Are Clinical Information Systems Acceptable to Critical Care Nurses?

Some Findings and a Reliable and Valid Tool for Further Research

Peer reviewed research paper

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Introduction

In an article published in the previous edition of this journal (Norrie 2003) a set of interviews was undertaken with critical care nurses, to identity their expectations of clinical information systems (CIS). To explore this topic further, it was decided to use the responses from this initial phase of research to construct a quantitative research tool which could be used to compare the acceptability to nurses of data management and display at sites which use CIS, with sites which use conventional manual data entry.

To do this there were a number of options. Given that attitudes could not readily be identified from a series of binary questions (i.e. 'yes' and 'no'), it was decided to construct a Likert scale, as the main instrument of the questionnaire.

Methods

The individual items to be included within the Likert scale were produced by returning to the original interview data. This resulted in 23 items which were randomly placed within the questionnaire. In line with the suggestion of Black (1999) statements were recast, where necessary, to result in 50% positive and 50% negative phrasing, to minimise bias in response. In addition some further rephrasing was necessary, so that the statements would be relevant in settings with either a CIS or conventional paper charts.

The pilot scale was administered to a group of ten critical care nurse, representative of those with whom the questionnaire was to be used. It has been recommended that the responses from this stage should then be scored and analysed to determine which of the items discriminate most clearly between the high scorers and the low scorers on the list (Selltiz al 1976; Oppenheim 1992) before completion of the final scale. However it was decided to omit these two steps, because of the nature of the statements. If the statements had been generated by the researcher *de novo*, this would have been an important step. However, because the statements originated from a set of research interviews, it was felt that the gains from this analytical process would have been outweighed by the possible distortion or unbalancing of the collection of statements, caused by editing them with what would inevitably be a small and potentially unrepresentative pilot sample.

It was decided to use a four point scale, thereby missing out using a median point such as 'acceptable' or 'uncertain.' Instead, the choices offered were 'strongly agree, agree, disagree and strongly disagree', which it was hoped would encourage the recipients to make positive or negative choices and so produce more emphatic data, avoiding what Oppenheim (1992 p200) describes as a *'lukewarm response.'* In addition to the Likert scale, a small selection of open ended questions were included, which will not be discussed here. Following the pilot stage, some minor alterations were made, primarily relating to phrasing. The completed tool is given in table one

Participants

A site which used Hewlett Packard's CareVue 9000 CIS was chosen, because this could be described as a mature implementation of a well established system. The unit employed approximately 114 nurses and had a full capacity of twelve intensive care and six high dependency beds. Broadly, it worked in line with the description by Duce and Harris (1990). CareVue interrogates the patient clinical monitoring systems several times

per minute. A nurse then validates and hence records and stores the data, typically on an hourly basis. In this way, the majority of patient parameters are directly accessed, including invasive pressures, heart rate, oxygen saturation and respiratory rate. In addition, the system can directly access observations from the patient's ventilator, where one is used. Although the system does not automatically access fluid administration details, it does automatically calculate balances from hand entered input and output data. In addition, the system has a drug prescription facility which is written up by the medical staff, and it can calculate concentrations of drugs for the nurses. The system is linked to the local Hospital Information System and can hence acquire results from the various pathology laboratories including microbiology, biochemistry and haematology. Although this site is has been termed 'paperless', in fact it is not, because the nursing care planning package that accompanies CareVue was not in use. Instead a paper system was used to conventionally record the assessment, planning, implementation and evaluation of care.

Access was also gained to two comparable non computerised sites for comparison. Instead of a CIS, a conventional paper charting system was used: the charts covered a 24 hour period and were replaced each day. In addition other data, such as laboratory results, were kept on ancillary sheets. There was however a direct computer link to the HIS, which prints off individual copies for storage in patients' records. Care planning was based upon a printed plan which was individualised by the bedside nurse.

Sampling

Within the three units, inclusive sampling was used of all the qualified nursing staff, to minimise sampling bias (Bowling 1997). In addition the inclusive sample also helped to maximise the amount of data generated.

Procedures

Following negotiations with the senior nursing staff at all three clinical areas, and receiving permission from relevant ethical committees, questionnaires were distributed by putting a questionnaire in the pigeon hole of each member of staff with their name on it. A 'post box' was put in the coffee rooms at the three sites to receive completed forms. A month was given to complete and return forms, plus occasional polite reminders from the researcher and from the clinical co-ordinator at the CIS site. The overall rate of response was 47%.

Data from the completed questionnaires were entered on to the data editor of the Statistical Package for the Social Sciences (SPSS: trademark of SPSS Incorporated of Chicago, USA) version 10.0 for Windows.

Analysis of statistical data

Prior to carrying out the statistical testing, a number of steps were required to make the data meaningful. Firstly, as the raw data stood, the Likert scale questions were a mix of both positive and negative statements. These were rearranged, so that the data were 'all pointing in the same direction' i.e. positive responses gave relatively positive numerical values, and negative responses gave relatively negative ones. Secondly, editing of the items in the questionnaire was required. CareVue has a nursing care planning capability, therefore items were included to cover this within the questionnaire. However, because the care planning facility had never actually been used, the four questions relating to care planning were not used in the initial batch of tests to gauge the effect of the CIS. Lastly, from the 19 remaining questions, mean responses were calculated, and these values were used for all subsequent statistical tests.

Internal consistency

Cronbach's alpha was used to provide an estimate of reliability. The alpha value of 0.85 shows an excellent level of internal reliability suggesting that the questionnaire looked largely at one issue only. Therefore it can be used as a summated scale with some confidence.

Analysis using the Kolmogorov-Smirnov test indicated that there was significant difference between the data and a normal distribution (p= 0.042) and so non parametric testing was used for the statistical analyses.

Statistical data

Graph one shows a box plot representation of the means from the data. This clearly suggests that the data from the CIS site had a higher mean and

range of scores and hence satisfaction than both non CIS sites. Indeed, a Mann Whitney (MW) test on the two sets of data from the non CIS sites, showed that there was no significant difference between the data from the two non computerised sites (p=0.60). Because of this, these two sets were combined for further analysis to minimise type I error due to multiple pair-wise testing. This new set of data was compared with the data from the computerised site and tested using MW. This showed that there was a significant difference (p<0.001) between the CIS and non CIS sites, of which the CIS site gives a higher mean rank score, showing that the nurses were significantly more satisfied with their computerised charting system than at the manual sites.

It is also worth noting at this point that if the original data values are considered (1= strongly disagree, 2= disagree, 3= agree, 4= strongly agree) then any value above 2.5 corresponds to a relatively positive evaluation of the charting system. Comparing mean values shows that although the CIS site gives the highest mean values overall (3.15), at both the non CIS sites, the values were still relatively positive (2.87 and 2.89). This suggests that, on average, both the manual and computerised systems of data collection and display were rated as at least satisfactory by the nurses who used them, however the computerised system was effectively more satisfactory.

Assessment of validity and reliability of the questionnaire

This research could be described as quasi experimental, in that control over the variables within the study was not sought. Therefore it is possible that differences in response could be due to extraneous factors, rather than the phenomena associated with the CIS. However, the result that the non CIS sites could not be identified as distinct populations suggests that the questionnaire may be robust. There is more evidence to support this.

Within the data, a number of extraneous variables were identified, and this section will explore their effect upon the main findings discussed above. Data relating to clinical grade and years of experience were collected within the questionnaire, in order to explore whether there was any correlation between either clinical grade, or years of experience and mean scores relevant to the charting methods. This was analysed using Spearman's rank test (or *rho*), as it is suitable for non parametric ordinal data (Bland 1995; Anthony 1999; Black 1999). Neither criterion gave a positive correlation with the scores, (p = 0.204 for clinical grade, p = 0.125 for years experience). To be rigorous, consideration should also be given to the possibility of error, specifically of type II. A power analysis was undertaken (Buchner et al 2001).This showed that for this size of population and using an alpha value of 0.05, a power threshold of 0.8 would suggest that coefficients of correlation of approximately 0.27 and larger would probably be identified. This means that although this use of Spearman's rank test might miss small correlation coefficients, it probably would not miss medium or larger effects. Therefore the non correlation should be allowed to stand.

This discussion suggests that whether the nurses valued their charting systems highly or otherwise was related to neither grading nor experience within the clinical area. This may be considered as giving some evidence to support the specificity of the research tool, because this analysis of correlation rules out these two variables as being responsible for any differences between sites.

Statistical tests relating to care planning data: more support for validity and reliability of the questionnaire

As identified earlier, four questions were taken out of the data for the initial analysis because they related to care planning, which was a manual process at all three sites. The mean values of the questions relating to care planning are illustrated with their distributions in graph two. It was previously suggested that mean responses above the median value of 2.5 were indicative of some measure of satisfaction and those below 2.5 of some level of dissatisfaction. Using this admittedly rather arbitrary measure, at both the CIS site and non CIS site #1, the care planning documentation was rated as just below satisfactory, whereas the care planning at the non CIS site #2 was identified as just above satisfactory. However, a Kruskal Wallis test on these data cannot show any significant differences between these populations (p= 0.065), therefore this distinction is probably not valid.

By contrast, a Wilcoxon signed ranks test (because these results are paired) on the mean of scores at all three sites for data relating to data collection and display, with mean scores relating to care planning, shows that the care planning evaluated significantly less well (p=<0.001). This shows that on the whole, the nurses at all three sites found their care planning paperwork to be less satisfactory than other aspects of their data recording and display, whether computerised or not. Although of some value in itself, this is another important result in terms of the validity of the data. The variable which it was hoped to explore by using the Likert scale was whether or not a CIS made a difference to nurse satisfaction. The results clearly suggest that the questionnaire could discriminate between CIS and non CIS functions of documentation.

Conclusion

This analysis of data has produced two main results, one intentional and one unintentional. The intentional set is that of comparison of data management and display at the CIS site with the non CIS sites, which shows that the CIS site was rated as significantly more satisfactory than the non CIS sites. This is an important result in that it shows that CIS can be an attractive adjunct to the delivery of nursing care, a position which has been speculated upon, but never tested. The unintentional set of results relates to the care planning, which was identified as being similar at all three sites, supporting validity of the questionnaire.

There remain limitations to this work. Firstly, it would be highly desirable to use the questionnaire at a number of different sites, to give a broader picture of the way in which critical care nurses work with their systems of data management. Secondly, as a quantitative deductive tool, the questionnaire does not allow self expression by the respondents, and in fact a small number of open ended questions were included with the questionnaire, which will be reported upon in the next edition of this journal. It is likely that the assessment of validity of the questionnaire could be enhanced if methodological triangulation were feasible.

Lastly, the questionnaire itself needs further development. It is suggested that for further use, the questions relating to care planning are removed to simplify the analysis of the data. In addition, inspection of the items within the questionnaire shows that two were included with directly opposing statements. Their inclusion therefore may result in a bias, in this case towards the ability of the CIS to alert the nurse to changes in the patient's condition. Therefore one of these questions should be removed. The final version of the questionnaire is given in table 2.

Clearly more investigation is required to explore the impact of CIS on nursing practice. However, it is suggested that this questionnaire may be of some use to researchers. As a tool there is some evidence to suggest that it has a measure of reliability and validity. In addition, it is both easy and quick to use, qualities which may commend it to researchers working within busy clinical areas. If any researchers wish to use the tool they are very welcome to. The first author would also be delighted to participate in any further collaborative research, using this or other tools.

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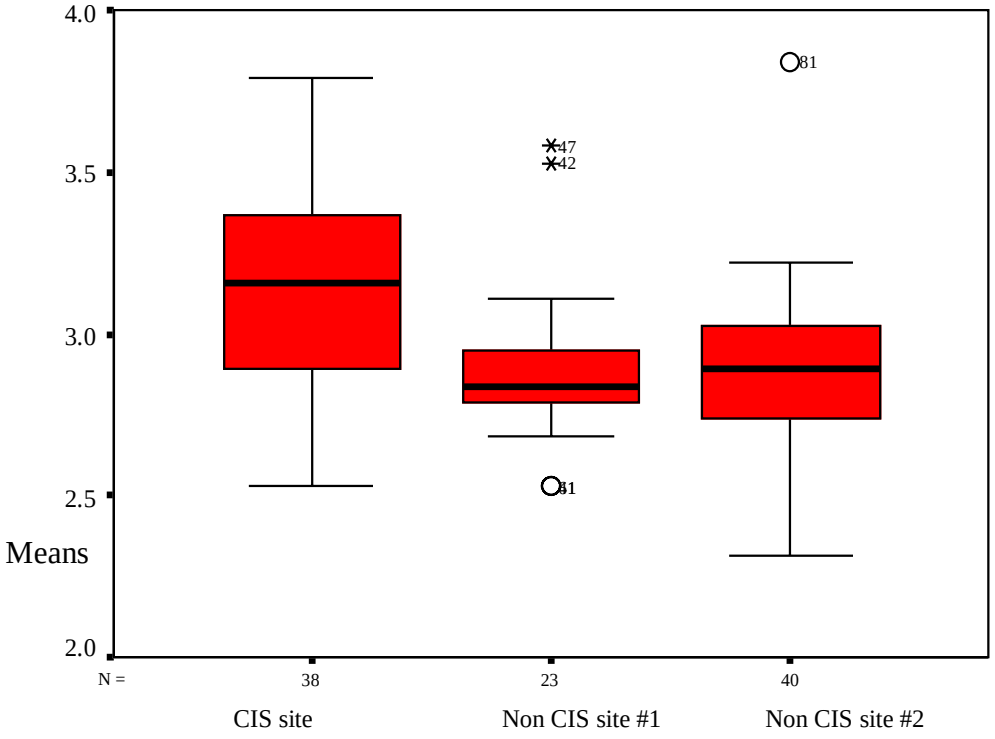
Table 1

	Strongly agree	Agree	Disagree	Strongly disagree
Our charting system works well.				
I cannot find information from the charts easily.				
It allows me to easily keep track of all my patients results.				
Our charting of patient data is unreliable.				
The care planning is difficult to use				
Our charting system is poor at finding the information I want about my patient				
The charting system provides a good record of the patient.				
If things happen to my patient I will not be alerted by the charting system.				
The charting system helps in communication within the nursing team				
The charting system compromises patient confidentiality				
The charting system hinders communication within the health care team				
The care planning is not an efficient use of my time				
I feel that the charting does not help me to review my patients progress.				
The care planning helps me look after my patient				
The care planning documentation is repetitious.				
I don't think we keep track of our patients progress well.				
The charting system doesn't make me feel in control of the situation.				
The charting system alerts me to what is happening with my patient.				
I did not need much training to be able to use the charting system.				
The system in use for charting adds to my workload.				
The current charting system helps me to deliver quality care.				
The charting system is always legible.				
The charting system is always accurate				

Table 2

	Strongly agree	Agree	Disagree	Strongly disagree
Our charting system works well.				
I cannot find information from the charts easily.				
It allows me to easily keep track of all my patients results.				
Our charting of patient data is unreliable.				
Our charting system is poor at finding the information I want about my patient				
The charting system provides a good record of the patient.				
The charting system helps in communication within the nursing team				
The charting system compromises patient confidentiality				
The charting system hinders communication within the health care team				
I feel that the charting does not help me to review my patients progress.				
I don't think we keep track of our patients progress well.				
The charting system doesn't make me feel in control of the situation.				
The charting system alerts me to what is happening with my patient.				
I did not need much training to be able to use the charting system.				
The system in use for charting adds to my workload.				
The current charting system helps me to deliver quality care.				
The charting system is always legible.				
The charting system is always accurate				

Graph 1 Box-plot showing distribution of mean scores which relate to CIS activities by site



Graph 2 Box plot showing distribution of mean scores of Likert scale statements which relate to care planning by site