers used for access to the internet and Windows applications. Laptop port. Extra desk used by staff.
4	Staff room /Kitchen	Two large tables, a small sink and kitchen apparatus. A partition for smokers. White board and notice board. Folders for each member of staff, amongst other things used by secretaries and educator to inform staff. Note that the notice board is also used to inform staff as well as face-to-face. It is more of a back up method.
5	Secretaries Office	Two secretaries with computer each. Access to Green System, internet and Windows applications.
6	Seminar Room	Used each morning for nurses' and doctors' conference. Also used by student doctors and nurses and for education purposes. This room holds the radiology computer where doctors are able to download the relevant x-rays for patients as and when they need to. This room houses medical reference books and a large white board as well as manuals for the monitoring and computer systems used on the unit.
7	Staff Lockers	N/A
8	ICU Beds	Monitoring system by the patient's bedside. The rooms hold small tables where nurses and doctors meet to discuss the patient. The patient daily observation sheet and the paper record can be found here. A computer also in each room, one between two beds, allows access to the laboratory and blood ordering software. The computer can also be used to access the internet, medical references and simple word processing.
9	Quiet Room	This room is used when a patient is unrecoverable. Patients are moved here from the intensive care rooms to allow relatives some personal space with the patient.
10	Medicine Kitchen	A fridge is available to hold patient, medications, bloods, foods etc. The room also holds basic medical apparatus as well as reference books and folders.
11	Conference Room	Used mostly for meetings and educating staff and students. Medical reference books and folders can also be found here.
12	Reception	Two large monitors display the status of patients in all four rooms, simultaneously. Mostly used by night staff, when patients are sleeping. Again reference books and folders as well as blank medical and nursing charts can be found here. A networked computer gives access to the laboratory system, the internet and Windows applications.
13	Entrance and Exit	N/A

Appendix F

Research Protocol

As outlined in the proposal I sent to you, I am happy to write a report of findings for the *hospital in question*. You are also welcome to access the research findings across all the hospitals next year, when a full comparison of all four hospitals will be written up.

All participating staff are promised anonymity, as is the hospital if it so desires.

The data collection plan is drafted below and is dependent up on the availability of and accessibility to the relevant data sources.

Requirements and Confidentiality

- Permission to use a Dictaphone when interviewing - only I will hear these tapes and no third party will view the transcriptions of the interviews.
- Permission to shadow and observe staff as they work.
- Distribution of a questionnaire.
- Access to relevant documentation.
- Attendance to relevant meetings.

Start Date:

End Date:

Hospital visits 4 days/ week, 1 day at university for consolidation.

Week No.	Primary Task	Methods and Other Tasks
1	Observation	<ul style="list-style-type: none"> ▪ Introduction to staff ▪ Distribution of questionnaires ▪ Collection of relevant documentation and observations ▪ Attendance to meetings where relevant ▪ Observing staff carrying out daily tasks.
2	Shadowing	<ul style="list-style-type: none"> ▪ Preferably a different user of patient clinical information in the ICU.
3	Interviews	<ul style="list-style-type: none"> ▪ Ideally with as many users of clinical, patient information in the ICU, as possible. At least one representative of each clinical staff group. ▪ Duration: approximately 10-20 minutes, as the questions will have an open structure, duration will depend upon how long the interviewee talks for. I am willing to listen for as long as possible.
4	Observation	<ul style="list-style-type: none"> ▪ If needed, similar to week one. Collection of Questionnaires.

Appendix G

Information Sheet

The Use of Clinical Information Systems in Critical Care – A Study in Denmark and England

You are invited to take part in a research study. Before you decide it is important for you to understand why the research is being conducted and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

This study is part of a PhD at the University of Salford's Health Informatics Research Centre. Health Informatics concerns the study of people, information and computers in healthcare.

The aim of this research is to develop and validate a theoretical model that considers Clinical Information Systems (CIS) and how they correspond with the environment in which they are being used. This model will enable further analysis and improve understanding of the complex interactions between CIS and critical care work processes.

This study is of one month's duration in your hospital and involves staff only.

The research student will observe staff using the CIS in their critical care centre and will not attempt to participate in anyway.

Shadowing and interviewing of two (where appropriate) representatives for each staff role is required (For example two nurses – representing the nurses on the ward, two doctors- representing the doctors on the ward, two consultants...etc.).

If you are willing to participate in this way then please indicate this on your consent form.

Do I have to take part?

It is up to you to decide whether or not to take part. *If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form.* If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

What will happen to me if I take part?

Requirements

- Permission to use a Dictaphone when interviewing - only I will hear these tapes and no third party will view the transcriptions of the interviews.
- Ask you to complete a questionnaire.
- The research student will visit the critical care unit four days per week.

A table describing the activities to take place and your involvement is given overleaf.

Week No.	Primary Task	Methods and Other Tasks
1	Observation	<ul style="list-style-type: none"> ▪ Introduction to staff ▪ Distribution of Questionnaires ▪ Collection of relevant documentation and observations ▪ Attendance to meetings where relevant ▪ Observing staff carrying out daily tasks.
2	Shadowing	<ul style="list-style-type: none"> ▪ Preferably a different user of patient clinical information in the ICU. ▪ This will involve following a member of staff as they carry out their work.
3	Interviews	<ul style="list-style-type: none"> ▪ Ideally with as many users of clinical, patient information in the ICU, as possible. ▪ Duration: approximately 10-20 minutes, as the questions will have an open structure, duration will depend upon how long the interviewee talks for. I am willing to listen for as long as possible.
4	Observation	<ul style="list-style-type: none"> ▪ If needed, similar to week one. <p>Collection of questionnaires</p>

The duration of this study is approximately one month depending upon progress made

What do I have to do?

As mentioned above, all that is required from you is your permission to be observed and your consent, if you wish to participate in the interviews and shadowing, and completion of a questionnaire.

What happens when the research study stops?

The research student will produce a report of findings that will be available to you on request a few months after the study has taken place.

Will my taking part in this study be kept confidential?

All information, which is collected about you during the course of this research will be kept strictly confidential. Any information about you, which leaves the hospital, will have your name removed so that you cannot be recognised from it.

Who is organising the funding?

The research student receives a bursary from the university of Salford for the PhD.

Who has reviewed the study?

The study has been reviewed and approved by the students supervisor, the X Research and Development Unit and by the X Local Research Ethics Committee. Approval from the Y local research Ethics committee has also been gained.

Contact for further information

Miss Samina Munir

Salford Health Informatics Research Environment, Faculty of Health and social care, University of Salford, Salford. M6 6PU.

Tel: 0161 295 3182

Email : s.k.munir@pgr.salford.ac.uk

Many thanks for your participation and cooperation.

Appendix H

Consent Form

Title of Project:

The Use of Clinical Information Systems in Critical Care – A Study in Denmark and England

Name of researcher: Samina K. Munir

Please initial box

1. I confirm that I have read and understood the information sheet dated for the above study and I have had the opportunity to ask questions.
2. I agree to this research being carried out at this ICU.
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected.
4. I give permission to be observed.
5. I would like to volunteer as an interviewee
6. I would like to volunteer to be shadowed

Name of staff

Date

Signature

Researcher

Date

Signature

Appendix I



NHS Trust

Research and Development Department
Telephone ~~XXXXXXXXXX~~

Samina K Munir, PhD Research Student
Salford Health Informatics Research Environment
Faculty of Health and Social Care
Frederick Road Campus,
University of Salford
Salford M6 6PU

26 March, 2002

Dear Ms Munir

Re: R&D Registration – The role of clinical information systems (CIS) in an organisational context: a multi-country perspective

To confirm, your study is now registered with the Research and Development Department at ~~XXXXXXXXXX~~. This ensures that you are compliant with the Department of Health requirement¹ to gain Trust approval before your study can commence. Approval from the local research ethics committee is also required.

To help the R&D Department maintain a profile of Trust research and research outputs I would ask you to ensure that you:

- Notify the R&D Department of any publications arising from your study,
- That you advise the R&D Department of any adverse events or changes to protocol that might arise during the study.

It is possible that you may be approached in accordance with Department of Health requirements to audit a sample (10%) of Trust research studies annually. As part of this exercise study records may be examined for evidence of ethics committee approval, evidence of consent forms and adherence to protocol.

I look forward to hearing of the progress of your study.

Yours sincerely

~~XXXXXXXXXX~~
Chairman of Research and Development Committee

Cc ~~XXXXXXXXXX~~ ICU, ~~XXXXXXXXXX~~

¹ 3.6.3, p25 "Research Governance Framework for Health and Social Care", DH March 2001



Appendix J

Chairman: [REDACTED] LREC

Telephone/Fax No: [REDACTED]

LREC PROTOCOL REF [REDACTED]
Please Quote This Reference on All Correspondence

11 July 2002

Miss S Munir
Salford Health Informatics
Research Environment
Faculty of Health & Social Care
University of Salford
Salford
M6 6PU

Dear Miss Munir

PROTOCOL NUMBER [REDACTED]
The Role of Clinical Information Systems (CIS) in Critical Care : A Multi-Country Perspective

The above protocol. (including Patient Information Sheet and Consent Form) was considered by the [REDACTED] Research Ethics Committee on Friday 5th July 2002.

I am pleased to advise you that the committee has no ethical objection to the protocol and has approved your request to undertake the study subject to:

- In accordance with discussions at the meeting please confirm that you have sought the written consent of the Clinical Director in Anaesthetics, [REDACTED] and the Clinical Staff Leader in ICU prior to starting the research project

A list of the [REDACTED] Research Ethics Committee Members is enclosed for your information in accordance with the current European (CCMP) GCP Guidelines and compatible with the agreed International (ICH) GCP Guidelines.

Conditions of Ethical Approval for Research Project

1. Your research project has been given approval only in relation to its acceptability from an ethical point of view. If, subsequently, departure from the methodology outlined in your protocol is contemplated, the Ethics Committee must be advised and the proposed changes approved.
2. A report should also be made to the Committee, if any significant adverse reactions are noted during the course of the study, or if the study is abandoned for any reason.
3. You are reminded that this ethical approval does not give management/financial approval or commitment on behalf of the Health Purchasers (Health Authority or Health Commissioners), the Trust or any of its Departments. It is also your responsibility to ensure that the research procedures comply with the Data Protection Act 1998.

The Ethics Committee would greatly value annual progress reports concerning your research study together with a final report or a copy of any published paper. If the research study has to be discontinued or withdrawn all together, the Committee would require details of the circumstances which have led to this action. A proforma is enclosed for your use in this respect.

With kind regards

Yours sincerely

[REDACTED]
Chairman

[REDACTED] Research Ethics Committee

Appendix K



LOCAL RESEARCH ETHICS COMMITTEE
 Phone:
 Fax:
 e-mail:

31st October 2002

Miss Samina Kauser Munir
 Room P042
 Shire
 Brian Blatchford Building
 University of Salford
 Salford
 M6 6PU

Tel:
 Fax:
 www..uk

Dear Miss Munir

Lead LREC No:
 Please quote this number on all correspondence

The role of clinical information systems (CIS) in critical care: a multi-country perspective.

As the Chairman of Local Research Ethics Committee (LREC) I have delegated authority and have considered the locality issues relating to the above application.

The issues reviewed were as follows:

- ❖ the suitability of the local researcher
- ❖ the appropriateness of the local research environment and facilities
- ❖ any specific issues that may relate to this local community

The locality issues have been adequately addressed and the proposed research can be conducted in Hospitals NHS Trust on the understanding that you follow the conditions set out below:

Conditions of Approval

You have a favourable opinion from LREC in for the ethics of the proposed research (this is the "Lead Local" LREC).

You do not undertake this research in an NHS organisation until the relevant NHS management approval has been gained as set out in the *Framework for Research Governance in Health and Social Care*.

You do not deviate from, or make change to, the protocol without prior written approval of the Lead Local LREC, except where this is necessary to eliminate

Chair:
 Chief Executive:

immediate hazards to research participants or when the change involves only logistical or administrative aspects of the research. In such cases the LREC should be informed within seven days of the implementation of the change.

You must report to the LREC one year from the date on this letter and thereafter on an annual basis. You must also notify the LREC when your research is completed and in this case should be sent to this LREC within three months of completion.

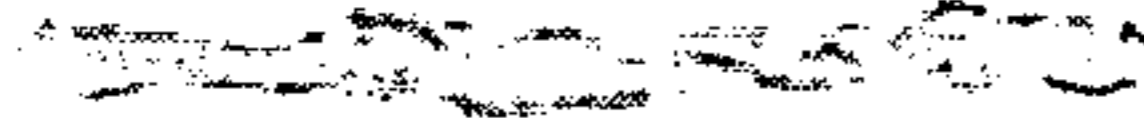
You notify this LREC when you have completed your research, or if you decide to terminate it prematurely.

You advise your sponsor of any unusual or unexpected results that raise questions about the safety of the research.

Yours sincerely



Chairman



c.c. Chairman/Administrator, (Handwritten Name) (Lead) LREC

Appendix L

List of interview participants at each ICU site. Please note that '*' also represents the participants that were observed during shadowing.

Place of interview

Name of the

Interview Questions

GENERAL

1. Clinical Role?

2. Duration of use?

3. Description of the system at the hospital

4. Form of CIS system?

5. When is it used?

6. What are its capabilities?

7. How does it integrate with other systems?

8. Any plans for expansion?

PROCUREMENT

9. Why was the CIS chosen?

10. Procurement process?

11. Responsibility for making the decision?

12. Who was involved in the decision?

13. Needs assessment?

14. Supplier selection?

15. What will you be doing to support the system?

16. What if the system proves to be difficult to manage?

IMPLEMENTATION

17. When was the CIS first implemented?

18. Changes over time?

19. How long before the system was fully implemented?

20. System usage?

Site	No. of Interviews	Interviewees
A	10	Ex Clinical Director Current Clinical Director System Supplier Doctor 1* Doctor 2 Sister 1 Sister 2 Sister 3 Nurse 1* Nurse 2
B	8	Clinical Director Doctor* Doctor Information Officer IT and Physiological Systems Manager* Sister Nurse 1* Nurse 2
C	9	Head of an EPR Module Clinical Director Doctor* Resident Head Nurse Nurse (1)* Nurse (2) Super User/Nurse (3)* Super-Super User /Nurse (N4)
D	10	Clinical Director 1* Anaesthetist (Clinical Director 2) Hospital-Wide IT Implementer Doctor 1* Doctor 2 Secretary Nurse Manager Nurse 1* Nurse 2* Student Nurse

Appendix M

Interview guides

Place of Interview:
Name of Hospital:

Date of Interview:
Type: Management

Interview Questions

GENERAL

1. Clinical Role?
2. Duration at ICU?
3. Description of *how* patient info is managed on the unit? Compare to other units in hospital
4. Form of CIS used on the unit? Used by...? Staff from other units?
5. When is it used?
6. What are its capabilities? Extent to which utilised?
7. How does it feed into the HIS? Other units e.g. Pharmacy/Radiology? PAS?
8. Any plans for integration?

PROCUREMENT

9. Why was the CIS procured? Factors influencing need for one.
10. Procurement process? Number of suppliers? Why this supplier? Why this system?
11. Resources? Financial, staff and management support? How supportive? Decision makers.
12. Who was involved in the procurement process?
13. Needs assessments? Staff asked or told? To what extent where they involved?
14. Support from suppliers during and after implementation? Static or evolving system?
15. What will you do when the system becomes obsolete? Funding? Management support? Management of information?
16. What if the system proved to be a strain on resources, to what extent would management support you? Alternative system? Resort to paper?

IMPLEMENTATION

17. When was the CIS first introduced on the unit? Date:
18. Changeover? Immediate or graduate.
19. How long before fully integrated? Staff acceptance? Parallel operations ceased? System used?

20. To what extent does the paper system (*still*) operate here?
21. Staff reaction?
22. Staff training? New staff? Changes to the system.
23. How did the unit change in terms of work processes, tasks and information compared to before? (information: storage/recording/availability/usage)

SYSTEM

24. What back-up procedures do you have in place for system crash *or* failure? To what extent would you be able to pick up where you left off?
25. For what duration is patient information stored on the system?
26. What can you do with the system?
27. How easy is it to change the system?
28. Who makes these alterations and how soon are they completed?
29. Have you experienced any problems and are there things about it that you don't like?
30. How many CIS do you have on the unit and where? E.g. by the bedside and more?
A control computer? Server room?
31. Can you see the status of all patients on one screen?
32. Are the systems by the bedside stand-alone, or do they feed into something else.....Each other or a control computer (Networked)?
33. What were and are your expectations of the CIS and do you think that they have been/will be realised?

USABILITY

34. How easy is it to enter information?
35. Can you erase patient information once it has been entered?
36. What security measures are in place?
37. What if you type incorrect information? How would that be monitored?
38. Are all staff happy to use it?
39. When data is omitted by staff how does this affect patient care...are there methods in place to detect and correct this lack of info?
40. What other uses does the system have other than storing patient data? E.g. auditing/reporting capabilities?
41. Can all staff access all the information or do different groups have different levels of access?
42. How often is the system updated and by whom?

43. What do you do at peak times when every one wants to use the system to update or access information?

44. Could you describe your typical day in terms of using the computer?

45. How easy is it to print?

INFORMATION

46. Are staff information requirements met?

47. What about changing shifts? How does this compare to before the CIS was introduced?

48. What do you think about the quality and accuracy of patient information here? Accessibility? Reliability? Flexibility?

49. Are there ever any disagreements between different user groups about the capability of the system? For example nurses and doctors will have different info requirements...how are these needs met?

50. Has it affected communication between staff in any way? Is it better/worse?

51. Do you feel you have all the information you need? How does this compare with before the CIS?

ORGANISATION

52. Do you think the CIS has/ would change(d) anything regarding patient care? Time with the patient +/- etc.

53. Please could you describe a 'typical' day from the beginning to the end of a shift? Basically what processes you go through what information you need to do your job and encounters with other people?

54. What was this like before the CIS was implemented?

55. How does the CIS fit in with your daily work, does it affect it in any way?

56. What kind of problems do you encounter on this unit? specific / general?

57. How easy is it to gain support from fellow workers and management in terms of access to resources? And staff involvement with management decisions?

58. Do you feel involved? Who has the ultimate say in what you can or cannot do?

59. Would you recommend your CIS to other ICUs?

60. And finally...what do you like the least about this unit and what do you like the most?

Place of Interview:
Name of Hospital:

Date of Interview:
Type: Clinical Staff

GENERAL

1. Clinical Role?
2. Duration at ICU?
3. Description of *how* patient info is managed on the unit? Compared to other units in hospital?
4. Form of CIS used on the unit? Used by...? Staff from other units?
5. When is it used?
6. How does it feed into the HIS? Other units e.g. Pharmacy/Radiology? PAS?

PROCUREMENT

61. Were you involved in the procurement process? To what extent?
62. Resources? Financial, staff and management support? How supportive? Decision makers?
63. Who else was involved in the procurement process?
64. Needs assessments? Staff asked or told? To what extent where they involved?
65. Support from suppliers during and after implementation? Static or evolving system?

IMPLEMENTATION

66. Changeover? Immediate or graduate
67. How long before fully integrated? Staff acceptance? Parallel operations ceased? System used?
68. To what extent does the paper system (still) operate here?
69. Staff reactions, are they happy with it?
70. Staff training? New staff? Changes to the system?
71. Do you feel that the training and support is adequate?
72. How did the unit change in terms of work processes, tasks and information compared to before? (information: storage/recording/availability/usage)

SYSTEM

73. Would you know what to do if the system crashed *or* failed? To what extent would you be able to pick up where you left off?
74. For what duration is patient information stored on the system?
75. What can you do with the system?
76. How easy is it to alter the system to do what you want it to do? Undo alterations that you don't like?

77. Who makes these alterations and how soon are they completed?
78. Have you experienced any problems and are there things about it that you don't like?
79. What were and are your expectations of the CIS and do you think that they have been/will be realised?

USABILITY

80. How easy is it to enter information?
81. What if you type incorrect information? Erasure? Audit trails? Are all staff happy to use it?
82. When data is omitted by staff how does this affect patient care... are there methods in place to detect and correct this lack of information?
83. What other uses does the system have other than recording/storing patient data? E.g. auditing/reporting capabilities?
84. Can all staff access all the information or do different groups have different levels of access?
85. How often is the system updated and by whom? How often is information updated by the bedside?
86. What do you do at peak times when every one wants to use the system to update or access information?
87. Could you describe your typical day in terms of using the CIS? Your information requirements etc.
88. How easy is it to make copies of the information /print?

INFORMATION

89. Are staff information requirements met? Improved or diminished since its introduction?
90. What about changing shifts? How does this compare to before the CIS was introduced?
91. What do you think of the quality and accuracy of patient information? For the better /worse? Accessibility? Reliability? Flexibility?
92. Are there ever any disagreements between different user groups about the capability of the system? For example nurses and doctors will have different info requirements...how are these needs met?
93. Has it affected communication between staff in any way? Is it better/worse?

94. Do you feel you have all the information you need? How does this compare with before the CIS?

ORGANISATION

95. Do you think the CIS has /would change(d) anything regarding patient care? Time with the patient +/- etc.

96. Please could you describe a 'typical' day from the beginning to the end of a shift? Basically what processes you go through what information you need to do your job and encounters with other people?

97. What was this like before the CIS was implemented?

98. How does the CIS fit in with your daily work, does it affect it in any way, make your working life better or worse?

99. What kind of problems do you encounter on this unit? Are they specific to this unit or more general?

100. How easy is it to gain support from fellow workers and management in terms of access to resources? And staff involvement with management decisions?

101. Do you feel involved? Who has the ultimate say in what you can or cannot do and who controls the resources?

102. Would you recommend your CIS to other ICUs?

103. And finally...what do you like the least about this unit and what do you like the most?

Appendix N

Questionnaire cover sheet for Sites A and B.



Clinical Information Systems in Intensive Care

Samina Munir, Salford Health Informatics Research Environment, Room PO42,
Brian Blatchford, University of Salford, Salford M6 6PU UK

As staff of this Intensive Care Unit (ICU) you are being asked to complete this questionnaire as part of a research project at the University of Salford, UK. Your ICU is one of four units in Denmark and the UK that is participating in this research.

The research is about how different healthcare professionals within an ICU use and manage patient information, specifically via a Clinical Information System. Clinical Information Systems require substantial investment in terms of finance, staff and time. It is therefore important that they are able to satisfy staff information requirements, so that they can be used optimally to help deliver the best possible care for patients.

Your input is important because it will enable us to gauge your information needs and your views and experiences of the CIS that is used in your unit. This is so that we are better able to understand how such systems can best be integrated into hospital environments.

The questionnaire should take **about 15 minutes to complete**. It is fast to complete as it mostly involves ticking boxes.

Anything you write in the questionnaire or say to me will remain confidential. It will not be possible to identify any individual who participates, so please be frank and open about your views.

Once you have completed the questionnaire, please place it in the envelope provided in your ICU or hand it back to me. I should be on the unit for about 4 weeks.

If you have any queries at any time, please contact me, Samina Munir.

Email: s.k.munir@pgr.salford.ac.uk) Tel: 0161 295 3182.

Terminology: I have used the term clinical information system (CIS) to mean any system that manages patient information, this may be **paper-based** and / or **computerised**.

Please answer all the questions in the questionnaire as accurately as possible and to the best of your knowledge. Where you are offered options, please tick the relevant box(es). Any comments that you can add at any point will be very welcome.

Thank you for your time and co-operation.

Samina Munir

Please Note: You are very welcome to write your comments in Danish if you wish to do so. I will remove the back pages about demographic information so that if someone from this department translates it, then it will not be possible to identify you.

*Lær Læger og plejerskerne på Intensiv afdeling, Salford University
bedes udfylde dette spørgeskema og tilsende det senest mandag, den 13. januar, på
undersøgelser@pgr.salford.ac.uk*

Appendix O

Questionnaire cover sheet for Site C



Clinical Information Systems in Intensive Care

Samina Munir, Salford Health Informatics Research Environment, Room PO42,
Brian Blatchford, University of Salford, Salford M6 6PU UK

As staff of this Intensive Care Unit (ICU) you are being asked to complete this questionnaire as part of a research project at the University of Salford, UK. Your ICU is one of four units in Denmark and the UK that is participating in this research.

The research is about how different healthcare professionals within an ICU use and manage patient information, specifically via a Clinical Information System. Clinical Information Systems require substantial investment in terms of finance, staff and time. It is therefore important that they are able to satisfy staff information requirements so that they can be used optimally, to help deliver the best possible care for patients.

Your input is important because it will enable us to gauge your information needs and your views and experiences of the CIS that is used in your unit. This is so that we are better able to understand how such systems can best be integrated into hospital environments.

The questionnaire should take **about 15 minutes to complete**. It is fast to complete as it mostly involves ticking boxes. *Anything you write in the questionnaire or say to me will remain confidential. It will not be possible to identify any individual who participates, so please be frank and open about your views.*

Once you have completed the questionnaire, please place it in the envelope provided in your ICU or hand it back to me. I should be on the unit for about 4 weeks.

If you have any queries at any time, please contact me, Samina Munir.

Email: s.k.munir@pgr.salford.ac.uk) during the study and (+44 161 295 3182) after.

Terminology: I have used the term clinical information system (CIS) to mean any system that manages patient information, this may be **paper-based** and / or **computerised**.

Please answer all the questions in the questionnaire as accurately as possible and to the best of your knowledge. Where you are offered options, please tick the relevant box(es). Any comments that you can add at any point will be very welcome.

Thank you for your time and co-operation.

Samina Munir

Please Note: You are very welcome to write your comments in Danish if you wish to do so. I will remove the back pages about demographic information so that if someone from this department translates it, then it will not be possible to identify you.

Kære Læger og plejepersonale på intensiv afsnit, Name of Site C

I bedes udfylde dette spørgeskema og aflevere det senest mandag, den 13. januar på sekretærkontoret i Samina's kasse. På forhånd TUSIND TAK for hjælpen. **Mvh. Samina Munir, PhD studerende**

Appendix P— Questionnaire cover sheet for Site D



Clinical Information Systems in Intensive Care

Samina Munir, Salford Health Informatics Research Environment, Room PO42,
Brian Blatchford, University of Salford, Salford M6 6PU UK

As staff of this Intensive Care Unit (ICU) you are being asked to complete this questionnaire as part of a research project at the University of Salford, UK. Your ICU is one of four units in Denmark and England that is participating in this research.

The research is about how different healthcare professionals within an ICU use and manage patient information, specifically via a Clinical Information System. Clinical Information Systems require substantial investment in terms of finance, staff and time. It is therefore important that they are able to satisfy staff information requirements so that they can be used optimally, to help deliver the best possible care for patients.

Your input is important because it will enable us to gauge your information needs and your views and experiences of the CIS that is used in your unit. This is so that we are better able to understand how such systems can best be integrated into hospital environments.

The questionnaire should take **about 15 minutes to complete**. It is fast to complete as it mostly involves ticking boxes. *Anything you write in the questionnaire or say to me will remain confidential. It will not be possible to identify any individual who participates, so please be frank and open about your views.*

Once you have completed the questionnaire, please place it in the envelope provided in your ICU or hand it back to me. I should be on the unit for about 4 weeks.

If you have any queries at any time, please contact me, Samina Munir.

Email: s.k.munir@pgr.salford.ac.uk) during the study and (+44 161 295 3182) after.

Terminology: I have used the term clinical information system (CIS) to mean any system that manages patient information, this may be **paper-based** and / or **computerised**.

Please answer all the questions in the questionnaire as accurately as possible and to the best of your knowledge. Where you are offered options, please tick the relevant box(es). Any comments that you can add at any point will be very welcome.

Thank you for your time and co-operation.

Samina Munir

Please Note: You are very welcome to write your comments in Danish if you wish to do so. I will remove the back pages about demographic information so that if someone from this department translates it, then it will not be possible to identify you.

Kære Læger og plejepersonale på intensiv *Name of Hospital*

I bedes udfylde dette spørgeskema og aflevere det senest mandag, den 2. December I den grå bakke på sekretærkontoret (Samina's spørgeskemaer). På forhånd TUSIND TAK for hjælpen. Mvh. Samina Munir, PhD studerende

Appendix Q - Questionnaire

This section is about the Clinical Information System (CIS) that is used in your ICU

Q1. Do you consider a computerised CIS to be useful?

- Very useful
- Useful
- Of some use
- Of no use

Please explain your answer

Q2. Do you use :

- A computerised CIS Go to Q3
- A paper-based CIS Go to Q4
- Both Go to Q3

Q3. Were you working at this ICU when the computerised CIS was first introduced?

- Yes Go to Q3a
- No Go to Q4

Please explain

Q3a. Were you involved in the process of choosing the computerised CIS that is used in your ICU?

- Yes Please explain
- No

Please explain what this involvement entailed.

Received - very useful		
Received - useful		
Received - not useful		
Did not receive		
Not relevant		

Q3b. Were you consulted about what you wanted the CIS to be able to do?

Yes
 No

Q3c. How long have you been using this CIS _____

Q3d. Did you have any other input?

Yes Please explain
 No

Please explain what this input was.

Q4. What expectations did you have of the CIS that you use? Please list them.

Q5. Do you feel that the CIS functions as you expected?

Exceeds my expectations
 Meets my expectations
 Is below my expectations

Please explain

The following questions are about how easy it is to use your CIS.

Q6. How important is it for you to receive training to use a CIS?

Very Important
 Important
 Of some importance
 Unimportant

Q7. Were you given any training to use your CIS? Please tick the relevant options below.

	Electronic CIS	Paper-based CIS
Received - very useful		
Received - useful		
Received - not useful		
Did not receive		
Not relevant		

Q8. How often are you given training to use the CIS? Please tick the relevant options below.

	Electronic CIS	Paper-based CIS
Once – when I started working at this ICU		
Every time the system is changed in any way		
When ever we are told to		
At least twice a year		
Never		

Q9. What would you do if the CIS that you use was damaged? E.g. if the electronic CIS crashed or if the paper work was lost or mislaid.

Q10. Have you ever experienced any problems with the CIS?

Yes Explain and then go to Q10a
 No Go to Q11

Please explain

Q10a. Do you receive adequate support to deal with the problems that arise?

Yes
 No Please explain

Please state what kind of support you would like to see

Q11. The following question is about how easy it is to use your CIS for tasks such as entering, viewing and printing information. For those who use a paper-based system the '**printing**' option does not apply.

Accessing patient information for viewing

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Is fast					
Is easy to use					
Is flexible					

Accessing patient information for entering data

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Is fast					
Is easy to use					
Is flexible					

Accessing patient information for printing

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Is fast					
Is easy to use					
Is flexible					

Please add any other comments you believe to be of importance

Q12. Please tick the statement about your CIS that best matches your opinion.

- I refuse to use it
- I try to avoid using it
- I only use it for the bare minimum
- I use it because I have to
- It makes no difference to me
- I don't mind using it
- I like using it

Q12a. If you don't like using the CIS, please explain why.

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
<i>I have too much else to do</i>					
<i>It's a hindrance</i>					
<i>It's too complicated</i>					
<i>It doesn't do what I want it to</i>					
<i>It takes too much time</i>					
<i>I don't like typing in the CIS</i>					
<i>I don't like writing in the CIS</i>					
<i>It interferes with caring for the patient</i>					

If you have any other reason(s) please state below.

The following questions ask you to compare a paper-based and computerised CIS

Q13. Which format do you prefer for your CIS? Please tick one option that indicates your preference

- Strong preference for computerised CIS
- Slight preference for computerised CIS
- No preference of type of CIS
- Slight preference for paper
- Strong preference for paper

Q14. Can you.... (Please tick one option)

- ...Do more with an electronic CIS than with a paper-based one?
- ...Do less with an electronic CIS than with a paper-based one?
- ...Do the same with both
- Uncertain

Please comment

Q15. From which system would you *trust* the information more? Please tick one option.

- Strong preference for computerised CIS
- Slight preference for computerised CIS
- No preference of type of CIS
- Slight preference for paper
- Strong preference for paper

Please comment

Q16. Which system do you think gives you more time with the patient?

- Strong preference for computerised CIS
- Slight preference for computerised CIS
- No preference of type of CIS
- Slight preference for paper
- Strong preference for paper

Please comment

Q17. In general which system do you believe to be better at informing all healthcare provider groups about the patient? E.g. Nurses, Doctors, nurses, physiotherapists, pharmacists etc.

- Strong preference for computerised CIS
- Slight preference for computerised CIS
- No preference of type of CIS
- Slight preference for paper
- Strong preference for paper

Please comment

Q18. This question is asking you about the system and **not the Information** that it contains. For each factor, please tick the better of the two systems. Tick the 'Both' option if you think that both the systems rate the same.

	Electronic CIS	Paper-based CIS	Both the same
More reliable			
More useful			
More flexible (in terms of how adaptable it is and the variety of things that you can do with it)			
Faster to access patient Information			
Faster to view patient Information			
Faster to enter patient information			
Easier to access patient information			
Easier to view patient information			
Easier to enter patient information			

Q18a. Please rate the importance of these factors for a CIS

	Of Great Importance	Important	Some importance	No Importance	Don't know
Reliability					
Usefulness					
Flexibility (in terms of how adaptable it is and the variety of things that you can do with it)					
Speed of access to patient Information					
Speed of viewing patient Information					
Speed of entering patient information					
Ease of access to patient information					
Ease of viewing patient information					
Ease of entering patient information					

Q22. How much do you think things change with the introduction of an electronic CIS? Please select one option.

Major changes	<input type="checkbox"/>
Some changes	<input type="checkbox"/>
Minor changes	<input type="checkbox"/>
No change	<input type="checkbox"/>

The following questions are about your information requirements

Please explain

Q19. What information do you require in order to provide care for the patient? Please state e.g. Patient Care Plan, Medical Notes, Vital Signs etc.

Q20. Do you feel that your information requirements are met? Please tick the option that applies to you.

Always	<input type="checkbox"/>
Most of the time	<input type="checkbox"/>
Sometimes	<input type="checkbox"/>
Never	<input type="checkbox"/>
Don't know	<input type="checkbox"/>

Q20a. How would you like to see this improve?

Please explain

Q21. In terms of the CIS **information content**, please rate which type of system you believe to be better.

	Electronic CIS	Paper-based CIS	Can't distinguish
Provides more reliable information			
Provides more relevant information			
Provides more useful information			
Provides more accurate information			
More flexible (in terms of how adaptable the information is and the variety of things that you can do with the information)			

Q22. How much do you think things change with the introduction of an electronic CIS? Please select one option.

- Major changes
- Some changes
- Minor changes
- No change

Please explain

Q23. In your opinion, would you say that the CIS is.....(please select one option)

- ...Fully integrated into the ICU
- ...Partially integrated into the ICU
- ...Not integrated into the ICU at all

Please explain

Q24. Do you feel that the CIS makes your work..... (Please select one option)

- ...Much better
- ...Better
- ...No change
- ...Worse
- ...Much worse

Please explain

Q25. What do you like the most about the CIS that you use? Please state below.

Q26. What do you like least about the CIS that you use? Please state below.

Q27. Would you recommend the CIS that you use to other hospitals?

- Yes definitely
- Yes, with reservation
- Maybe
- Probably not
- Definitely not

Please explain

The following questions are about your role in the ICU and your relationship with other staff.

Q28. How involved are you in the decision making process about your ICU, the patient and the CIS?

	Patient	CIS	ICU
Greatly involved	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Some involvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No involvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please explain

Q29. Do you think that your input is considered to be of any value by management?

- Yes, very valuable
- Yes, of some value
- Not sure
- Of no value

If you answered 'other' please explain

Q34. How long have you worked in these roles?

Official Role(s)

Unofficial Role(s)

Q30. Which of the following statements describes you best?

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
I like to develop contacts					
I like to solve difficult problems					
I like to organise people and resources					
I like to challenge convention					
I like to evaluate all options before I make a judgment					
I like to cooperate, avert friction and listen to others					
I like to put my ideas into action					
I give much attention to detail and like finding error and omissions					
I provide a skill or knowledge to the group that is in rare supply.					

Q31. What do you like the most about your ICU?

Q32. What do you like least about your ICU?

Information about you

Please complete this section as accurately as possible. Please remember that it is impossible to identify you from the information you provide.

Q33. What is your job title and what other jobs do you do in the ICU? If you have more than one job title, please state them all.

Official Role(s):

Unofficial Role(S):

Q34. How long have you worked in these roles?

Official Role(s):

Unofficial Role(S):

Q35. How long have you worked in an ICU? _____

Q36. How long have you worked at your present place of work? _____

Q37. Are you:

Male	<input type="checkbox"/>
Female	<input type="checkbox"/>

Q38. Do you use a computer when not at work?

Yes	<input type="checkbox"/>	→	Go to Q38a
No	<input type="checkbox"/>		You have finished (P.T.O)

Q38a. Do you enjoy using a computer?

Yes, very much	<input type="checkbox"/>
Yes, sometimes	<input type="checkbox"/>
Not much	<input type="checkbox"/>
Not at all	<input type="checkbox"/>

Q38b. How often do you use a computer when not at work?

Daily	<input type="checkbox"/>
3-4 times per week	<input type="checkbox"/>
1-2 times per week	<input type="checkbox"/>
Every other week	<input type="checkbox"/>
Once a month	<input type="checkbox"/>
Less than once a month	<input type="checkbox"/>

If you have any other comments that you would like to add please feel free to do so. If you wish to add additional pages to the questionnaire with you comments please don't hesitate to do so.

I appreciate that you are very busy. I thank you greatly for all your input. Please place the completed questionnaire in the envelope provided in your ICU or hand it back to me. The results of this questionnaire will be available March 2003. If you require a copy please feel free to contact me.

Appendix R – Questionnaire Results

Questionnaire Results for All Sites

- Results for each question are given as percentage respondents for each Site. The **greatest occurrence for each Site is highlighted in bold**, and the most *infrequent is highlighted in italics*, where this is appropriate.
- For questions where respondents may choose more than one option, the number of people who select each option is given, hence the total for a question may sum to greater than 100%, this can also be caused by rounding errors.
- Total respondents per question are also given. A number below 100% indicates that not all respondents answered this question.
- Free text answers are collated, and numbers of respondents are given in brackets, with total percentage of respondents at the end of each question.
- Comments have been collected and written below the question, where relevant. The frequency of occurrence for each comment is given in brackets. Please note that each person may give more than one comment, therefore the total may sum to greater than 100% in some cases.

	Site			
	A	B	C	D
Distributed	75	75	75	70
Received	31	14	7	11
Response Rate	41%	19%	9%	16%

This section (O1 – O5) is about the Clinical Information System (CIS) that is used in your ICU

Q1. Do you consider a computerised CIS to be useful?

	A	B	C	D
Very useful	87	57	0	36
Useful	13	36	71	46
Of some use	0	7	29	18
Of no use	0	0	0	0
Total responses to this question	100	100	100	100

Please explain your answer

Site A
<ul style="list-style-type: none"> ◆ Easier to use: Legible notes; immediate access; easier to find information; Systematic organisation; collated data bank and easily accessible (9) ◆ Good storage and recording mechanism (2) ◆ Automated data download and calculations (2) ◆ Accurate (1) ◆ Saves time (3) ◆ Multidisciplinary access (1) ◆ Minute by minute collection of data (2) ◆ Reduced paper work and environmentally friendly (3)
Site B
<ul style="list-style-type: none"> ◆ To obtain patient data, observations and history (1) ◆ Avoid repetition of investigation (1) ◆ Rapid data access (7) ◆ Can take longer (1) ◆ Useful if it saves time but would need a back-up system (1) ◆ If it means a paperless working environment then this can only be good (1) ◆ Less time spent on written notes and no errors when replicating data (1) ◆ I could go back to the system any time (1) ◆ The information can be readily available, efficient and easy to use (1)
Site C
<ul style="list-style-type: none"> ◆ Technical Hiccups always frustrating and annoying hence not very useful (1) ◆ A good thing is that we do not have to write a lot of numbers down. The bad thing is that the computer registers all numbers uncritically and that the system is not very flexible and it is hard to have a quick 'overview' (1) ◆ Work saving possible for collecting data for statistical purposes (1) ◆ Systemization of data, standardization of data, more correct data (1) ◆ It will up to a point save us time. But with the problems always associated with computers (breakdowns, malfunctions, electricity failure) it could be a nuisance at times. It will also help us collect data more efficiently once the entire system works. (1) ◆ We started using a computerized CIS a couple of months ago in my unit. There have been a lot of technical problems. I find the system slow. (1)
Site D
<ul style="list-style-type: none"> ◆ Fast – The newest information is always available. It's easy to go back and check up on poor decisions (1) ◆ If it works it will of course be more than some use. So far I am somewhat skeptical (1) ◆ Paper won't disappear but computers may go 'down' (1) ◆ I mean the Lab system is very useful. (1) ◆ A good computerized version could make better organization of data and make them more easily available. I do however have fears concerning system user friendliness and speed. (1) ◆ Accessible everywhere, simultaneously – robust – less storage space (1) ◆ It is always available and easy to read (1)

Q2. Do you use?

	A	B	C	D
A computerised CIS	77	36	57	0
A paper-based CIS	0	50	0	45
Both	19	14	43	55
Total responses to this question	96	100	100	100

Q3. Were you working at this ICU when the computerised CIS was first introduced?

	A	B	C	D
Yes	58	0	100	36
No	39	0	0	27
No computerised CIS	0	100	0	0
Total responses to this question	97	100	100	63

Q3a. Were you involved in the process of choosing the computerised CIS that is used in your ICU?

	A	B	C	D
Yes	16	0	14	0
No	52	0	86	55
No computerised CIS	0	100	0	0
Total responses to this question	68	100	100	55

Please explain what this involvement entailed.

Site A
<ul style="list-style-type: none"> ◆ Attendance at talks on different CIS on the market (1) ◆ As well as a specialised implementation team ICU staff were considered via an 'ideas' book (1) ◆ Assessment and evaluation of several systems; Tendering process (1) ◆ Chose the software for ease of use admin wise (1) ◆ Not consulted initially but once installed had better idea of what it could do. (1)
Site B
<ul style="list-style-type: none"> ◆ No comments
Site C
<ul style="list-style-type: none"> ◆ Heading the group of staff that has done the clinical implementation of the CIS (PDM) (1)
Site D
<ul style="list-style-type: none"> ◆ No comments

Q3b. Were you consulted about what you wanted the CIS to be able to do?

	A	B	C	D
Yes	32	0	29	9
No	32	0	71	46
No computerised CIS	0	100	0	0
Total responses to this question	64	0	100	55

Q3c. How long have you been using this CIS?

	A	B	C	D
Less than 1 year	3	0	100	18
1-2 years	3	0	0	9
2-3 years	23	0	0	9
3-4 years	19	0	0	0
4-5 years	13	0	0	18
More than 5 years	0	0	0	0
No computerised CIS	0	100	0	0
Total responses to this question	61	100	100	54

Q3d. Did you have any other input?

	A	B	C	D
Yes	13	0	14	0
No	52	0	29	36
No computerised CIS	0	100	0	0
Total responses to this question	65	100	43	36

Please explain what this input was.

Site A
<ul style="list-style-type: none"> ◆ Involved in cascading training (1) ◆ Formulated the care plans for the CIS (1) ◆ I was a trainer for the system (1)
Site B
<ul style="list-style-type: none"> ◆ No comments
Site C
<ul style="list-style-type: none"> ◆ Paper (lab results- patients journal) (1)
Site D
<ul style="list-style-type: none"> ◆ No comments

Q4. What expectations did you have of the CIS? Please list them.

Site A
<p>Positive Expectations</p> <p>Information: Accessible; Accurate storage, retrieval and use; Comprehensive (5)</p> <p>System: Automatic and continuous downloads (4)</p> <p>Governance: Maintain patient privacy; facility to undertake audit (4)</p> <p>Communication: Dr's notes accessible; Improve communication; multi-disciplinary entry (4)</p> <p>Efficiency: Easy and fast to use, access and store; Paper free; Less time consuming results search; reduced paper work (17)</p>
<p>Negative Expectations</p> <p>Time consuming (2)</p> <p>In accuracy's (2)</p> <p>Fear of losing information (2)</p> <p>Steep learning curve (1)</p> <p>Complicated (1)</p>
Responses: 84%
Site B
<ul style="list-style-type: none"> ◆ Fast (7) ◆ User friendly (8) ◆ Clear information (2) ◆ Reliable (8) ◆ Easy to access (7) ◆ Efficient (2)

<ul style="list-style-type: none"> ◆ Comprehensive (2) ◆ No replication of written data (2) ◆ Gives you an overview of the patient condition at a glance (1) ◆ Can see deterioration in patient (1) ◆ Useful (1) ◆ To be multi-disciplinary (1) ◆ Trend setting (1) ◆ Applicable to practice (1)
Responses: 79%
Site C
<ul style="list-style-type: none"> ◆ Efficiency: Easy and fast to use, better over all view (3) ◆ System: Automatic number registration and possibility of statistics (2) ◆ Ease: Access/ Use, Easy to find information (3) ◆ Governance: Easy to see who has looked at it (1) ◆ Precise: Standardisation, systematic filing, retrieve-ability of data (1)
Responses: 86%
Site D
<ul style="list-style-type: none"> ◆ Efficiency: Easy and fast to use, access and store; Paper free; Less time consuming results search; reduced paper work ◆ Speed: Fast (3) ◆ System: Logical (1) ◆ Ease: Access/ Use, Easy to find information (10) ◆ Reliability: (2) ◆ Availability: Always at hand (2) ◆ Safety: (2) ◆ Precise: (3) ◆ Complete: Sufficient information about the patient (1) ◆ Secure: (1) ◆ Simple: (1)
Responses: 72%

Q5. Do you feel that the CIS functions as you expected?

	A	B	C	D
Exceeds my expectations	29	7	0	0
Meets my expectations	55	43	71	64
Is below my expectations	3	50	29	36
Total responses to this question	87	100	100	100

Please explain

Site A
<ul style="list-style-type: none"> ◆ Easier to retrieve information about past patients (1) ◆ Would like access to patient history on admission (1) ◆ Audit facility would improve the system (2) ◆ Able to record much more detailed information than expected (2) ◆ Much more user friendly than initially due to continuous changes (2) ◆ Fearful of system initially as used to pen and paper all my life (1) ◆ Performs all nursing information satisfactorily (1) ◆ It is very simple and I don't have to wait (1) ◆ No preconceived expectations (1) ◆ Unsatisfactory method of transferring patient from ICU to HDU and vice-versa (1)
Site B
<ul style="list-style-type: none"> ◆ It meets my expectations (1) ◆ Slow (2) ◆ Unfriendly (1)

<ul style="list-style-type: none"> ◆ Unreliable (1) ◆ Counter-intuitive (1) ◆ When I want to send samples I choose the CIS as it saves time in writing and I can view the results whenever I want (1) ◆ Know this system from other workplace where hardware was not up to date and therefore CIS was incredibly slow (1) ◆ Poor care plan and nursing documentation although this has been condensed with introduction of new care plan (1) ◆ At present there is a lot of written data which requires replication when needed in other environments, observations and fluids have to be hand transferred to ward documents (1) ◆ Charts are upside down (1) ◆ Not easy when you want to compare settings to the previous day (1) ◆ Computerised (1) ◆ Less manpower (1) ◆ Less time, memory storage, data storage (paper-based) (1) ◆ Direct picture can be obtained, difficult for future, limited space, poor storage (1) ◆ Clinical work station always breaking down (1) ◆ Writing out your assessment every morning is very time consuming and laborious. It is very rare that I refer back to what I have written previously (1)
Site C
<ul style="list-style-type: none"> ◆ Not computer wise but once the system is up and running it works well (1) ◆ Not very flexible (1) ◆ I don't expect it to work perfectly yet but in time I am sure it will improve (1)
Site D
<ul style="list-style-type: none"> ◆ The green system is a bomb and the Lab system is okay (1) ◆ Mostly, sometimes the (Paper) CIS is not at the spot where you need it – sometimes the decisions from other colleagues have not yet been written (1) ◆ Could be faster (1) ◆ All breakdowns are disturbing (1) ◆ It's not perfect but works most of the time (1) ◆ It (the paper system) is not at all fulfilling my expectations (1)

The following questions (Q6 – Q12a) are about how easy it is to use your CIS

Please note respondents from hospitals where both systems operate may select an option for each type of system i.e., electronic and paper based.

Q6. How important is it for you to receive training to use a CIS?

	A	B	C	D
Very important	71	57	72	18
Important	26	29	14	36
Of some importance	3	14	14	46
Unimportant	0	0	0	0
Total responses to this question	100	100	100	100

Q7. Were you given any training to use your CIS? Please tick the relevant options below.

	Site A		Site B		Site C		Site D	
	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS
Received - very useful	55	0	21	14	0	0	0	9
Received - useful	45	0	29	0	100	0	46	36
Received - not useful	0	0	21	7	0	0	0	0
Did not receive	0	0	0	36	0	0	18	55
Not relevant	0	0	0	7	0	0	9	0
Total responses	100	0	71	64	100	0	73	100

Q8. How often are you given training to use the CIS? Please tick the relevant options below.

	Site A		Site B		Site C		Site D	
	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS	Electronic CIS	Paper-based CIS
Once when I started at the ICU	26	0	50	21	28	29	46	55
Every time the system is changed in any way	71	0	0	14	29	0	0	0
Whenever we're told to	3	0	0	0	14	0	9	0
At least twice a year	0	0	0	0	0	0	0	9
Never	0	0	21	21	0	0	18	36
Total responses	100	0	71	57	71	29	73	100

Q9. What would you do if the CIS that you use were damaged? E.g., If the electronic CIS crashed or if the paper work was lost or mislaid?

Site A
<ul style="list-style-type: none"> ◆ Revert - Revert to paper (21) ◆ Ask - Ask for assistance (3) ◆ Report - Report to nurse in charge (7) ◆ Contact - Contact system help line (4) ◆ Unexpected - Should not happen (1) ◆ Maintain - Transfer data on to system when back in service (1)
Responses: 93%
Site B
<ul style="list-style-type: none"> ◆ Report it to ward in charge (4) ◆ I would revert to paper, but difficult as form is not available (7) ◆ Try to locate from previous patient hospital, talk to relatives refer, to documents ◆ Be in trouble!
Responses: 86%
Site C
<ul style="list-style-type: none"> ◆ Revert to Paper (4) ◆ Try to recover the data (1) ◆ Gather new data (1)

◆ Responses: 86%

Site D

- ◆ Contact IT Unit (3)
- ◆ Create Draft (4)
- ◆ Own Judgement (1)
- ◆ Paper - Look around and ask (1)
- ◆ Use older paper copies (1)
- ◆ Gather new data (1)

Responses: 90%

Q10. Have you ever experienced any problems with the CIS?

	A	B	C	D
Yes	58	64	86	73
No	42	36	14	27
Total responses	100	100	100	100

Please explain

Site A

- ◆ The machine sometimes crashes (4)
- ◆ Only in the beginning (1)
- ◆ Too slow reading archive (1)
- ◆ Becomes slow when patient admitted for a long period of time (1)
- ◆ Screen freezes sometimes (6)
- ◆ Minor data entry problems – missing data (2)

Site B

- ◆ Crashes (1)
- ◆ Couple of times when I couldn't change my password (1)
- ◆ Sometimes printer doesn't work (2)
- ◆ Server down (2)
- ◆ Lab computer crashed so we had no request forms for investigations, required forms made, all request made via old methods. (2)
- ◆ Slow (2)

Site C

- ◆ More comprehensive introduction to the system would have bettered the start up period (1)
- ◆ Lots! There have been many start up problems for both the computers and the staff. For example the numbers values has disappeared for hours from a patient, nothing was kept and so no documentary on the patients state. (1)
- ◆ Several unexplained difficulties in the first weeks – many probably due to wrong use- fewer problems after the upstart period (1)
- ◆ User mishandling of CIS – crash down, Software instability, Hardware problems (1)
- ◆ Computer failure: failure to obtain relevant data or to find the data I required. (1)
- ◆ Many. Among others the system being very, very slow and data as pulse, blood pressure etc. not transmitting to computerized CIS (1)

Site D

- ◆ Denied access – Breakdown of the system (3)
- ◆ I use it very little (1)
- ◆ Files were lost or temporarily misplaced (2)
- ◆ When nurses who are not permanent start to fill out the paper, there are a lot of problems (1)
- ◆ Downtime, error messages, lost passwords (1)

Q10a. Do you receive adequate support to deal with the problems that arise?

	A	B	C	D
Yes	68	21	57	9
No	0	29	29	64
Total responses	68	50	86	73

Please state what kind of support you would like to see.

Site A
<ul style="list-style-type: none"> ◆ Onsite software development and trouble shooting (1) ◆ More expertise colleagues give us a hand (2)
Site B
<ul style="list-style-type: none"> ◆ Slow to respond (3) ◆ I would like a help in the system itself instead of contacting the IT department (2) ◆ No training given on trouble-shooting (1)
Site C
<ul style="list-style-type: none"> ◆ Resources to deal with problems are too scarce – both for user problems and software problems (1) ◆ We need an around the clock support to help us retrieve data if the system crashes – or a member to teach our new staff how to use the paper based CIS in case the electronic base fails us. (1) ◆ Two nurses. Some doctors and others worked with the system for one year before we started using it. A group of nurses were given more lessons than others in order to give support but there is not always one of these persons present in the ICU. Technicians can only be called in daytime. (1)
Site D
<ul style="list-style-type: none"> ◆ Hot-line and personal assistance (1) ◆ Technician was called but did not feel responsible (1) ◆ The whole CIS has just been started (1) ◆ Trouble shooting (1) ◆ More user orientated interface (1) ◆ We don't back up paper records (1)

Q11. The following question is about how easy it is to use your CIS for tasks such as entering, viewing and printing information. For those who use a paper-based system the '*printing*' option does not apply.

11.a Accessing patient information for viewing

	Site A					Total Per Category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
Is fast	16	71	3	0	0	90
Is easy to use	16	74	0	0	0	90
Is flexible	7	58	13	3	0	81
Total Per Category	39	203	16	3	0	
	Site B					Total Per Category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
Is fast	7	43	14	7	14	93
Is easy to use	14	57	14	7	0	93
Is flexible	7	36	29	7	7	86
Total Per Category	28	136	57	21	21	

	Site C					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	14	57	0	29	0	100
Is easy to use	0	71	0	29	0	100
Is flexible	0	57	29	14	0	100
Total Per Category	14	185	29	72	0	

	Site D					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	46	36	18	0	0	100
Is easy to use	0	73	9	18	0	100
Is flexible	0	18	46	36	0	100
Total Per Category	46	127	73	54	0	

11.b Accessing patient information for *entering data*

	Site A					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	26	65	7	0	0	98
Is easy to use	19	65	0	0	0	84
Is flexible	10	52	13	7	0	82
Total Per Category	55	182	20	7	0	

	Site B					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	7	29	21	29	0	86
Is easy to use	7	57	14	21	0	100
Is flexible	0	29	29	29	0	87
Total Per Category	14	115	64	79	9	

	Site C					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	0	57	29	14	0	100
Is easy to use	0	72	14	14	0	100
Is flexible	0	43	43	14	0	100
Total Per Category	0	172	86	42	0	

	Site D					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	0	36	46	18	0	100
Is easy to use	9	27	37	27	0	100
Is flexible	0	0	55	36	9	100
Total Per Category	9	63	138	81	9	

11.c Accessing patient information for *printing*

	Site A					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	29	55	7	7	0	98
Is easy to use	19	65	0	0	0	84
Is flexible	16	48	10	10	0	84
Total Per Category	64	168	17	17	0	
	Site B					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	7	14	29	14	0	64
Is easy to use	14	21	21	14	0	71
Is flexible	7	14	29	7	7	64
Total Per Category	28	49	79	35	7	
	Site C					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	0	43	57	0	0	100
Is easy to use	0	57	43	0	0	100
Is flexible	0	43	57	0	0	100
Total Per Category	0	143	157	0	0	
	Site D					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total Per Category
Is fast	18	36	9	9	0	72
Is easy to use	18	46	0	9	0	73
Is flexible	0	27	27	18	0	72
Total Per Category	36	109	36	36	0	

Please add any other comments you believe to be of importance.

Site A
<ul style="list-style-type: none"> ◆ Printer trouble (4) ◆ Can't always find things immediately when in a rush (1) ◆ Relies on typing skills therefore slow initially (1)
Site B
<ul style="list-style-type: none"> ◆ Printing instructions not clear (1) ◆ Slow when there are multiple users, and sometimes times out (1) ◆ Entering data: old multi screens are no longer in use, too many different screens (1) ◆ Too much paper and separate sheets make it difficult to write cases and conditions (1) ◆ Personally I find the old system time consuming of little importance and old fashioned (1)
Site C
<ul style="list-style-type: none"> ◆ I have not been printing yet (1) ◆ Difficulty in connecting different data sets (1) ◆ I am not uncertain but I don't entirely agree either. It is easier to access the paper based CIS if I'm in a hurry. Mainly because the electronic-based needs passwords to get in – and that takes time (1)
Site D
<ul style="list-style-type: none"> ◆ Depends upon the secretary (1) ◆ I think it is very hard for me to answer because I use it very little (1) ◆ Log in is too long procedure (1)

Q12. Please tick the statement about your CIS that best matches your opinion.

	A	B	C	D
I refuse to use it	0	0	0	0
I try to avoid using it	0	0	0	0
I only use it for the bare minimum	0	7	0	0
I use it because I have to	0	21	29	36
It makes no difference to me	0	0	14	10
I don't mind using it	26	50	0	36
I like using it	68	21	57	18
Total responses to this question	94	100	100	100

Q12a.

If you don't like using the CIS, please explain why.

	Site A					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I've too much else to do	7	0	0	0	0	7
It's a hindrance	7	0	0	0	0	7
It's too complicated	7	0	0	0	0	7
It doesn't do what I want it to	0	0	0	7	0	7
It takes too much time	7	0	0	0	0	7
I don't like typing in the CIS	0	7	0	0	0	7
I don't like writing in the CIS	7	0	0	0	0	7
It interferes with caring for the patient	7	0	0	0	0	7
Total responses	42	7	0	7	0	
	Site B					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I've too much else to do	0	14	0	14	0	28
It's a hindrance	0	14	0	14	0	28
It's too complicated	0	7	0	21	0	28
It doesn't do what I want it to	7	0	7	14	0	28
It takes too much time	0	21	0	7	0	28
I don't like typing in the CIS	0	14	7	7	0	28
I don't like writing in the CIS	0	14	7	7	0	28
It interferes with caring for the patient	0	21	0	7	0	28
Total responses	7	105	21	91	0	
	Site C					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I've too much else to do	0	0	29	0	0	29
It's a hindrance	0	14	14	0	0	28
It's too complicated	14	0	0	14	0	28
It doesn't do what I want it to	0	0	29	0	0	29
It takes too much time	14	0	14	0	0	28
I don't like typing in the CIS	0	0	0	29	0	29
I don't like writing in the	0	0	0	29	0	29

CIS						
It interferes with caring for the patient	0	14	0	0	0	14
Total responses	28	28	86	72	0	
	Site D					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Total response per category
I've too much else to do	0	1	0	1	0	2
It's a hindrance	0	1	0	0	1	2
It's too complicated	0	0	1	0	1	2
It doesn't do what I want it to	0	2	0	0	0	2
It takes too much time	0	1	0	1	0	2
I don't like typing in the CIS	0	0	0	2	0	2
I don't like writing in the CIS	0	0	0	2	0	2
It interferes with caring for the patient	0	0	1	1	0	2
Total responses	0	5	2	7	2	

Q13. What format do you prefer for your CIS? Please tick one option that indicates your preference

	A	B	C	D
Strong preference for computerised CIS	71	50	43	36
Slight preference for computerised CIS	13	29	14	46
No preference of type of CIS	13	7	29	9
Slight preference for paper	3	7	0	9
Strong preference for paper	0	0	14	0
Total responses to this question	100	93	100	100

Q14. Can you.... (Please tick one option)

	A	B	C	D
...Do more with an electronic CIS than with a paper-based one?	58	43	43	64
...Do less with an electronic CIS than with a paper-based one?	0	14	14	0
...Do the same with both	23	0	29	18
Uncertain	13	14	14	18
Total responses to this question	94	71	100	100

Please comment

Site A
<ul style="list-style-type: none"> ◆ Real-time information (1) ◆ Feel more competent with the electronic one (1) ◆ Prefer for speed much faster searching for information (3) ◆ Advantages and disadvantages of both but electronic out weighs paper system (1) ◆ Some doctors don't put in as much as they would write (1) ◆ Each system as good as the person who inputs the system (1) ◆ Access much better (3) ◆ Not used the paper system in the ICU (1) ◆ Data well organised (2)
Site B
<ul style="list-style-type: none"> ◆ Better, as faster and reliable (1) ◆ As I am computer literate I would like to use an electronic CIS (1) ◆ On paper things are said / explained easier (1) ◆ Never used the electronic CIS, so don't know (1)

♦ A computer system would offer a more comprehensive information gathering opportunity that is applicable to patient care and thus influencing the care given (1)
Site C
♦ Less flexible (1) ♦ When our system is fully equipped it will allow many valuable comparisons (1) ♦ Until the electronic CIS has been fully developed it is no better than the paper based one. (1) ♦ We have not use the computerized CIS for long (1)
Site D
♦ Connect information in new ways (1) ♦ Provided the electronic one is more stable and fast (1) ♦ Trends and storage (1)

Q15. From which system would you *trust* the information more? Please tick one option.

	A	B	C	D
Strong preference for computerised CIS	32	29	14	9
Slight preference for computerised CIS	23	14	29	27
No preference of type of CIS	42	14	57	55
Slight preference for paper	3	36	0	9
Strong preference for paper	0	0	0	0
Total responses to this question	100	93	100	100

Please comment

Site A
♦ Paper can get lost (1) ♦ Both can be equally as accurate as depends upon person inputting data (6) ♦ All data centralised (1) ♦ Legibility of typed notes is much better (1) ♦ Computer is faster (1)
Site B
♦ Reliable (1) ♦ It saves time (1) ♦ Not confident from have printed out at different sites and no feedback to confirm (1) ♦ Mistakes can be made in both (1) ♦ Computer can go wrong (1) ♦ Depends upon who inputs the data (1) ♦ This is dependent on the info put in by the user. It needs to be concise (1)
Site C
♦ The computerized CIS automatically keeps the values but they can be wrong because of 'machine faults'. The nurse can choose to write or not to write some values. The values on paper are then not objective (1) ♦ We can make mistakes on the paper-based system and computer errors have been seen on the computer based. (1) ♦ Computerized CIS ought to be the most trust worthy but till now I have seen the wrong data that could not immediately be removed. (1)
Site D
♦ It depends upon who put the information to the computer/paper (1) ♦ With paper based there is risk of receiving out of date data (1)

Q16. Which system do you think gives you more time with the patient?

	A	B	C	D
Strong preference for computerised CIS	55	43	0	9
Slight preference for computerised CIS	29	21	14	27
No preference of type of CIS	13	29	72	37
Slight preference for paper	3	0	0	18
Strong preference for paper	0	0	14	9
Total responses per category	100	93	100	100

Please comment

Site A
<ul style="list-style-type: none"> ◆ Automated downloads mean less time writing (4) ◆ Depends upon typing skill (1) ◆ More time with patient once adapt to system (1) ◆ System by bedside so in close contact with patient (2) ◆ Less time looking for paper (1) ◆ Used paper for 20 and CIS for 2 years -- (experience) (1)
Site B
<ul style="list-style-type: none"> ◆ Saves time and quick (1) ◆ Results retrieving much easier (1) ◆ If information was-tick based as in other systems being used in ITU, you can see the info straightaway without having towards through reams of paper work (1)
Site C
<ul style="list-style-type: none"> ◆ But hopefully computerized CIS will not go on taking that much time (1)
Site D
<ul style="list-style-type: none"> ◆ In the beginning – paper, later perhaps equal amounts of time for both systems (1)

Q17. In general, which system do you believe to be better at informing all the health care provider groups about the patient? E.g., nurses, doctors, physiotherapists, pharmacists, etc.

	A	B	C	D
Strong preference for computerised CIS	48	36	14	27
Slight preference for computerised CIS	39	21	29	46
No preference of type of CIS	10	21	57	18
Slight preference for paper	3	14	0	0
Strong preference for paper	0	0	0	0
Total response to this question	100	93	100	91

Please comment

Site A
<ul style="list-style-type: none"> ◆ Not always used by all staff (3) ◆ If everyone understands the system and good training given (5) ◆ Frequent change of doctors means they cannot always make best use of the system so they rely heavily upon nursing staff (2) ◆ All staff would need to be at same level of competence with the system (1) ◆ Multidisciplinary access (1) ◆ Information is on one place, legible, quick to access and easily accessible (4) ◆ The same information but better trends can be see by use of graphs (1)
Site B
<ul style="list-style-type: none"> ◆ Prefer computerised CIS and on top of that I use phone for informing other specialities about the patient (1) ◆ Can't be mislaid (1) ◆ Easy to see when on paper chart as it is in front of you (1) ◆ There is a lot of reliability and common sense in having all the information on the same screen. It is my belief that this will fundamentally benefit patient care (1)
Site C
<ul style="list-style-type: none"> ◆ We have not used it for long (1)
Site D
<ul style="list-style-type: none"> ◆ System needs to be accessible and fast (1)

- Q18.** This question is asking you about the system and **not the information** that it contains. For each factor, please tick the better of the two systems. Tick the 'Both' option if you think that both the systems rate the same.

		Site A			
		Electronic CIS	Paper-based CIS	Both the same	Total Response
	More reliable	39	3	55	97
	More useful	84	0	16	100
	More flexible	77	13	7	97
	Faster to access patient Information	94	0	3	97
	Faster to view patient Information	90	0	7	97
	Faster to enter patient information	74	0	23	97
	Easier to access patient information	80	3	10	93
	Easier to view patient information	84	3	7	94
	Easier to enter patient information	68	7	19	94
Total responses per category		690	29	147	
		Site B			
		Electronic CIS	Paper-based CIS	Both the same	Total Response
	More reliable	21	36	14	71
	More useful	43	0	28	71
	More flexible	36	29	7	71
	Faster to access patient Information	64	7	0	71
	Faster to view patient Information	64	7	0	71
	Faster to enter patient information	36	14	21	71
	Easier to access patient information	50	14	0	64
	Easier to view patient information	50	21	0	71
	Easier to enter patient information	50	14	7	71
Total responses per category		385	184	141	
		Site C			
		Electronic CIS	Paper-based CIS	Both the same	Total Response
	More useful	0	14	29	43
	More flexible	57	0	29	86
	Faster to access patient Information	42	29	29	100
	Faster to view patient Information	43	43	14	100
	Faster to enter patient information	0	14	71	85
	Easier to access patient information	29	43	28	100
	Easier to view patient information	29	57	14	100
	Easier to enter patient information	43	43	14	100
Total responses per category		286	243	271	
		Site D			
		Electronic CIS	Paper-based CIS	Both the same	Total Response
	More reliable	27	27	36	90
	More useful	73	0	18	91
	More flexible	64	18	18	100
	Faster to access patient Information	64	9	18	91
	Faster to view patient Information	55	27	18	100
	Faster to enter patient information	27	45	27	99
	Easier to access patient information	36	46	18	100
	Easier to view patient information	73	18	9	100
	Easier to enter patient information	36	55	9	100
Total responses per category		455	245	171	

Q18a.

Please rate the importance of these factors for a CIS

	Site A					
	Of Great Importance	Important	Don't know	Some importance	No Importance	Total Response
Reliability	81	16	3	0	0	100
Usefulness	68	29	3	0	0	100
Flexibility	48	45	7	0	0	100
Speed of access to patient information	61	32	7	0	0	100
Speed of viewing patient information	65	32	3	0	0	100
Speed of entering patient information	48	39	13	0	0	100
Ease of access to patient information	67	26	7	0	0	100
Ease of viewing patient information	67	26	7	0	0	100
Ease of entering patient information	58	29	13	0	0	100
Total responses	563	274	63	0	0	
	Site B					
Reliability	79	0	0	7	7	93
Usefulness	57	36	0	0	0	93
Flexibility	36	57	0	0	0	93
Speed of access to patient information	50	36	0	0	7	93
Speed of viewing patient information	57	29	0	0	7	93
Speed of entering patient information	64	14	0	0	14	93
Ease of access to patient information	64	29	0	0	0	93
Ease of viewing patient information	71	21	0	0	0	93
Ease of entering patient information	64	14	0	0	14	93
Total responses	542	236	0	7	49	
	Site C					
	Of Great Importance	Important	Don't know	Some importance	No Importance	Total Response
Reliability	86	14	0	0	0	100
Usefulness	71	29	0	0	0	100
Flexibility	57	43	0	0	0	100
Speed of access to patient Information	57	43	0	0	0	100
Speed of viewing patient Information	43	43	0	0	0	86
Speed of entering patient information	57	43	0	0	0	100
Ease of access to patient information	43	57	0	0	0	100
Ease of viewing patient information	43	57	0	0	0	100
Ease of entering patient information	57	43	0	0	0	100
Total responses	514	372	0	0	0	

	Site D					Total Response
	Of Great Importance	Important	Don't know	Some importance	No Importance	
Reliability	91	9	0	0	0	100
Usefulness	64	36	0	0	0	100
Flexibility	27	64	9	0	0	100
Speed of access to patient information	36	46	18	0	0	100
Speed of viewing patient information	36	64	0	0	0	100
Speed of entering patient information	36	55	9	0	0	100
Ease of access to patient information	36	36	27	0	0	100
Ease of viewing patient information	46	36	18	0	0	100
Ease of entering patient information	27	55	18	0	0	100
Total responses	399	402	99	0	0	

The following questions (Q19-Q27) are about your information requirements

- Q19.** What information do you require in order to provide care for the patient? Please state all, e.g. *Patient Care Plan, Medical Notes, Vital Signs etc.*

Site A

- Vital signs
- Patient care plan
- Medical notes
- Fluid balance
- Drug/medication information
- Laboratory test results
- Observations
- Trends
- Multidisciplinary notes
- Medical history
- Times and dates of CT scans
- Daily management plan
- Demographics
- Record of interviews with relatives
- Family contacts

Responses: 97%

Site B

- Medical notes
- Vital signs
- Patient care plan
- CT Scan
- Results
- Anatomy and physiotherapy
- Medications
- Multidisciplinary notes
- Doctor and nurse care plans
- Request forms

<ul style="list-style-type: none"> ▪ Disease progression ▪ Protocols ▪ Comment space
Responses: 79%
Site C
<ul style="list-style-type: none"> ▪ Medical Notes ▪ Vital Signs ▪ Fluid Balance ▪ Observation Chart ▪ Allergies ▪ Doctor and nurse journals ▪ Medication given ▪ Comments about anything unusual
Responses: 71%
Site D
<ul style="list-style-type: none"> ▪ Vital signs ▪ Patient care plan ▪ Medical notes ▪ Journal ▪ Test results ▪ X-rays ▪ Anamnesis ▪ Medical story ▪ Medications ▪ Social matters ▪ Multidisciplinary notes
Responses: 81%

Q20. Do you feel that your information requirements are met? Please tick the option that applies to you.

	A	B	C	D
Always	10	0	0	0
Most of the time	84	50	71	73
Sometimes	3	43	14	18
Never	0	0	0	0
Don't know	0	0	0	9
Total responses	97	93	85	100

Q20a. How would you like to see this improve?

Site A
<ul style="list-style-type: none"> ▪ Link to hospital information system (2) ▪ Cannot view fluid balance prior to 24 hour period (1) ▪ Multidisciplinary use of system...not just nurses (2) ▪ Change system of up/down grading patients between ICU and HDU (2) ▪ Greater flexibility (1) ▪ Care plan too repetitive (1) ▪ Better printing, not just page by page (1) ▪ All patient history from case notes to CIS (1) ▪ Access to audit information (1)
Responses: 30%
Site B
<ul style="list-style-type: none"> ▪ Printer needs improving (1) ▪ Multidisciplinary care pathways and centralising information (1)

<ul style="list-style-type: none"> ▪ One file for all disciplines to put comments (1) ▪ A system which gives all the information at a glance (1)
Responses: 31%
Site C
<ul style="list-style-type: none"> ▪ More introduction and closer to start date of using the system (1) ▪ I think it holds all the information I need it just takes time and a lot of clicking to find it (1) ▪ Need for greater flexibility in making reports (1) ▪ Not all information is in the CIS. Diagnosis, operation, plans are not in the CIS. This information is still to be found in the paper based case sheet (will be computerised) and this information is told by one nurse to the next at shift (1)
Responses: 57%
Site D
<ul style="list-style-type: none"> ▪ Easier access to prior information (1) ▪ More Speed in the system, easier access, more flexibility (1)
Responses: 18%

Q21. In terms of the CIS *information content*, please rate which type of system you believe to be better.

	Site A			
	Electronic CIS	Paper-based CIS	Both the Same	Total response per category
Provides more reliable information	55	0	42	97
Provides more relevant information	45	0	48	93
Provides more useful information	48	0	45	93
Provides more accurate information	55	0	39	94
More flexible	81	7	7	95
Total responses per category	284	7	181	
	Site B			
	Electronic CIS	Paper-based CIS	Both the Same	Total response per category
Provides more reliable information	21	14	57	93
Provides more relevant information	21	21	50	93
Provides more useful information	29	14	50	93
Provides more accurate information	29	14	50	93
More flexible	36	21	36	93
Total responses per category	136	84	243	
	Site C			
	Electronic CIS	Paper-based CIS	Both the Same	Total response per category
Provides more reliable information	43	0	43	86
Provides more relevant information	14	0	71	85
Provides more useful information	14	0	71	85
Provides more accurate information	29	0	57	86
More flexible	43	0	43	86
Total responses per category	143	0	285	
	Site D			
	Electronic CIS	Paper-based CIS	Both the Same	Total response per category
Provides more reliable information	46	9	36	91
Provides more relevant information	27	9	54	90
Provides more useful information	36	18	36	90

Provides more accurate information	46	9	36	91
More flexible	55	9	27	91
Total responses per category	210	54	189	

Q22. How much do you think things change with the introduction of an electronic CIS? Please select one option.

	A	B	C	D
Major changes	42	43	57	9
Some changes	48	43	43	82
Minor changes	0	0	0	9
No change	0	0	0	0
Total responses	90	86	100	100

Please explain

Site A
<ul style="list-style-type: none"> ◆ Now there is very little paper (1) ◆ Need to learn to use the system and gain confidence (2) ◆ Continuous monitoring of patient (1) ◆ Quicker and more accessible (1) ◆ Greater training needs for new staff and computer literacy needed (3) ◆ Care does not change (1) ◆ Increased awareness of necessity for accurate information (1) ◆ Legible notes (1) ◆ Can be used for audit, best practice and monitoring of change (2) ◆ Same information just dealt with differently (1)
Site B
<ul style="list-style-type: none"> ◆ Staff need training and system maintenance needs to be established (1) ◆ Will require a new way of working and thinking (1) ◆ Reorganisation of unit and positioning of computer and work station (1) ◆ Education and support for staff (1) ◆ Would require training (1)
Site C
<ul style="list-style-type: none"> ◆ System recently introduced hard to tell yet (1) ◆ Lots of new working situations- have to evolve (1) ◆ Completely different way of handling patient data and summarizing this in a data chart (1) ◆ Routines to ensure a general view of the patient has to be changed as all data is fragmented in the computerized CIS we have in our ICU (1)
Site D
<ul style="list-style-type: none"> ◆ It is going to take quite a while to implement the system (1) ◆ A lot of mess, not enough using, Babel tower interface problems – working okay in ten years time. (1) ◆ Lot of routines have to be changed (1)

Q23. In your opinion, would you say that the CIS is ... (please select one option)

	A	B	C	D
...Fully integrated into the ICU	84	21	0	36
...Partially integrated into the ICU	13	43	100	55
...Not integrated into the ICU at all	0	21	0	0
Total responses to this question	97	85	100	91

Please explain

Site A
<ul style="list-style-type: none"> ◆ In terms of nursing care: fully integrated (Once staff trained and felt comfortable with it). In terms of medical care: partially integrated (2) ◆ All established staff fully competent in using the system (4) ◆ Fully integrated and part of our working day (1) ◆ Still required to write same information on paper and record on computer – defeats object of having a computer system (I.E Results reporting) (2)
Site B
<ul style="list-style-type: none"> ◆ Quick (1) ◆ Only some patient info on the computer (1) ◆ It is impossible to find out when a patient last had an X-Ray, this needs to be investigated immediately (1)
Site C
<ul style="list-style-type: none"> ◆ Still too early (1) ◆ In several ways we still have to use paper based systems (1)
Site D
<ul style="list-style-type: none"> ◆ Maybe in time the system will be improved. As for now there will be a lot of problems (1) ◆ Only CIS in use is Lab CIS (1)

Q24. Do you feel that the CIS makes your work ... ? (Please select one option)

	A	B	C	D
...Much better	39	14	0	9
...Better	48	50	57	64
...No change	7	21	14	9
...Worse	0	0	29	9
...Much worse	0	0	0	0
Total responses	94	85	100	91

Please explain

Site A
<ul style="list-style-type: none"> ◆ Speedy and more readily accessible information (no hunting for case notes and can't be lost like paper) (9) ◆ Easier to input than on paper (2) ◆ Because it is multi-disciplinary it makes me more conscious of being accurate and explicit (1) ◆ Continuous recording –more options (2)
Site B
<ul style="list-style-type: none"> ◆ Quick (1) ◆ Less time writing means better time efficiency therefore freeing one to do other things - also reduces the workload (1)
Site C
<ul style="list-style-type: none"> ◆ System still too new to tell (1) ◆ The 'writing down' values time can be used for other things but it is so far used to find my way in the computer (1) ◆ Reliable, unbiased data collecting (1) ◆ It will help us better than the paper based as soon as it is fully developed (1)
Site D
<ul style="list-style-type: none"> ◆ Paper CIS is functioning and is well known (1)

Q25. What do you like the most about the CIS that you use? Please state below.

Site A
<ul style="list-style-type: none"> ▪ Information: Accessible; collated, retrieval and use; Comprehensive, printable, drug information and protocols, useful for tracking trends (5) ▪ System: Automatic and continuous downloads and calculations, good screen display, simplicity and clarity, good layout (9) ▪ Communication: more time with patient, user friendly (3) ▪ Efficiency: Easy and fast to use, access and store; Paper free; Less time consuming results search; reduced paper work, by patients bedside (14) ▪ Everything : (1)
Responses: 84%
Site B
<ul style="list-style-type: none"> ▪ Ease of use: Results section (1); Patient demographics automatically filled in (1); Huge paper sheets, all the information is on one sheet (1) ▪ Accessible: Ease of accessibility (2); ▪ Speed: For computerised, test requests and results retrieving faster as less time wasted looking for print outs of results (1); Saves time and minimal effort for data input (1) ▪ Integration: Referral X-Ray and lab requests/results (1)
Responses: 79%
Site C
<ul style="list-style-type: none"> ▪ Accessible: swift access of precise information (1) ▪ Reliable: unbiased data collection however I don't see some data now and am therefore unable to reflect on it (2) ▪ Speed: I don't need to write down vital signs every hour and I'm documenting more of the things happening's saves time. (1)
Responses: 57%
Site D
<ul style="list-style-type: none"> ▪ Ease of use: We decide production of data (2) ▪ Accessible: That it is there, that you can read it and touch it and easily go from one part to the other to look for things (1) ▪ Reliability: Higher reliability – better overview - More (all) information about patient (4) ▪ Integration: When all information is integrated (1) ▪ Monitoring: Trend monitoring – Lab data (1) ▪ Speed: (1)
Responses: 90%

Q26. What do you like least about the CIS that you use? Please state below.

Site A
<ul style="list-style-type: none"> ▪ Resources: Share one computer between two HDU beds (2) ▪ Network: Required to use paper to communicate with rest of hospital as system stand-alone. Transferring patient between ICU and HDU, inputting laboratory results (2) ▪ Awareness and Education: Other Disciplines apprehensive, Heavy reliance on nursing staff by Medics regarding the CIS, Doctors do not complete notes on system (5) ▪ Nothing: (4) ▪ Crashes: Occasionally crashes (2) ▪ Governance: Cannot edit info once input (problematic when make a mistake, have to make another entry), lack of query and audit option (2) ▪ Existing Processes: Little info available to send on patient discharge (3) ▪ Speed: Sometimes slow to access, waiting for other members to finish (2)
Responses: 81%

Site B
<ul style="list-style-type: none"> ▪ Reliability: Unreliable (1); Printer problems (3) ▪ Speed: Times out (1); Time consuming (1) ▪ Accessibility: Need more terminals (2)
Responses: 36%
Site C
<ul style="list-style-type: none"> ▪ Change: Information on screen hard to get used to when paper has been the gold standard for so long (1) ▪ Speed: It takes a lot of time to find the words/thing I want to document but that might be because it is a new system in our ward (1) ▪ System: Heavy apparatus physically to handle in operating room. Lots of electric/data cables at work place (1) ▪ Non-Pervasive: The PC can't be moved, the computer is bedside, not portable. I cannot hold the hands of the patient and use the computer at the same time. (2) ▪ Reliability: It is not completely reliable as yet and not as easy to access as the paper-based version. The nurse observations (personal care, e-pad and so on) is not visible (1)
Responses: 86%
Site D
<ul style="list-style-type: none"> ▪ System: Old system with number codes (1); Little information about the prior days, other diseases (1); Data it is missing (2) ▪ Reliability: Breakdowns (1) ▪ Speed: It's slow and inflexible (1); It is slow paper module which must be put in a database (1) ▪ Learning: It takes a lot of time in the beginning (1) ▪ Accessibility: When my password expires frequently (1)
Responses: 81%

27. Would you recommend the CIS that you use to other hospitals?

	A	B	C	D
Yes, definitely	87	14	0	9
Yes, with reservation	10	7	58	18
Maybe	0	29	14	46
Probably not	0	14	14	18
Definitely not	0	14	14	0
Total responses	97	79	100	91

Please explain

Site A
<ul style="list-style-type: none"> ◆ I would recommend some changes first (1) ◆ Still learning about it (1) ◆ Less paper work, accurate data and trends (1) ◆ Efficient and practical (1) ◆ Makes life easier – storage of information is better all information is together (2) ◆ It's an excellent set-up (1)
Site B
<ul style="list-style-type: none"> ◆ Saves times (1) ◆ Any system that saves time can only be of benefit (1)
Site C
<ul style="list-style-type: none"> ◆ Too early days (1) ◆ Have not yet seen a properly function of 'data out' (1) ◆ It needs to be better before some one else can use it (1) ◆ I would recommend them to find a faster, easier less fragmented CIS (1)

Site D
<ul style="list-style-type: none"> ◆ I would recommend a fully integrated computerized CIS (1) ◆ I would prefer an electronic CIS totally (1)

The following questions are about your role in the ICU and your relationship with other staff

Q28. How involved are you in the decision making process about your ICU, the patient and the CIS?

	Site A			
	Patient	CIS	ICU	Total response per category
Greatly involved	58	13	16	87
Some involvement	27	55	42	124
No involvement	7	16	26	49
Total responses per category	92	84	84	
	Site B			
	Patient	CIS	ICU	Total response per category
Greatly involved	43	0	28	71
Some involvement	29	36	36	101
No involvement	7	50	21	78
Total responses per category	79	86	86	
	Site C			
	Patient	CIS	ICU	Total response per category
Greatly involved	43	14	14	71
Some involvement	57	0	0	57
No involvement	0	0	0	0
Total responses per category	100	14	14	
	Site D			
	Patient	CIS	ICU	Total response per category
Greatly involved	64	27	27	118
Some involvement	27	27	27	81
No involvement	9	36	36	81
Total responses per category	100	90	90	

Please explain

Site A
<ul style="list-style-type: none"> ◆ Most changes are made without our consultation (1) ◆ I am a sister so part of my role is to be involved (1) ◆ I look after the patients and I am involved in ICU management and training (1) ◆ Staff meetings (1) ◆ We can make suggestions for CIS improvement (1) ◆ I choose to have no involvement in any decisions about the CIS (1)
Site B
<ul style="list-style-type: none"> ◆ Lack of space and equipment (1) ◆ People ask you if you are okay when a problem occurs but I don't feel involved in the decision making aspect of this unit (1)
Site C
<ul style="list-style-type: none"> ◆ Mostly working in the ICU as evening and night hours (1)

◆ Position: Consultant intensivist - head of implementing electronic CIS (PDM) (1)
◆ As I am the prime caretaker I'm greatly involved in the patient. As staff have some involvement in the ICU. As staff I haven't yet been given an opportunity to be involved. (1)
Site D
◆ It is quite seldom that I have duty on the ICU (1)
◆ I am chief of the department (1)

Q29. Do you think that your input is considered to be of any value by management?

	A	B	C	D
Yes, very valuable	19	14	14	18
Yes, of some value	45	50	43	36
Not sure	26	14	43	36
Of no value	0	7	0	0
Total responses	90	85	100	90

Q30. Which of the following statements describes you best?

	Site A					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I like to develop contacts	16	52	19	0	0	87
I like to solve difficult problems	26	45	13	3	0	87
I like to organise people and resources	23	45	13	7	0	88
I like to challenge convention	10	39	32	7	0	88
I like to evaluate all options before I make a judgement	26	58	7	0	0	91
I like to co-operate, avert friction and listen to others	32	48	10	0	0	90
I like to put my ideas into action	16	58	10	0	0	84
I give much attention to detail and like finding error and omissions	16	45	10	16	0	87
I provide a skill or knowledge to the group that is in rare supply.	13	39	19	16	0	87
Total responses per category	178	429	133	49	0	
	Site B					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I like to develop contacts	14	50	14	7	0	86
I like to solve difficult problems	14	64	7	0	0	86
I like to organise people and resources	7	57	21	0	0	86
I like to challenge convention	29	43	7	7	0	86
I like to evaluate all options before I make a judgement	29	43	14	0	0	86
I like to co-operate, avert friction and listen to others	29	43	7	7	0	86
I like to put my ideas into action	36	29	21	0	0	86
I give much attention to detail and like finding error and omissions	29	29	21	7	0	86
I provide a skill or knowledge to the group that is in rare supply.	14	29	36	7	0	86
Total responses per category	201	387	148	35	0	

	Site C					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I like to develop contacts	29	43	29	0	0	101
I like to solve difficult problems	29	43	14	14	0	100
I like to organise people and resources	14	43	29	14	0	100
I like to challenge convention	14	29	29	29	0	100
I like to evaluate all options before I make a judgement	29	43	14	14	0	100
I like to co-operate, avert friction and listen to others	57	29	0	14	0	100
I like to put my ideas into action	14	57	14	14	0	99
I give much attention to detail and like finding error and omissions	14	71	14	0	0	99
I provide a skill or knowledge to the group that is in rare supply.	0	43	43	0	0	86
Total responses per category	200	401	186	98	0	

	Site D					Total response per category
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	
I like to develop contacts	36	36	18	0	0	90
I like to solve difficult problems	27	55	9	0	0	91
I like to organise people and resources	18	46	27	0	0	91
I like to challenge convention	18	36	36	0	0	90
I like to evaluate all options before I make a judgement	18	46	27	0		91
I like to co-operate, avert friction and listen to others	27	36	18	9	0	90
I like to put my ideas into action	27	55	9	0	0	91
I give much attention to detail and like finding error and omissions	9	18	63	0	0	90
I provide a skill or knowledge to the group that is in rare supply.	27	9	46	9	0	91
Total responses per category	207	337	253	18	0	

Q31. What do you like the most about your ICU?

Site A
<ul style="list-style-type: none"> ▪ Opportunities: Given opportunities for new ideas, excellent learning opportunities, being involved with decisions about patients (3) ▪ Standard of Care: High standard of care (2) ▪ Time: Time to do things (1) ▪ Environment: Friendly, ICU environment, New well designed ICU, large, spacious and clean (8) ▪ People: Fantastic people I work with, enjoy patient contact and people I work with, enjoy dealing with patients and their relatives (10) ▪ Teamwork: (10) ▪ All of It: (2)
Responses: 71%
Site B
<ul style="list-style-type: none"> ▪ The ICU itself (1) ▪ Critical thinking (1) ▪ Environment (1)

<ul style="list-style-type: none"> ▪ Critical care of patients (1) ▪ Rewarding (1) ▪ The hours that I do (1) ▪ Good opportunity for study leave and teaching sessions (1)
Responses: 29%
Site C
<ul style="list-style-type: none"> ▪ People: My colleagues, working with other specialities, taking care of patients and children (3) ▪ Stimulating never boring, wide spectrum of diseases. Complexity of patient admitted (3) ▪ Team work: The co-operative way of patient care, working together with other specialities (1)
Responses: 86%
Site D
<ul style="list-style-type: none"> ▪ Standard: Well organised, High Standard (2) ▪ People: Good Staff – Human Factor (3) ▪ Challenging Work: challenges (1) ▪ Team work: The co-operative way of patient care, working together with other specialities (2)
Responses: 55%

Q32. What do you like least about your ICU?

Site A
<ul style="list-style-type: none"> ▪ Politics: Doctors don't always organise themselves, Politics, Inappropriate admissions and their management, Day to day changing of consultants (5) ▪ Speed: slow at times, sloppy or lazy staff (2) ▪ Morale: Sometimes feel unsupported and undervalued, not feeling valued for what I do (1) ▪ Communication: Medics don't always use a team approach, Lack of consistency between consultant anaesthetists (2) ▪ Nothing: (2)
Responses: 65%
Site B
<ul style="list-style-type: none"> ▪ Nothing (2) ▪ Morale: Pressure of work (2) ▪ Physically and emotionally tiring (2). ▪ There is a lot of gossiping on the unit, which I find causes a bad atmosphere (1) ▪ Resources: Equipment store room (1)
Responses: 29%
Site C
<ul style="list-style-type: none"> ▪ Resources: The scarcity of staff (nurses and doctors) (2) ▪ Workload: Workload too great for amount of hands (1) ▪ Size: It's far too big, greater than 200 nurses employed so big that your part in the decision-making is little. The top management of the ICU has no contact to 'normal' staff. You can just go to work, nurse your patient and go home again, year after year without having to involve you in the ward itself and without getting any education. (1) ▪ Reorganisation: In the Danish Hospital System we are never at peace to do our work and be better at that. Things are to be reorganised again and again. This also happens in my ICU. (1)
Responses: 86%
Site D
<ul style="list-style-type: none"> ▪ Poor Resources: Lack of resources – Working around the clock/the year – Lack of space and rooms, When resources are scarce – when there is more work than you feel you can cope with and still have a good overview, Constant Lack of money and personnel, Need for beds, Low budget (6)
Responses: 55%

Q33. What is your job title and what other jobs do you do in the ICU? If you have more than one job, please state all.

<u>Official Role</u>					<u>Unofficial Role(s)</u>				
	A	B	C	D		A	B	C	D
Administration Assistant	3	0	0	9	Educator	6	0	14	0
Ancillary Staff	12	7	0	9	Information Manager	3	0	0	0
Nurse	81	57	43	18	Internal verifier	3	0	0	0
Doctor (MD)	0	35	57	72	Mentor	7	7	0	0
Total responses	96	100	100	108	Outside ordering of non stock items	3	0	14	0
					Research and development	3	0	0	0
					Transport link nurse	3	0	0	9
					Pain Team Member	0	0	0	9
					Total responses	28	7	28	18

Q34. How long have you worked in these roles?

<u>Official Role(s)</u>													
A	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	7	23	19	10	7	0	7	7	0	0	7	3	3
Total response to this question													93
B	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	14	14	14	7	7	0	0	7	0	7	0	0	0
Total response to this question													71
C	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	29	0	29	0	0	0	14	0	14	0	0	14	0
Total response to this question													100
D	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	27	0	9	9	0	9	18	0	0	0	9	9	0
Total response to this question													90

Unofficial Role(s)

A	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	0	10	3	3	3	0	0	0	0	0	3	0	0
Total response to this question													22
B	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	0	0	0	0	7	0	0	0	0	0	0	0	0
Total response to this question													7

C	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	0	14	0	0	0	0	0	0	14	0	0	0	0
	Total response to this question 28												
D	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	0	9	0	0	0	0	0	0	0	0	0	0	0
	Total response to this question 9												

Q35. How long have you worked in an ICU?

A	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	7	10	19	10	7	0	10	7	0	0	10	10	7
	Total response to this question 90												
B	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	21	7	0	7	14	7	0	7	7	7	0	0	0
	Total response to this question 79												
C	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	0	0	0	29	0	0	14	0	0	0	29	14	14
	Total response to this question 100												
D	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	18	9	18	9	0	9	0	0	0	0	18	9	0
	Total response to this question 90												

Q36. How long have you worked at your present place of work?

A	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	7	7	16	13	7	0	7	7	3	0	7	16	7
	Total response to this question 97												
B	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	14	7	7	0	7	0	21	0	0	0	0	0	0
	Total response to this question 57												
C	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	29	0	29	0	14	0	0	0	0	0	29	0	0
	Total response to this question 100												
D	Less than 1 year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	15-20	>20
	27	9	18	9	18	0	0	0	0	0	9	0	0
	Total response to this question 90												

Q37. Are you?

	A	B	C	D
Male	3	50	43	64
Female	90	29	57	36
Total responses	93	79	100	100

Q38. Do you use a computer when not at work?

	A	B	C	D
Yes	87	86	100	91
No	7	0	0	0
Total responses	94	86	100	91

Q38a. Do you enjoy using a computer?

	A	B	C	D
Yes, very much	39	57	43	27
Yes, sometimes	42	7	57	27
Not much	7	14	0	36
Not at all	0	7	0	0
Total responses	88	86	100	90

Q38b. How often do you use a computer when not at work?

	A	B	C	D
Daily	16	64	43	46
3-4 times per week	16	0	57	18
1-2 times per week	23	21	0	18
Every other week	16	0	0	0
Once a month	7	0	0	0
Less than once a month	7	0	0	0
Total responses	85	86	100	82