The CISQ: A Tool to Measure Staff Involvement in and Attitudes Toward the Implementation of a Clinical Information System

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Abstract

The Clinical Information System Questionnaire (CISQ-15) is a new 15-item tool designed to measure staff involvement in and attitudes towards CIS implementations. It was developed during a clinical trial which tested the effects of a combined managerial and IT intervention on staff attitudes and patient outcomes. The CISQ-15 appears to have high construct validity and internal consistency, although further studies are needed. Such studies are under way, and an expanded 36-item version, the CISQ-36, is now being evaluated.

Introduction

A Critical Care Clinical Information System (CCCIS) is a computer data management system that collects, stores, organizes, retrieves and manipulates all data related to direct patient care in a critical care environment [1]. Gugerty studied nurse perceptions of team function and performance in general, and perceptions of the implementation of a CCCIS in particular, as part of a larger study of the effectiveness of a managerial intervention [2]. This intervention used the techniques of Total Quality Management (TQM) to customize and implement a CCCIS in a Surgical/Trauma ICU. Since the effective use of a team approach is a central concept of TQM, it was theorized that the TQM approach would minimize any potential negative impact of the implementation of the CCCIS on staff perceived team function and performance. In order to test this prediction, a standard tool called the Team Performance Profile (TPP) was administered pre and post intervention to nurses on the experimental unit and to those on a control unit. In addition, a questionnaire to measure staff involvement in and attitudes toward the implementation of the Clinical Information System (the CISQ-15) was developed and administered post intervention [2], [3]. It was theorized that: 1) CISQ-15 scores would tend to be higher on the experimental unit than on the control unit; and 2) that high scores on the CISQ-15 would tend to lead to more positive post intervention scores on the TPP. In other words, it was predicted that the CISQ-15 would mediate the effects of the intervention on the TPP. The purposes of this paper are to describe the CISQ-15, to discuss its reliability and construct validity, and to present data testing the above hypotheses.

Setting and Intervention

The study was conducted at a 550-bed University-Affiliated Medical Center. Two pre-existing eight-bed critical care units were used as the experimental and control units. These units had different unit names and were physically separate, but in most significant and relevant ways the units were alike. Each unit cared for Surgical, Trauma and a small number of other types of patients requiring intensive care. They had the same set of physicians and ancillary health care practitioners, such as respiratory therapists. Each unit received patients from the same population, based on bed availability only. The two units had separate, all RN nursing staffs, but staff members from each unit often "floated" to the sister unit, so all the nurses were trained in and used both the new CCCIS and the previous system as well. There were no important differences between control and experimental nurses on any of the demographic variables analyzed (See [2] for a detailed description).

Initially, the Medical Center only had sufficient funds to install the Critical Care Clinical Information System in one eight-bed ICU. During a Medical Center network-wide upgrade, one of the two eight-bed ICU's received wiring to accommodate the CCCIS. This became the experimental unit for the study. The CCCIS included: a) an interface with bedside physiologic monitors; b) interfaces with other systems (e.g., a laboratory information system and a hospital information system); c) point of care documentation capability; d) the ability to create complex computed variables; e) enhanced use of graphics and trending; f) a graphical user interface; and g) exploitation of network computing.

Nurses on the experimental unit staff were chosen to form a team with the Principal Investigator. Using a Total Quality Management (TQM) approach, they helped to customize the CCCIS in ways that they believed would improve clinical processes. They then used the CCCIS to document care and related clinical processes for their home unit patients. The nurses on the control unit were not represented on the clinical process improvement team, nor did they use

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the CCCIS on their home unit. The control unit nurses were exposed to some of the changes in care activities generated by the clinical process improvement team on the experimental unit, however, such as modifications in the paper flow sheet and documentation processes. In addition, they used the new CCCIS when they floated to the experimental unit. They were thus in a position to answer the questions on the CISQ-15 on the basis of their own experiences.

Team Performance Profile

The Team Performance Profile (TPP) assesses organizational members' perceptions of team function and performance [4]. It is a 78-item questionnaire, of which 11 items are for demographic purposes and 12 items measure "satisfaction", rather than performance per se. The TPP team function and performance items are organized into six dimension categories, or sub-scales, of four to seven items each. These are: 1) Functional Diversity; 2) Alignment on Purpose; 3) Rational Processes; 4) Creative Diversity; 5) Shared Norms; and 6) Communication Processes. These dimensions were summed to yield a total TPP Score, which is the only score reported in this paper (See [2] for further TPP results).

Kaplan and Greenbaum reported on the Team Interaction Profile, which was slightly changed in order to create the TPP [5]. Factor analysis of TIP data from over 5000 participants generally supported the above sub-dimensions. Reliabilities (alphas) for 1) pre-intervention, 2) post-intervention and 3) pre-intervention to post-intervention changes were reported by Brennan to be moderate to high for the component TPP sub-scales and overall [3]. Brennan also found that stability coefficients were moderately high, with the exceptions of Functional Diversity (Corr=.212) and Rational Processes (Corr=.260). Changes were underway at the site which may have affected these scales in ways that differed from nurse to nurse, so relatively low stability was to be expected. In addition to the generally encouraging psychometric data reported on the TPP, it was judged to fit very well with Katzenbach and Smith's [6] definition of a Team, which was used as a guide in the TQM intervention.

Development of the Clinical Information System Questionnaire (CISQ-15)

The TPP was not designed specifically for the healthcare industry, nor to address aspects of team function and performance specific to the implementation of a CCCIS. The CISQ-15 was developed to address such issues more specifically, and was administered 6 months after implementation of the CIS on the experimental unit (at the same time as the second administration of the TPP). It is composed of fifteen questions, which are divided into five sub-dimensions. These sub-dimensions deal with perceptions of the Clinical Information System implementation with respect to: 1) training adequacy and effectiveness; 2) participation/ ownership; 3) impact on nursing practice & patient outcomes; 4) feedback, and 5) general satisfaction (See table 1). The CISQ-15 is not a human-computer interaction scale (see Shniederman's text on interface design).

The CISQ-15 was developed in part by grounded theorizing, which may make our results somewhat less generalizable to other sites. Except for the dimension of General Satisfaction, the CISQ items were constructed after observing and talking with the experimental nurses about their roles in and attitudes towards the implementation of the CCCIS. For example, it was noted that experimental nurses often helped to train other staff members (including doctors) in how to use the new system. This led directly to Question 5, and indirectly to some of the other items on the Training sub-dimension. It was theorized that this involvement would give the nurses a sense of "ownership" for the system, and some recalled nurses' comments tended to corroborate this supposition, which led to question 11. Differences in means between the experimental and control nurses in their answers to these CISQ items thus measure differences in the constructs which they represent which were already "known" to exist. They therefore support the construct validity of the items. (Data from repeated measurements at three years demonstrated that the CISQ-15 also has discriminant validity.)

The CISQ-15 was administered to 38 nurses and doctors six months after the implementation of the CCCIS. Only the nurses that were present during the entire implementation time period are included in the analyses reported here (n=23). Alpha reliabilities were generally high, even for sub-scales with few items. (See Table 1.) They ranged from .841 to .944, except for Ownership, which had only a moderate alpha of .753. The CISQ-15 Total had very high internal consistency (alpha=.963). The individual item means and standard deviations reported in Table 1 are raw scores on a scale from 1 to 6. The scale scores are standardized to vary from 0 to 100. Item scores were generally in the moderate (3-4) range of satisfaction for the experimental group nurses, while the control group nurses' scores were in the low range (1-2). None of the item means indicated high (5-6) satisfaction with the CCCIS. Scores on the experimental unit thus tended to be lower than originally expected, indicating that the TQM/CCCIS intervention was not as successful as had been hoped. This did not come as a complete surprise, since several aspects of the original plan for the TQM intervention were never implemented, and others were implemented only in part [2].

Table 1 – CISQ-15 1) Items; 2) Mean Scores and T-Tests by Treatment Group and; 3) Scale & total alpha Reliabilities

	Experimental (n=12)		Control (n=11)		Mean Difference	t-value	Sgnfc nce
Scales/ Items	**mean**	**SD**	**mean**	**SD**			
CISQ-15 Satisfaction* alpha = .841	43.33	29.95	9.09	10.45	34.24	3.72^	.01
1. The introduction of the CIS has been effective in the ICU.	3.50	1.38	1.91	1.04	1.59	3.09	.01
15. Overall, I prefer using the CIS than the paper flowsheet.	2.83	1.80	1.00	0.00	1.83	3.53^	.01
CISQ-15 Training* alpha = .922	63.33	28.79	14.09	15.78	49.24	5.02	.001
2. The training I received about the CIS was adequate.	3.83	1.64	1.73	1.01	2.11	3.66	.001
5. I have had the opportunity to train a staff member in the new system.	4.50	1.93	1.73	1.49	2.77	3.83	.001
8. I feel confident in my ability to train other staff in the CIS.	4.75	1.54	1.73	0.91	3.02	5.66	.001
14. Adequate resources were available when I was learning the system.	3.58	1.56	1.64	1.21	1.95	3.32	.01
CISQ-15 Suggestions* alpha =.875	54.17	38.01	21.82	28.57	32.35	2.29	.05
6. I feel my suggestions for improvement in the CIS are utilized.	3.50	1.73	1.73	1.42	1.77	2.67	.05
9. I am given a chance to make suggestions for change in the CIS	3.92	2.23	2.45	1.81	1.46	1.71	NS
CISQ-15 Ownership* alpha = .753	47.22	27.63	20.61	19.20	26.62	2.66	.05
10. Nursing had a role in the development and implementation of the CIS.	3.83	1.99	3.00	1.73	0.83	1.07	NS
11. I feel a sense of ownership for the system.	2.42	1.93	1.18	0.41	1.23	2.17	.1
13. Nursing representatives influenced the design of the CIS.	3.83	1.53	1.91	1.40	1.92	3.16	.01
CISQ-15 Practice* alpha = .944	35.00	33.51	6.36	7.78	28.64	2.88^	.05
3. I feel the use of the CIS has improved patient outcomes.	2.67	1.67	1.18	0.41	1.48	2.99^	.05
4. The electronic flowsheet is more efficient than paper documentation.	2.92	1.88	1.64	0.92	1.28	2.04	.1
7. The CIS has improved my practice of nursing.	2.58	1.62	1.00	0.00	1.58	3.38^	.01
12. I expect continued improvement in nursing practice because of the CIS.	2.83	1.95	1.45	0.69	1.38	2.30^	.05
CISQ-15 Total* alpha = .963	48.67	27.98	29.30	11.30	19.37	3.90	.001

^ = t-value and probability level reported for unequal variances formula, due to statistically significant (.05 level) differences in variances, using Levine's test for equality of variance. * Scale scores standardized to 100. Item scores based on a scale of 1 - 6.

These results imply that the TQM/CCCIS intervention may have been only partly successful, and suggest that a fuller implementation would have been desirable. This result is fully consonant with the overall impression of the Principal Investigator, indicating that the CISQ-15 was valid enough and sensitive enough to detect and document this originally unexpected finding.

Nurses on the experimental unit scored consistently higher than did those on the control unit, thus tending to confirm the construct validity of the CISQ-15 as a measure of the immediate effects of the TQM/CCCIS intervention. These differences were statistically significant for all but items 4, 9 and 10 (the effects of CIS on clinical practice, the effect of making suggestions regarding the CIS, and sense of ownership in the CIS, respectively). Experimental

nurses scored substantially and statistically significantly higher than control nurses on overall satisfaction, training (both training received and opportunity to train others), their suggestions being incorporated into the CIS, a sense of ownership of the CIS and the perception that the CIS improved patient care. It follows that the total CISQ-15 scale score was also much higher for experimental nurses than control nurses ($t=3.90$; $p < .001$).

Within units, the experimental nurses scored highest on CIS training (both training received and opportunity to train others) and their suggestions being incorporated into the CIS. Their scores were somewhat lower on ownership of the CIS and general satisfaction and least on the perception that the CIS improved patient care. The control nurses' scores were all low, the lowest being general satisfaction and the perception that the CIS improved patient care. These patterns of differences corresponded closely to the impressions of the Principal Investigator, once again suggesting that the CISQ-15 was a sensitive and valid measure.

Table 2 - Regressions in Standardized Deviation Units (Beta weights) of Change in TPP Scales on Treatment Group with and without controlling for Baseline Score and CISQ-15 (n=23)

	Model 1	Model 2		Model 3			
	Rx Group	Rx Group	Base-line	Rx Group		Base-Line	CISQ-15
				Direct	Indirect		
TPP Total	.40+	.18	-.58**	-.21	.39	-.56**	.63**

Significance Levels: + = .10; * = .05; ** = .01

Discussion

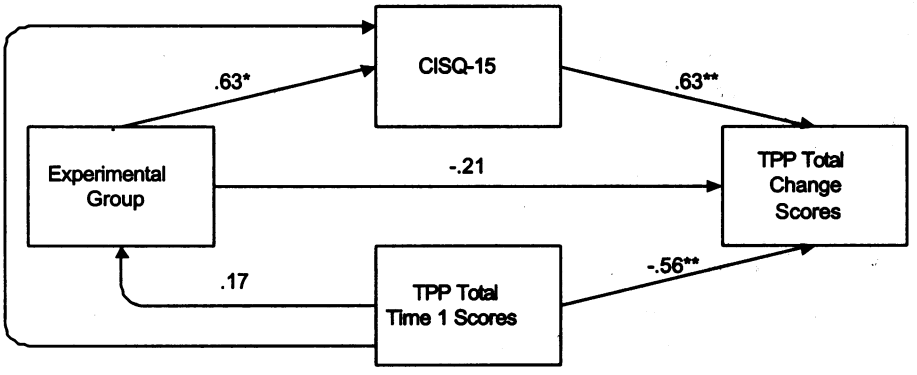
Model 1 in Table 2 regresses TPP change scores on Treatment Group (0 for control, 1 for experimental). The effect of the TQM/CCCIS intervention (beta=.40) was only marginally significant in this analysis (.10 level, direction not predicted). This analysis is confounded by the effects of differential regression to the mean (an artifact of repeated administrations of a less than fully stable measurement instrument under circumstances where the groups to be compared have somewhat different means on the pretest). Since the experimental group nurses had started with somewhat lower TPP scores than the control group, they were, in theory, more likely to increase their scores (and/or less likely to decrease their scores) than the control group nurses were. The TPP before score was therefore controlled by regression analysis (Model 2) in order to remove this potential bias. The estimated treatment effect in Model 2 is smaller than in Model 1 (beta = .18), as expected, and not statistically significant at the .05 level. The further regression analysis reported in Model 3 divides this estimated treatment effect into two components -- an indirect effect mediated by the CISQ-15, and a direct effect due to other processes linking the between unit differences to TPP scores. In this analysis, the CISQ-15 was found to be strongly and significantly (beta=.63; $p<.01$) related to changes in the TPP scores. This is a further construct validation of the CISQ, since it was constructed with the expectation that high scores on the CISQ-15 would tend to be positively related to TPP changes.

A path analysis, reported in Figure 1, completes the picture and serves as the best test of the original predictions. The intervention is seen to have had a large, statistically significant effect (beta = .63; $p <.01$) on staff perceptions of CIS implementation, as measured by the CISQ-15. Perceptions of the CIS implementation is seen in turn to have a strong effect on changes in the nurses' perception of team function and performance, as measured by regression adjusted change scores on the TPP. This leads to an indirect effect of .63 x .63 = .39, and an direct effect of -.21, which sum to the total effect of .18 that was previously discussed (see Model 2 of Table 2). Both paths of the indirect effect are large and statistically significant, so these results support the process by which the combined TQM/CCCIS intervention was theorized to alleviate possible deterioration in team performance. The negative direct effect might be due to chance (it is not statistically significant), or it might indicate that there were systematic differences between the units other than those measured by the CISQ-15, and these favored the Control unit nurses. Further analyses based on a third administration of the CISQ and TPP at a later point in time suggest that the chance interpretation is probably the correct one.

Summary and Conclusions

The findings of this study strongly support the reliability and validity of the CISQ-15. The internal consistency of the CISQ-15 total was very high (.963), and all but one of the sub-scales demonstrated high internal consistency.

Figure 1: Path Analysis



Construct validity is defined as the degree to which an instrument measures the construct under investigation [7]. The CISQ-15 was designed to mediate the effects of the intervention on the TPP, and it did just that. Its results corresponded well to the overall qualitative assessments of the Principal Investigator, and it was sensitive enough to detect a less than full implementation of the TQM aspects of the intervention.

The method by which the CISQ-15 was developed, in combination with its subsequent use in a path analysis, raise interesting and possibly controversial questions concerning cause and effect, theoretical interpretation, measurement, data analysis, and the interplay between qualitative and quantitative methodologies. A fuller discussion of these issues will be presented in a separate publication. Similarly, it was felt to be beyond the scope of this paper to present and discuss the relation of sub-scales of the CISQ-15 to changes for the TPP, or to include results for TPP sub-scales. For such analyses, see [2], [3].

The CISQ-36

Development of the CISQ tool is ongoing. About a year after the development and administration of the CISQ-15, the tool was expanded to include negatively worded items related to CIS implementation, and more fully to explore issues related to technical problem resolution, CIS associated workload, multi-disciplinary teamwork, and ergonomics. This was done in consultation with an expert panel of 7 clinicians experienced with CIS implementation. The expanded version of the CISQ-15 that resulted has 21 additional items, so it is referred to as the CISQ-36. We anticipate, however, that the original CISQ-15 may still be used when a shorter tool is preferred.

An early version of the CISQ-36 was recently administered to nurses on the experimental and control Units at the original study site, and a new version of the CISQ-36 is currently being used in survey studies at two different sites. Data on the extent to which the high reliability and validity of the CISQ-36 are generalizable to sites where no experimentally manipulated differences exist thus will soon be available.

We believe that this approach can work in other areas in which computers are used to enhance practice. We currently have a grant proposal in to expand this now.

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