Key Words: Clinical Information Systems, Critical Care, Intensive Care, Systems Training.

Abstract
This paper presents a comparative case study to assess the feasibility of training nurses to use electronic clinical information systems in an intensive care environment. It describes three critical care units, each at a different stage of implementing a clinical system.

The study has found that it is possible to train nurses to use clinical systems on-the-job. However, it is difficult and not desired by nurses; nurses prefer to work with mock cases away from the unit. Furthermore, in order to motivate nurses to learn on-the-job, the perceived usefulness of the system is an important factor and is a prerequisite to success.

Introduction
It has been reported that the information requirements of intensive care units differ substantially from those of other units of a hospital [1, 2, 3]. Given the complexity of the environment, the need for timely, accurate and comprehensive patient information is imperative; yet there is often poor access [2, 3]. This need for information is one of many factors driving hospitals to adopt new technologies. As demand for systems has grown, so suppliers have responded with numerous systems [4, 5].

Having grappled with the plethora of Clinical Information Systems (CIS) available and procured an appropriate system, decision makers are then faced with the challenge of implementing the chosen system. Users need to be trained to use the CIS efficiently and effectively; unless they do so the investment may not be worthwhile [6, 7, 8]. Furthermore, it has been found that a majority of clinical staff are not competent in informatics [9]. In an area such as acute care, one cannot afford to get it wrong.

Failed systems not only waste resources; they also cause negative impacts on the attitudes of health care professionals toward future implementations [10, 11, 12].

This paper investigates the feasibility of training nurses to use clinical information systems in a critical care environment, where the patient requires dedicated twenty-four-hour attention.

Background
To preserve anonymity, the hospitals are referred to as Sites A, B and C and the names of individual CIS are not stated.

This study was based in three intensive care units (ICU): two sites in Denmark (Site A and Site B) and one site in the UK (Site C). A summary description of the three sites is given in Table 1. Sites B and C had introduced a computer CIS while Site A used paper records for patient information. Sites A and B were both situated within the same county in Denmark; they used the same automated laboratory results reporting tool, which had been deployed for over a decade. The study focused on ICU nurses and doctors as they were the primary and most frequent users of the systems; the focus of this paper is on nurses.

Site A
A Danish university hospital. The ICU had eight beds, of which six were in use during this study. Approximately 40 shift nurses and 30 doctors were employed and the unit was heavily involved in testing two of the five modules of the Electronic Health Record (EHR). The Danish EHR is
not the same as a UK EHR. This paper looks at any system that manages patient information, for example an EPR,

EHR or Patient Data Management system. This includes paper systems, electronic systems and hybrids of both that were to be implemented hospital wide in all hospitals across the county. At the time of the study, 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. At the time of the study, the EHR had been delayed by six months due to technical difficulties; although training of staff had already begun. This had consisted of training three core nurses (super users); this training would be cascaded to other nurses once the system was fully implemented. One of the two ICU leaders who was involved with the development and implementation of these particular modules taught the super users. Training was given on-the-job, nurses were not pulled out of the unit and any practice with the system was undertaken when they were not busy with the patient. The nurses found it difficult learning to use the system while caring for the patient.

Site B
Another Danish hospital. The ICU had twenty beds and was divided into four specialist areas: heart, respiratory, brain and child-specific intensive care. All had the same staffing, technologies and similar physical layout. Over 220 shift nurses and approximately 100 duty doctors were employed here, making it one of the largest ICUs in Denmark.

The patient data management system (PDM)\textsuperscript{3} was introduced in September 2002 in parallel with the paper system, which was phased out in December 2002. As well as replacing the nurses’ 24-hour paper observation charts, the PDM facilitated management to make better use of the data for planning and financing resources.

Data were collected during parallel running of the PDM and the paper system and then three weeks later, after parallel operations ceased. The PDM comprised 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; and a reporting tool to enable analysis for quality assurance, cost containment, process monitoring, scoring, and outcomes management. The work process change for nurses involved using the system to record data that they would otherwise have recorded on the 24-hour observa-

### Table 1: Summary description of the three sites included in this study

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Approx. No. Staff</th>
<th>Approx. No. Beds</th>
<th>CIS Situation</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Denmark</td>
<td>70</td>
<td>8</td>
<td>Paper based patient records. About to implement county wide EHR. Involved in two of five EHR modules</td>
<td>Initial training given to Head of ICU who trained 3 nurses to cascade training down to other ICU nurses</td>
</tr>
<tr>
<td>B</td>
<td>Denmark</td>
<td>300</td>
<td>20</td>
<td>Implemented PDM to replace paper observation sheets. Paper based patient records</td>
<td>One ICU Doctor and three ICU Nurses given training by suppliers. One 3 hour lecture session for nurses and doctors. Training then cascaded by 3 Nurses and Doctor to all staff, on the job. Parallel use of paper and PDM system for three months</td>
</tr>
<tr>
<td>C</td>
<td>United Kingdom</td>
<td>100</td>
<td>7</td>
<td>Complete replacement of paper based patient records in ICU only.</td>
<td>Head of ICU and Head Nurse given training by supplier. Training cascaded to all users, on the job. Parallel use of paper and PDM system for three months</td>
</tr>
</tbody>
</table>
Training consisted of one 3-hour lecture session offered to nurses and doctors of the unit. Staff were expected to learn the system on-the-job and were supported by super users. At least one super user was available everyday.

**Site C**

A hospital situated in the North West of England. The ICU had seven beds and employed 90 shift nurses and 58 duty doctors. Their system was a complete patient information system, replacing all paper records, including doctor’s notes and patient care plans. The system was tailored for nurses and doctors, so that nurses had an area in the system for patient care plans; doctors had a separate area for their notes. Among other things, some observational data were downloaded directly from monitoring equipment; this is in contrast to Site B where all patient data was typed into the system. Drugs calculations were performed automatically, and full patient administration was offered by the system.

The system was first implemented in August 1998, with full changeover from paper to computer eight months later in April 1999. The aim of implementation was to eliminate paper in the ICU and to aid report writing and statistical analysis of data, as well as to carry out calculations that were described as ‘vexing’ by nurses, especially at the end of a shift when fatigue sometimes led to human error. It must be noted that the CIS was not hospital wide nor networked to any other information system within the hospital. It was available in the ICU only.

Training was given by two staff responsible for procuring and managing the system, to a team of nurses, who then cascaded this to other nurses in the unit whilst they worked.

**Data Collection**

A local research ethics committee approved research for Site C, while more informal methods were used at the Danish sites; formal procedures were not required where research involved staff only. Participants were promised confidentiality and anonymity as far as possible and were given a research protocol.

Data were collected using semi-structured interviews with nurses, doctors and managers. Four to five nurses and five doctors were interviewed for between 10 and 30 minutes at each site. Managers of the systems were interviewed for approximately one hour.

Observations of staff using the systems and shadowing nurses and doctors while they worked, during the day shift, further verified data collection (questionnaires were also distributed - however they are part of a much larger study [13] and not considered further within this paper).

A qualitative approach was employed, as it was considered the most appropriate for researching people and their behaviours, attitudes, and cultures in their natural environment [14]. This enabled the researcher to attain a rich understanding of not only the participants, but also the environment in which they worked; thus ensuring that the results were not out of context and had real world significance.

Data were analysed using QSR®™ NVIVO, a software package that aids the analysis of rich text documents. It was chosen specifically as it enables automatic coding, provides modeling tools not found in any other software and suited the analysis needs of the researcher [15]. Findings were formulated by application of grounded theory, a common and well-documented methodology in qualitative research, where theory emerges from the data collected [16,17,18]. As well as methodological triangulation (i.e., a variety of data collection methods) and source triangulation (i.e., a variety of informants), findings were further grounded, in that the ICUs are of different sizes and were also at different stages of CIS implementation.

**Findings**

**Site A - Electronic Systems Education and Training**

Each hospital in this county had an implementer
responsible for the introduction of the EHR in their 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 organized accordingly. Of the 1000 staff at this hospital, 300 have 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 was to pull 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 on-the-job.

Although this sounds ideal for an intensive care unit, it meant that the unit had to run with fewer nurses. 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 this unit who would then cascade 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 unhelpful.

“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.”

As implementation had been subject to both political and technical delays, users were quite sceptical about it but willing to give it a go. This had more to do with the organisational culture of this unit rather 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”

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”

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 are 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 major concerns were about learning to use the system whilst caring for the patient and losing time with the patient; this was exemplified further in Site B.

When asked how they would like to be trained, most nurses and doctors wanted to have a few hours with the computer and no patient, so that they could interact with it. As things stood, this was impossible.

**Site B - Electronic Systems Education and Training**

The computer system replaced only the paper 24-hour observation sheet, and was implemented primarily for better management and use of the data. Staff could therefore not perceive how this could possibly benefit them. All they could see 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.

All users were invited to a three-hour session showing them how to use the system. Attendees were mostly nurses, 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.”

“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.”

The implementation had also been plagued with technical delays, so that when parallel computer and paper operation ceased, and the paper observation sheets were phased out, staff claimed to have forgotten how to use the system.

Again, similar concerns as at Site A were raised, only these concerns were not predictions, but actualities. Users were spending at least twice as long with the computer systems than with the paper observation sheet, especially once parallel operation ceased, as most staff relied on the paper system and tried to avoid using the computer system where possible. Even after the full changeover, nurses were waiting until the end of a shift or until they had a spare moment before they filled in the details on the computer. Nurses complained that staff from other shifts were not completing it as they should, so they had to go over what others had input. They felt this was too much for them.

One systems educator, also a nurse, expressed the difficulties she was having training nurses to use the system:

“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.”

“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…”

At this site, as for Site A, 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.

Site C also encountered similar problems to the other sites. However site C managed to overcome these problems, resulting in a system that was well used, at least by the nurses.

**Site C - Electronic Systems Education and Training**

Two core leaders provided user support and taught a team of nine nurse who cascaded training throughout the unit. The full changeover took a period of nine months, during which parallel paper and computer use operated. Site C encountered similar problems as the other two units, namely teaching users on-the-job.

However, it should be noted that this system downloaded some observations automatically. Moreover while nurses used it to complete their care plans and doctors their notes, these could be completed at the end of a shift rather than requiring hourly inputs, as for the system in Site B. The overview of patient data, was also much better and the system was much more user friendly. When asked why the same system as Site B was not procured, one of the CIS leaders replied that the Site B system was not what they wanted, it was too complicated to use and that it did not computerise everything that they would want.

When training began in use of the system, the teaching team did meet resistance from some nurses who found parallel operations time consuming and demanding. However, the difference was the way in which the project was led and
taught. The leader was charismatic; support from suppliers was constant; there was always somebody to help if they encountered problems. Importantly the nurses perceived the benefit of using the system.

Nurses complained that they have to use paper at all - this was necessary when communicating with other departments, as they were using stand-alone systems. Problems did arise as the system was used more. However nurses were able to give formal feedback about any problems or changes to the system that they would like to see. The CIS had changed dramatically from when it was first introduced; this was because a) users were given a mechanism for feedback, b) the system itself was flexible and c) users had a very good relationship with their suppliers.

The next task was to encourage doctors to use it more:

“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.”

“I think the doctors would all like to blow it up and go back to paper.”

The two leaders of the system were very diligent and involved. They would check the system for inconsistencies and errors, they would chase-up users who had not used it correctly or not at all and they would support users as they used the system. This audit trail would have been impossible to do with the paper record. It is not known what might have happened when the two leaders were no longer able to provide this support.

Summary of Findings
Site A suffered from lack of technical user support and had experienced projects that had not worked in the past due to lack of support and investment in training. However, users were positive about the system to be integrated and felt that it had much potential benefit for them. Site B, endured many delays during start up, and then many technical problems. Users felt that training was scarce and that support was inadequate. An imbalance between user and management expectations of the system was evident. Hospital management introduced the system so that they could make better use of data collected; the users saw themselves as a tool for inputting the data that would then be used by management. Nurses and doctors could not perceive the benefit of using the PDM as it only replaced a single paper chart and doubled the size of the paper patient record due to printouts, significantly increasing the time taken to gain an overview of patient status. In both cases, training, particularly on-the-job was felt to be inadequate.

Site C encountered similar problems, but was able to deal with them appropriately. It had good user support and feedback mechanisms; leadership was strong and training though not ideal, was cushioned by the strong support structure in place. A strong relationship with the system suppliers was achieved through direct links via email and telephone. Two support technicians from the company were assigned to the ICU during the implementation stage, the unit had a contact line it can call if it required any changes or had any queries about the system (these are dealt with overnight depending upon the nature of the query and extent of changes required). This site also received free upgrades to the system as it had agreed to demonstrate the system to potential buyers. This close link meant that the supplier was able to react to user comments in a positive and timely manner, provide feedback and deal with technical difficulties promptly. The benefit of the system to the users was much greater than for Site B, as it improved the way that they dealt with patient data. Calculations were automated, visually the data was much improved, with large monitors and coloured graphs, and some observations were downloaded automatically.

Discussion
This study has shown that educating users on-the-job in an ICU is difficult. The types of problems encountered are very similar, regardless of the systems used and the size of unit. The difference is in how they are dealt with. This has to do with the extent to which user requirements are determined and accommodated, as well as the support mechanism in place and the strength of leadership.
This has also been found to be of significance by Moen [19]. It could be argued that the size of the organisation is also a problem. However this is also dependent upon the teaching and support mechanisms that are planned and budgeted for.

This study has found that educating nurses in a critical care environment is challenging, as the nature of critical care work demands complete attention. However, Site C illustrated that it is feasible if user requirements are adequately gauged and the necessary support needed is planned for. On-the-job training is not ideal, from the perspective of nurses; training away from the unit and the patient is much preferred. Training away from the unit would provide a different environment and, depending upon the organisational leadership and planning, an environment more conducive to learning. As the ICU leader in Site A commented:

“it may help users feel more invested in and valued, and it may improve staff morale.”

A significant success factor is the perceived usefulness of the new system to nurses. Where this benefit is obvious, users are more inclined to want to learn to use the system, as found in Site C.

In summary, the following factors were found to be significant in engaging nurses to learn to use a new system system:
1. perceived benefit of the system to the user
2. system suitability
3. strong leadership
4. investment in training and education
5. good feedback mechanisms
6. strong relationships with the supplier.

Factors 3, 4 and 5 have been found to be of importance in a separate study carried out by Vliet [20]. Whether or not these factors are considered important by organisational leaders will depend upon the organisational culture, i.e., the particular set of values, beliefs, expectations, customs and systems that are common to an organisation [21,22,23].

Further work investigating the relationship between time taken for acceptance and amount of benefit to the user is needed. For example it would be interesting to see whether, as in Site B where user benefit of the system is minimal, users accept the system over time or whether the system fails to be integrated.

In all three cases implementers promoted the longer-term benefits of using the systems but only Site C was able to offer a system with perceived and actual benefit to nurses.

Conclusions
This study has shown that although an environment such as an ICU is highly demanding in terms of patient care, it is difficult but not unfeasible to train nurses in a critical care setting to use a new system. It has found that perceived benefit of the system to nurses is a significant factor for nurses to want to learn to use the system. It has established six factors that are essential for gauging user interest in learning to use the system; furthermore, it has demonstrated that how these factors are deployed is dependent upon the organisational culture.

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References

Footnotes
1 Please refer to http://www.systematic.co.uk/UK/Healthcare
2 for reasons of retaining anonymity the EHR module being tested at this unit is not described.
3 Here a PDM is synonymous to CIS.