

## The Clinical Information System Implementation Evaluation Scale

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### Abstract

*Measurement instruments to assess user satisfaction with Clinical Information Systems (CIS) and with the implementation of CIS are needed as part of multi-faceted evaluation of CIS. Seven years of experience in developing measurement instruments to assess staff satisfaction with CIS preceded the development effort that created the Clinical Information System Evaluation Scale (CISIES). The scale was developed using precursors of the CISIES and it was guided by an expert panel. Following its construction the 37-item measurement instrument was piloted as part of the assessment of a Critical Care Clinical Information System implementation at a medical center in Florida, USA. Results indicated satisfaction with the implementation, although not strong, at the time of administration. The results of the CISIES administration were used by informaticians at the research site to plan and execute an intervention to improve satisfaction with the implementation. Re-administration of the CISIES at the site to evaluate the success of this intervention is planned. The CISIES was found to be a useful instrument, easy to administer, acceptable to respondents, easy to score and understandable by non-researcher at the study site. Early indications are that it will be useful in the formative and summative evaluation of CIS implementations.*

**Keywords:** *Clinical Information Systems, Electronic Health Record, Implementation, Evaluation, Attitudes, Satisfaction, Measurement Instrument*

### Introduction

Social science disciplines outside of clinical informatics routinely use standardized measurement instruments to assess customer and staff attitudes. There is a paucity of such measurement instruments or even simply standardized questions for use in clinical informatics, perhaps due to the relative newness of the discipline. Of course many measurement instruments, like usability scales, from other related disciplines can and should be used in clinical informatics. Nonetheless, there are instances where the existence of a measurement instrument specifically designed for clinical informatics use can assist in evaluation and improvement efforts. In the mid-1990's the lead author searched for a

measurement instrument that fundamentally answered the question 'Does the implementation of this CIS positively impact my clinical practice'. Having searched and found none, development of measurement instruments to assess staff satisfaction with implementation of CIS with an emphasis on impact on practice was begun.

### Background

Gugerty, Wooldridge and Brennan developed the first Clinical Information System Questionnaire (dubbed the CISQ-15) as part of a larger study that evaluated a Critical Care Clinical Information System implementation [1] [2] [3]. This tool was designed to measure staff involvement in and attitudes towards CIS implementation on a critical care unit. It was developed using grounded theory based on a planned change approach to CIS implementation, and observations of staff behaviors to CIS implementations. Alpha reliabilities were high for the instrument as a whole ( $\alpha=.963$ ), and were generally high for the instrument's sub-scales. In addition, the patterns of differences between the experimental and control unit nurses strongly supported the face and construct validity of the CISQ-15. [2]

Following the original administration of the CISQ-15, Gugerty convened an expert panel to review the instrument to develop additional items that would be sensitive to additional issues commonly found in CIS implementations, thus improving content validity. Negatively phrased items were also included, in order to counterbalance for acquiescence response set bias. The research team, guided by the expert panel added 21 items to the CISQ-15, resulting in a questionnaire dubbed the "CISQ-36", which was then tested on the same two nursing units used to test the CISQ-15. The sub-dimensions of the CISQ-15 were 'impact on practice', 'satisfaction with training', 'satisfaction with handling feedback' and 'ownership'. Ten of the new items could logically be placed in the originally formulated CISQ-15 sub-dimensions. The other eleven items were tentatively grouped under proposed new sub-dimensions of the CISQ; these were 'technical difficulties' 'impact on team' and 'impact on workload'. It is important to note that these sub-dimensions were theoretical as they were not confirmed by empirical methods such as factor analysis due to low sample sizes resulting from the

administration of the CISQ-15 and CISQ-36. The pilot study administration of the CISQ-36 had a high internal consistency ( $\alpha=.959$ ), based on the 33 items that remained in the CISQ-36 after deleting three items because they were judged to be ambiguous. [4]

The CISQ-36 was used as a basis and starting point for developing a measurement instrument to assess staff attitudes towards electronic medication administration modules of healthcare information systems, which resulted in the CISQ-MA. The methodology used in the construction of the CISQ-MA was composed of two phases: 1) tool development and 2) piloting. Tool development consisted in large part of analyzing data from focus groups of eight nurses at two sites that had recently experienced implementations of electronic Bar Code Medication Administration applications. Piloting of the CISQ-MA yielded an alpha reliability for the total scale of .97 and the sub-dimension alpha's ranged from .70 to .97. Further details of the tool development methodology and data from the pilot administration of the CISQ-MA were reported at an American Medical Informatics Association conference. [5]

Other variants of the CISQ, focusing on emergency room CIS and long term care CIS were constructed in a similar manner to the development of the CISQ-MA, that is, taking the CISQ-36 as a starting point, convening expert panels and changing the wording of the questions to suit a particular administration. [6] The CISQ was also translated into French. What became apparent during all these measurement instrument development exercises was that the intent of the questions was not changing. What was changing was the wording of some of the statements to make the system name more recognizable to the respondents and the department or role orientation of statements, as appropriate, for variants of the instruments for various respondents. In two statements, specific functional terms had to be changed, for example the term flowsheet was replaced with the term form during one of the CISQ variant constructions. The fact that the intent of the original CISQ-15 and CISQ-36 statements were not changing during the several CISQ variant construction processes, as the new tools were created, gave support to the original grounded theory which guided the CISQ-15 and CISQ-36 development efforts. [1], [2] In other words, statements that were modified from the CISQ-15 or CISQ-36 in the creation of the CISQ-MA or CISQ-LTC or CISQ-ER were substantially the same as the original statements, only specific referents were changed.

## Methods

### Development of the CISIES

Our experience with the CISQ family of measurement instruments led to a decision to create a generic measurement instrument that would be system name, system type, staff role and staff department neutral. The aim of this new development effort was to create a measurement instrument to assess staff satisfaction with any implementation of CIS, whether a small

“departmental” CIS, clinical module of an electronic health record (EHR) or an entire EHR. Furthermore, the instrument is intended to be used in formative evaluations, as well as summative evaluations. We created a new name for the new instrument to better reflect its intended purpose, the Clinical Information System Implementation Evaluation Scale (CISIES).

As the CISQ-MA was the most highly developed CISQ variant, having used focus groups of users as well as an expert panel in its development, we used the CISQ-MA as the starting point in CISIES development. The authors BG and MM took each CISQ-MA statement and assessed whether it was generic enough to contribute to the evaluation of any CIS implementation by any clinical staff member. If it was not, authors BG and MM created a more neutral or generic statement that attempted to preserve the intent of the original statement. For example, the CISQ-MA item:

The nurses who I work with on a daily basis support me in my use of BCMA.

Became the proposed CISIES item:

The people who I work with on a daily basis support me in my use of the system.

An expert panel consisting of the authors of this article, and four nurse informaticians from the United States was formed. The senior author has had substantial experience with CIS implementations. Author DR was also an informatician with implementation experience. Three of the four ‘outside’ experts each had more than ten years experience with CIS implementation. Four regions in the US were represented. Rural community hospitals, large urban academic medical centers, as well as health care delivery organizations between these two extremes were represented on the expert panel.

The expert panel was given information about the CISQ-15, CISQ-36, CISQ-MA, the intent of the revision/transformation project to create the CISIES, as well as the proposed neutral/ generic CISIES statements prepared by authors BG and MM. The panel was then convened in a teleconference where each of the proposed statements were reviewed and discussed. Some statements were further revised during the teleconference. Three statements were removed due to ambiguity. It was judged that the three statements could not be interpreted unambiguously regarding whether the respondent felt negatively or positively about each item. Three statements were added to make up for the three removed. Notes of the teleconference were taken and recorded next to each statement. Authors BG and MM then further revised some of the statements after the teleconference and the entire proceedings were e-mailed to each panel member for their careful review and comment. The comments from each of the panel members were compiled by authors BG and MM, further very minor wording changes were made and the final version of the CISIES with all supporting documentation of the revision process was then sent back to the panel members by e-mail. There were no further changes recommended by the panel and the CISIES, version 1, was finalized in January, 2005.

Here are four sample CISIES statements representing the theoretical CISIES sub-dimensions of 'impact on practice'(a), 'work/ work team'(b,c), and general satisfaction (d).

Sample CISIES Statements:

- The system has improved my practice.
- The system has added to my workload.
- The system facilitates communication of patient information among members of our health care team.
- Overall, the introduction of the system has been effective.

### Scoring the CISIES

The 37 CISIES items are scored on a six point Likert scale that ranges from Strongly Disagree to Strongly Agree. The actual scale is Strongly Disagree = 1; Disagree = 2; Somewhat Disagree = 3; Somewhat Agree = 4; Agree = 5; and Strongly Agree = 6. Thus, the range of possible scores for CISIES items is one through six. Because there is no neutral point, this is a forced choice format, i.e., the respondent must indicate either some agreement or disagreement with the statement

Most CISIES items are "positively" worded. During data analysis, the ten "negatively" worded items are recoded such that strong agreement on a negative item is scored one and strong disagreement on a negative item is scored six with similar adjustments for two through five. This allows one to analyze data, compare means and create sub-dimensions without confusion. Since the CISIES items express satisfaction or dissatisfaction with the system a high score is thus interpreted as satisfaction with the system implementation and a low score as dissatisfaction with the system implementation.

The mean score of the CISIES items taken together is examined as well as the mean scores of the individual items. Through examining individual items problems with system implementation can be identified

### Piloting of the CISIES

The CISIES was administered by one of the authors, an informationist, in a hospital in the State of Florida with the intent to examine user satisfaction with a recent Critical Care Clinical Information System implementation. Approval from the organization's institutional review board for the administration of the CISIES was obtained. The CISIES was administered in a confidential manner and assurances were given that subjects' responses would not result in negative consequences for individuals. The respondents were staff nurses from two ICUs. One ICU had a Go-Live date in October, 2004 and the other was December, 2004. The CISIES was administered in March, 2005, 3-5 months post Go-Live. In addition to administering the CISIES, information on the respondent's age and gender was collected. Age was presented as broad categories to assure anonymity.

A total of 44 individuals returned questionnaires with useable data. The data was analyzed using SPSS. Responses to negatively worded items were recoded so they compared to other items.

### Characteristics of respondents:

Most were women (68.2%) and a little more than two-fifths were from 36 to 45 years of age. Table 1 below presents the age breakdown of the respondents.

Table 1: Age of Respondent

Age Category	N	Percent
35 years or younger	12	27.3
36 to 45 years	18	40.9
46 to 55 years	11	25.0
56 years or older	3	6.8
Total	44	100.0

The Cronbach alpha for this administration of the CISIES was .94.

### Results

The means for the majority of the CISIES items for this administration were 3.5 or greater, which indicates satisfaction with the implementation, although not strong satisfaction at that point. Based on the CIS literature and our previous research in this area, this indicates an adequate level of satisfaction with implementation of the system; especially at the point post go-live when the CISIES was administered.

Possible scores for CISIES items range from six which suggests extremely satisfied to one which suggests extremely dissatisfied. Mean score of the CISIES items for this administration ranged from a high of 4.84 to a low of 2.28. The five CISIES items that received the *highest* scores are listed below, presented in order from highest to lowest score. The highest score is listed first. The scores indicate that at the time of administration the users had:

1. a strong commitment to the successful use of the system; (mean=4.84, n=43)
2. a comparatively high satisfaction with system's impact on team functioning; (mean=4.58, n=43)
3. a comparatively high satisfaction with their department's role in the introduction of the system; (mean=4.56, n=43)
4. a comparatively high satisfaction with the training they received about the system; and, (mean=4.55, n=44)
5. a comparatively high satisfaction with patient information being more confidential and secure. (mean=4.47, n=43)

The five *lowest* CISIES item scores are listed below, in order from lowest to highest. The scores indicate that at the time of administration the users:

1. had a strong sense that people who use the system should have had more to say about the design of the system; (mean=2.28, n=43)
2. had a relatively strong belief that the system added to their workload; (mean=2.73, n=44)
3. believed that the system did not allow them to spend more time on other aspects of patient care; (mean=2.91, n=44)

4. believed that the use of the system had a neutral impact on the quality of patient care; and, (mean=2.93, n=44)
5. did not believe the system improved their practice(mean=2.95, n=43)

Although the results of the CISIES was generally positive, the scores on the five items above raise concern and suggest that there is room for improvement. Based on the data, it was recommended that:

1. The hospital conduct focus groups of staff that use the system to further explore the low CISIES item scores;
2. Based on the CISIES and focus group data, plan an informatics intervention aimed at increasing satisfaction with the implementation and execute the intervention;
3. Re-administer the CISIES;
4. Analyze both administrations of the CISIES and issue a final report.

Focus groups with relevant staff at the hospital were conducted. Analysis of the focus group data revealed that the problem was largely attitudinal regarding change in work and change in general. A new staff training module was designed and implemented. A second administration of the CISIES is planned, but has not yet occurred so no formal evaluation of success of the intervention is available at this time.

## Discussion

It is important to note that the CISIES, like the precursor CISQ tools, focuses on satisfaction with implementation of CIS, not on how the system functions per se. Our research has shown us that end-users frequently do not differentiate between implementation of the system and the system itself, however. Therefore the authors believe that it is important and beneficial to assess other staff attitudes towards the system and its implementation, like system performance and usability. CIS and EHR implementations are complex, multi-faceted, and impact organizations on many levels and in many different ways. We believe the CISIES can cover one important aspect of CIS and EHR evaluation, but that it is wise to measure several other aspects of the implementation to yield a more comprehensive evaluation.

Evaluation of staff satisfaction with a CIS and/or implementation of a CIS are usually done in a summative fashion. Bhola defines summative evaluation as a method of judging the worth of a program or project at the end of the programs' or projects' activities. Formative evaluation, on the other hand is a method of judging the worth of a program or project while the program or project activities are forming or happening. [7] Most evaluation of CIS is done as summative. Our experience with administering the CISQ and now the CISIES over many years at many different sites indicates there may be significant opportunity to use measurement instruments in evaluation of CIS in a formative manner; and, thus facilitate its successful implementation. This is because we have come to understand that CIS implementation is

a process that has phases and milestones as illustrated in Figure 1.

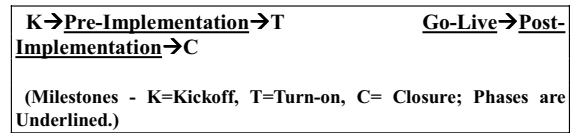


Figure 1 – The CIS/EHR Implementation Process

In this model, kickoff is a milestone. It happens at a defined moment in time and represents the beginning of the entire implementation project. Pre-implementation in this model is a phase that generally lasts for one month to one year depending on the size of the CIS implementation. Examples of activities that occur in the pre-implementation phase are planning and training. Turn-on, another milestone, happens at the beginning of the next phase, Go-Live. Go-live is characterized by first use of the system in clinical practice and intense support by the implementation team to end users. Go-live for small implementations can occur in one day, large implementation generally last for two to four weeks. Our experience with CIS implementations is that the third phase, post-implementation, can last surprisingly long for large or important CIS implementations, especially if the implementations are problematic. In the CISQ-MA research, our judgment was that one site was still in the post-implementation phase 18 months post Go-Live for an implementation of electronic barcode assisted medication administration. Examples of activities that occur in the post-implementation phase are adjustments in workflow by the end users and evaluation of the implementation by the project team. The post-implementation phase ends when closure, the final milestone, has been judged to occur.

Based on our observations that closure is many times inordinately delayed during the post-implementation period there is a significant opportunity for the CISIES-- and other measurement instruments such as usability scales--to be used *formatively* in this period to assess the implementation as it is still unfolding. Analysis of the implementation can then be based on data and interventions can be designed and instituted as appropriate during the post-implementation phase, all in an effort to bring closure more quickly.

The CISIES was used in just such a formative manner during this pilot administration. It was administered 3-5 months post system initiation. (In our judgment the ideal time to administer the CISIES is 45-90 days from turning on the system. The pilot site had administrative delays, mainly due to IRB approval, that somewhat lengthened the period between turning on the system and administering the CISIES.) The data was analyzed and a report was written and returned to the site within two weeks of receipt of the data. The informatician at the site indicated that the report was very helpful in understanding staff's attitude toward the implementation. Furthermore, it provided an objective measure that was used to stimulate discussion among about the system implementation and how to improve it.

Although the pilot administration of the CISIES only included nurses, it is designed to be used with any clinical staff. Three other sites have requested the CISIES and intend to administer it in late 2005 or early 2006.

## Conclusion

Disciplines other than clinical informatics routinely use standardized measurement instruments to assess customer and staff attitudes. The need for such instrument in clinic informatics generated the impetus that resulted in the CISIES.

Although the CISIES was recently created, it is based on empirical research with CIS implementations over the last seven years. It is the latest instrument to evolve from the CISQ-15. Unlike its predecessors, it is a generic measurement instrument that can be used in most, if not all, CIS implementations and with all types of clinical staff.

The CISIES is still a work in progress. It has only been tested at one location and one administration. Although the CISIES needs to be studied further, the results of this administration indicate that the CISIES is a useful instrument, easy to administer, acceptable to respondents, easy to score and understandable by non-researchers. More administrations are needed before we can use factor analysis to better understand the instrument and empirically verify any subscales.

With billions of dollars being spent on CIS world-wide, the CISIES or instruments like the CISIES can facilitate the successful implementation of these systems. The CISIES is provided free of charge by the senior author provided the user provides information on the implementation of the CISIES so that it can be further refined.

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