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Clinicians' perceptions about use of computerized protocols: A multicenter study

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ABSTRACT

Purpose: Implementation of evidence-based techniques, such as explicit computerized protocols, has achieved limited success among clinicians. In this study, we describe the development and validation of an instrument for assessing clinicians' perceptions about use of explicit computerized protocols.

Methods: Qualitative assessment of semi-structured interviews with clinicians gave rise to a cognitive model evaluating the factors that motivate clinicians to use explicit computerized protocols. Using these constructs we developed a 35-item instrument which was administered to 240 clinicians (132 nurses, 53 physicians and 55 respiratory therapists), in three health-care institutions.

Results: Factor analysis identified nine factors that accounted for 66% of the total variance cumulatively. Factors identified were: Beliefs regarding Self-Efficacy, Environmental Support, Role Relevance, Work Importance, Beliefs regarding Control, Attitude towards Information Quality, Social Pressure, Culture, and Behavioral Intention. The strongest predictor was Beliefs regarding Self-Efficacy, which accounted for 26% of the total variance of intention to use explicit computerized protocols. Results supported the reliability and construct validity of the instrument.

Conclusions: Clinicians' perceptions play a critical role in determining their intention to use explicit computerized protocols in routine clinical practice. Behavioral theories will help us understand factors predicting clinicians' intention to use explicit computerized protocols and recognize the implications of these factors in the design and implementation of these protocols.

1. Introduction

Computerized guidelines providing decision support are increasingly being used in various domains of routine clinical practice. These tools decrease practice variation between clinicians [1], standardize patient care [2], and improve patient outcomes [2,3]. Despite their proven value, clinicians' adoption of guidelines has had limited success [4–8]. Phillips et al. described the failure to implement valid evidence-based guidelines as 'clinical inertia' [9]. Grol noted that barriers to adoption include failure to imbed the guideline into workflow, the ease of data entry, the degree of involvement

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regarding protocol design and the support of administration [10].

Computerized guidelines vary significantly in terms of how dynamic they are, the degree of specificity of their recommendations and the level of integration into workflow [1]. On one end of the spectrum exist non-explicit computerized guidelines that consist of a set of static recommendations [11] or pop-up reminders regarding a recommended care process [12]. On the other end are computerized guidelines that function as a set of standardized orders, with detailed, explicit instructions based on dynamic patient-specific parameters, available at the point-of-care in complex clinical scenarios [13,14]. The focus of this paper is on the latter type of computerized guidelines which we call 'explicit computerized protocols' [15].

Explicit computerized protocols have been used in the intensive care unit (ICU) at Latter Day Saints (LDS) Hospital, in Salt Lake City, Utah, since 1985 [16]. Once a patient is ordered to be on a particular protocol by a physician, the nurses, respiratory therapists and other providers assigned to care for the patient follow a set of standardized orders. Detailed recommendations are received at the patient's bedside and changes in the patient's treatment plan are made by nurses and respiratory therapists based on the results of pre-established algorithms. The protocols were developed and monitored by an interdisciplinary team of ICU clinicians and based on the latest scientific evidence. The logical reasoning behind the instructions can be viewed directly and clinicians have the ability to over-ride the protocol instructions [1,17].

The attitudes of physicians and the barriers to the use of guidelines in general have been studied previously [5,18,19]. Studies examining provider perceptions of non-explicit computerized guidelines have noted concerns with "black box" instructions, the accuracy of instructions, the lack of flexibility to adapt to varied situations and a reduced role for clinicians in medical practice [5]. Explicit computerized protocols are specifically developed to provide more standardized decision-making for patient care; these protocols thus provide even less flexibility for clinician judgment than non-explicit computerized guidelines. The socio-behavioral impact of explicit computerized protocols on clinicians may differ from that of non-explicit computerized guidelines. Previous studies have expressed the need for research on factors affecting adoption that are specific to the technology under consideration, so as to improve their predictive ability [20,21]. Thus, there is a need to identify the specific cognitive and attitudinal factors associated with clinicians' adoption of explicit computerized protocols.

The goal of this paper is to report the development and validation of an assessment instrument for assessing clinicians' perceptions about use of explicit computerized protocols. An understanding of clinicians' perceptions will help determine barriers to adoption and enable protocol developers, clinical administrators and health service researchers design interventions to better meet the needs of end-users [6].

2. Methods

The study was conducted in two stages. The first stage consisted of a qualitative assessment and analysis based on interviews of experienced clinicians giving rise to a cognitive model evaluating the factors that motivate clinicians to use explicit computerized protocols. Development and validation of the instrument constituted the second stage.

2.1. *Stage 1*

In a previous study, we conducted semi-structured interviews of clinicians with extensive experience in the use and development of explicit computerized protocols at LDS Hospital, in Salt Lake City, Utah. Five physicians, 3 nurses and 6 respiratory therapists were interviewed. The interview consisted of 21 open-ended questions probing clinicians about their experience with using explicit computerized protocols. All interviews were tape-recorded and later transcribed verbatim. The results of this work are published elsewhere [22] but we will summarize them briefly here. Three reviewers examined the transcripts looking for themes. After substantial group discussion, 39 themes were identified. The 39 themes were then reduced and categorized into 10 constructs. Matching of themes to constructs was done independently by two reviewers with an initial kappa of 0.48 (moderate) and consensus was attained following discussion.

Two behavioral theories guided this work, specifically, the Theory of Planned Behavior (TPB) and Intrinsic Motivation theories. These theories were developed in the domain of psychology and have been used extensively to predict behavior [23–30]. While TPB focuses on the choice and initial engagement in the behavior, Intrinsic Motivation theories focus on factors predictive of interest, persistence over time and creative involvement, of the individual performing the behavior. According to the TPB, behavioral intention is predicted by beliefs regarding the type and value of outcomes, the attitude towards performing the behavior, perceived control over the behavior and subjective norms [26–28,31]. Subjective norms are beliefs about what others, e.g. co-workers, administrators expect of us. Similarly, from the intrinsic motivation point of view, behavioral intention is predicted by perceived autonomy, self-efficacy, enjoyment or interest experienced while performing the behavior, congruence of the behavior with professional and personal goals, and ability of the behavior to enhance one's self-identity [32,33]. Substantial empirical evidence supports the predictive ability of both these theories to predict behavior and intention, with general agreement that intentions are the strongest predictor of behavior [31].

In an earlier model, we proposed that Perception of the Situation was defined as the "way individuals categorized or defined a task, which determined their general attitude or approach towards performing the task". This construct is largely determined by the individual's roles, responsibilities, well-learned habits and over arching goals [22]. Additionally, in the qualitative interviews we identified the construct of Habit, which referred to "behavior that is well learned, frequently executed, occurs easily and with little stimulation—almost automatically". Since we intended to validate the current instrument largely based on populations who were relatively new to the use of computerized protocols, we omitted both these constructs of Perception of Situation and Habit. The final constructs employed in our assessment in this study were: Role Relevance, Work Importance, Beliefs regarding Control,

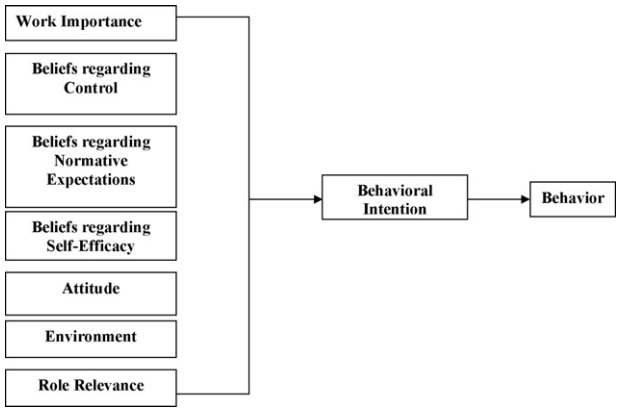

Fig. 1 – Model predicting use of computerized protocols among clinicians.

Beliefs regarding Normative Expectations, Beliefs regarding Self-Efficacy, Attitude, Environment and Behavioral Intention. Fig. 1 outlines the model tested here.

2.2. *Stage two*

2.2.1. *Item generation*

The items for the instrument were then developed from the eight constructs using the language and terms identified from clinician interviews. All items used a 7-point Likert scale with end-points or anchors stated in terms of the dimension addressed. For example, one item was, "Using computerized protocols results in Nurses having": 1 = decreased responsibility to 7 = increased responsibility. The full range of responses (1–7) was used for all items. For each of the eight constructs, we constructed up to five items. We pilot tested the instrument and revised the items accordingly. Table 1 lists the constructs with corresponding questionnaire item.

2.2.2. *Instrument administration*

Sample size recommendations to achieve sufficient power in a factor analysis is minimally five participants per item [34]. Since our instrument contained 35 items, we determined that a sample size of 175 would be required to provide sufficient power. In addition, the validity of factor analysis is improved by using a diverse sample [35]. As a result, we solicited physicians, including interns, residents and fellows, nurses and respiratory therapists from University of Utah Hospital, Veterans Affairs Medical Center, Salt Lake City, and Intermountain Healthcare (LDS Hospital and Cottonwood Hospital), to take the survey. The Institutional Review Boards (IRBs) of all three institutions approved the study. All participating clinicians signed an informed consent that explained the goals of the study and protection of the privacy of the clinicians along with permission to use the survey responses for research purposes.

One researcher [SP] distributed the instrument during clinical rounds, at staff meetings, in physician classrooms, at the nurses' station and in the clinical wards, at each study site using a convenience sampling process. Only clinical wards where some protocols, in paper or computerized form, were in use were chosen. All units had access to an electronic medical record (EMR). Redundancy in response, i.e. subjects taking the survey twice, was prevented because the instruments were manually administered to the clinicians by one researcher. The researcher described to the participants the aim of the study along with the definition of computerized protocols. To increase validity, the researcher described situations in which explicit computerized protocols could be used and the nature of how highly structured decision support would work in their clinical settings.

2.2.3. *Factor analysis*

Factor analysis is one of the more effective statistical tools for assessing the construct validity of models and validating the internal structure of related instruments [36]. We conducted exploratory factor analysis using orthogonal Varimax rotation. The number of factors to be retained was determined by using Kaiser's rule of retaining factors with eigen values >1 and visual inspection of Catell's scree plot. All analyses were carried out using SPSS Version 11.5 [37].

2.2.4. *Scale construction*

Scales were constructed by using items that loaded high on a specific factor and relatively lower on all other factors. The cut off point of greater than or equal to 0.40 was used [35]. The reliability or internal consistency of the scales was measured using Cronbach's coefficient alpha [38]. An alpha value of 0.70 or greater was determined adequate for the purpose of this analysis [36,39]. Additionally, items were eliminated if their intended meaning was not consistent with the scale.

2.2.5. *Construct and predictive validity*

Construct validity was further examined by obtaining bivariate Pearson's correlation coefficients between the scales. Additionally, Behavioral Intention was regressed on all of the variables to determine the degree to which variables were independent predictors.

3. Results

The instrument had a response rate of 84.2%. The final sample consisted of 240 clinicians, including 53 physicians, 132 nurses and 55 respiratory therapists. The demographic characteristics of the participants are reported in Table 2.

Following factor analysis the scree plot indicated that nine factors had eigen values greater than 1.0. These nine factors explained 65.8% of the total variance after varimax rotation. Inspection of the factor structure revealed that except for the construct of Beliefs regarding Normative Expectations, the proposed model was validated as predicted. Items developed for this construct loaded onto two new factors namely, Culture and Social Pressure. In addition, the constructs of Environment and Attitude were renamed as Environmental Support and Attitude towards Information Quality, based on the items that loaded on these factors.

Twenty-nine of the original 35 items were retained after factor analysis and scale development. Two items that were excluded owing to low factor loadings were on "ability to customize the protocols" (Item 13, $N = 235$, mean = 5.99, S.D. = 1.17) and "trust among clinicians" (Item

Table 1 – Constructs from the model and underlying questions that were generated for the instrument

Constructs and Related Items	Item #	Response Options
Work Importance		
Computerized protocols make it so any layperson can practice medicine	10	Disagree strongly/agree strongly
Computerized protocols will become part of my job	11	Disagree strongly/agree strongly
Role Relevance		
A clinician using computerized protocols requires	3	Less clinical knowledge/more clinical knowledge
Using computerized protocols results in nurses having	7	Decreased responsibility/increased responsibility
Using computerized protocols results in respiratory therapists having	8	Decreased responsibility/increased responsibility
Using computerized protocols results in physicians having	9	Decreased responsibility/increased responsibility
Beliefs regarding Control		
Clinicians using computerized protocols are:	1	Compliant/self-reliant
Computerized protocols make clinical decisions very:	12	Rigid/flexible
Being able to customize computerized protocols is:	13	Not very important/very important
I expect declining instructions in computerized protocols to be:	14	Difficult/easy
Using computerized protocols is very much like "Cookbook Medicine":	15	Disagree strongly/agree strongly
Using computerized protocols might make me feel:	16	Dependent/independent
With computerized protocols I would have:	17	Very little control/a lot of control
Beliefs regarding Normative Expectations		
The people I work with feel that using computerized protocols is:	19	Not expected/expected
If I decided to not use computerized protocols, I would experience:	20	Little social pressure/a lot of social pressure
If I decided to not follow computerized protocol recommendations, I would experience a lot of social pressure in the workplace	21	Not at all/definitely
Beliefs regarding Self-Efficacy		
When using computers, I am generally:	22	Nervous/calm
I expect that learning to use computerized protocols would be:	23	Very hard/very easy
When trying new things, I am generally:	24	Resistant/receptive
When using computerized protocols, I might be:	25	Not competent/very competent
When using computerized protocols, I feel I might be:	26	Not at all capable/very capable
Attitude		
When using computerized protocols, it is easy for clinicians to be lazy:	2	Not possible/very possible
Computerized protocols are:	4	Not very trustworthy/very trustworthy
Computerized protocols are:	5	Not very explicit/very explicit
Computerized protocols are generally:	6	Not well-tested/well-tested
Environment		
The support I expect to receive from the computer office will be:	30	Not sufficient/very sufficient
The support I expect to receive from my co-workers when using computerized protocols might be:	31	Not sufficient/very sufficient
When asking for help with using computerized hospital, I feel very:	32	Uncomfortable/comfortable
When using computerized protocols, it is essential that people on a team trust each other:	33	Not important/very important
In my hospital, administrators are:	34	Not supportive/very supportive
In my hospital, using computerized protocols is very much a part of the culture:	35	Disagree strongly/agree strongly
Behavioral Intention		
When computerized protocols are developed at my hospital, I expect to have:	18	Little involvement/a lot of involvement
When using computerized protocols in the future I intend to:	27	Avoid them if possible/use them whenever possible
With regards to using computerized protocols, I am very:	28	Uninterested/interested
With regards to the use of computerized protocols I am:	29	Not at all committed/very committed

33, $N = 238$, mean = 5.95, S.D. = 1.19). Three items, Item 1 ($N = 229$, mean = 4.22, S.D. = 1.58), Item 11 ($N = 238$, mean = 5.42, S.D. = 1.59), and Item 18 ($N = 237$, mean = 4.81, S.D. = 1.75) were discarded in the process of scale construction owing to low Cronbach's coefficient alpha values. Item 1 loaded on the scale of Role Relevance, the reliability of this scale was 0.73 and after elimination of Item 1 the Cronbach's alpha rose to $\alpha = 0.74$. Although the rise in Cronbach's alpha was not much higher the item was eliminated owing to lack of semantic consistency with the scale. Item 11 loaded on the scale of Work Importance and after elimination led to an increase in the internal consistency of the scale from $\alpha = 0.13$ to 0.62. Item 18 was eliminated from the scale of Behavioral Intention and resulted in an increase in internal consistency from $\alpha = 0.86$ to 0.92. One item, Item 14 ($N = 228$, mean = 4.23, S.D. = 1.51) referring to "declining instructions in computerized protocols" was removed owing to frequent comments by respondents asking about its meaning and the fact that it did not load on the predicted factor of Beliefs regarding Control. The factors, the items that loaded on them, descriptive statistics of the items, the cumulative percent of variance and the Cronbach's coefficient alpha for each of the scales, are presented in Table 3.

Table 2 – Demographic characteristics of sample

Demographic variable	N[a]	Percent
Specialty		
Nurses	132	55.0
Physicians	53	22.1
Respiratory therapists	55	22.9
Unit		
Critical care	105	43.9
Acute medicine unit	61	25.5
Respiratory	55	22.9
Miscellaneous	19	7.9
Operating room		
Emergency		
Women and new born		
Bone marrow transplant		
Urology		
Hospital		
IHC	83	34.6
LDS	67	27.9
CWH	16	6.7
VAMC	80	33.3
UUHC	77	32.1
Years of Experience		
0–5	148	61.6
6–10	25	10.5
11–15	18	7.4
16–20	4	1.6
21–25	1	0.4
26–30	1	0.4

[a] N, number of clinicians for whom data were available.

3.1. *Construct validity*

As shown in Fig. 2, Behavioral Intention and the constructs of Attitude towards Information Quality ($r = 0.54$, $p < 0.001$), Beliefs regarding Control ($r = 0.54$, $p < 0.001$), Environmental Support ($r = 0.51$, $p < 0.001$) were strongly correlated. In addition, Behavioral Intention had a significant negative correlation with Work Importance ($r = -0.50$, $p < 0.001$), because items underlying this construct were negatively worded. Although not as high, the correlation between Behavioral Intention and the remaining scales was positive and significant, as shown in Table 4.

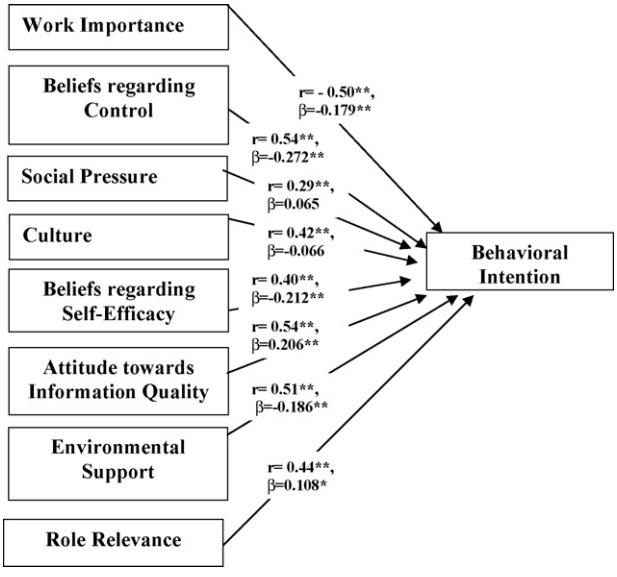

Fig. 2 – Final constructs predicting Behavioral Intention to use computerized protocols Strengths of correlation (*r*) and standardized regression coefficients (*β*) along with level of significance ($p < 0.001$; * $p < 0.05$) are presented.**

The linear regression model was a good fit ($R^2_{adj} = 60.4\%$), and the overall relationship was significant ($F_{6,192} = 51.26$, $p < 0.001$). Except for the two variables of Social Pressure ($\beta = 0.065$, $p = 0.174$) and Culture ($\beta = 0.066$, $p = 0.209$), all the variables significantly predicted Behavioral Intention. The standardized regression co-efficient, β and the corresponding level of significance, p for each of the variables is given below. The results for the other variables are as follows: Beliefs regarding Self-Efficacy ($\beta = 0.212$, $p < 0.001$), Environmental Support ($\beta = 0.186$, $p < 0.001$), Work Importance ($\beta = -.179$, $p = 0.001$), Beliefs regarding Control ($\beta = 0.272$, $p < 0.001$), Attitude towards Information Quality ($\beta = 0.206$, $p < 0.001$), and Role Relevance ($\beta = 0.108$, $p < 0.05$).

4. Discussion

The purpose of this study was to develop and validate an instrument for assessing clinicians' perceptions about use of explicit computerized protocols. The results of this work provide a theoretical framework for assessing clinicians' perceptions about adoption of explicit computerized protocols.

Many of the results found in this study were similar to previous work in the area of technology adoption. In our study, we found that the strongest predictor of clinicians' intention to use computerized protocols was Beliefs regarding Self-Efficacy. This construct loaded exactly as predicted and accounted for 26% of the total variance of intention to use computerized protocols. This was congruent with other studies, which have reported the importance of perceived self-efficacy as a significant predictor of behavioral intention [40]. In a systematic review of 76 studies, Cabana et al. identified the potential barriers to physicians' guideline adherence [6]. They classified the barriers into three categories namely, physician's knowledge, physician's attitudes and external barriers. The theme of attitude included the barrier of lack of self-efficacy as a deterrent to physicians' guideline compliance. Several other studies have identified the importance of this construct in clinicians' adoption and adherence to clinical guidelines [41–43].

Our study added to the current literature by specifying constructs with relevance to explicit computerized protocols. Previous studies have identified clinicians' attitude as an important factor in determining adoption of guidelines [6,42,43] but our study specifically identified that it was the clinicians' attitude towards the information content and quality that determined their future use of the protocol. The construct, that we initially called "Attitude", was renamed "Attitude towards Information Quality", as a function of the items loading on this factor. Attitude towards Information Quality specifically encompasses clinicians' perceptions

Table 3 – Factors extracted and descriptive statistics for loaded items.

Factor	Item no.	N[a]	Mean	S.D.	Factor loading	%Cumulative variance	Cronbach's alpha
Beliefs regarding Self-Efficacy	25	237	5.62	1.13	.80	26.11	.81
	26	237	5.85	1.11	.77		
	22	238	5.93	1.32	.73		
	23	238	5.17	1.39	.70		
	24	238	5.62	1.25	.70		
Environmental Support	30	237	4.88	1.62	.80	35.17	.82
	31	237	5.34	1.36	.77		
	32	235	5.50	1.38	.75		
	34	226	4.98	1.35	.70		
Role Relevance	7	237	4.78	1.52	.79	41.44	.73
	8	224	4.71	1.55	68		
	9	233	3.75	1.54	.60		
	3	239	4.32	1.55	.51		
Work Importance	10	238	2.12	1.60	−.75	46.62	.62
	2	237	4.21	1.75	−.56		
	15	235	3.85	1.81	.55		
Beliefs regarding Control	16	237	4.21	1.60	.78	51.08	.81
	17	238	4.31	1.49	.73		
	12	238	3.47	1.33	.60		
Behavioral Intention	27	238	5.22	1.45	.40	55.38	.92
	28	238	5.11	1.70	.48		
	29	238	4.87	1.48	.55		
Attitude towards Information	5	238	5.05	1.32	.80	59.54	.80
Quality	6	237	4.99	1.48	.76		
	4	239	4.83	1.34	.64		
Social Pressure	20	237	4.24	1.87	.85	62.77	.79
	21	237	4.38	1.78	.79		
Culture	35	232	4.53	2.20	.73	65.81	.66
	19	235	4.80	1.69	.59		

[a] N, number of clinicians for whom data were available for calculating Cronbach's alpha.

Table 4 – Pearson correlation coefficients between factors

	Beliefs regarding Self-Efficacy	Environmental Support	Role Relevance	Work Importance	Beliefs regarding Control
Beliefs regarding Self-Efficacy	1	.26**	.05	−.10	.23**
Environmental Support		1	.18*	−.22**	.26**
Role Relevance			1	−.38**	.46**
Work Importance				1	.45**
Beliefs regarding Control					1
Behavioral Intention	.40**	.51**	.44**	−.50**	.54**
Attitude towards Information Quality	.32**	.40**	.37**	−.33**	.30**
Social Pressure	.06	.16*	.25**	−.15*	.17**
Culture	.17**	.36**	.33**	−.28**	.42**

	Behavioral Intention	Attitude towards Information Quality	Social Pressure	Culture
Behavioral Intention	1	.54**	.29**	.42**
Attitude towards Information Quality		1	.26**	.31**
Social Pressure			1	.37**
Culture				1

**$p < 0.001$, *$p < 0.05$.

regarding the content of the protocols and the quality of the information contained in them. These perceptions were related to the degree to which the protocol is accurate, up to date and trustworthy. If the information was not continually maintained and well tested, it would affect clinicians' trust in these protocols. Also, clinicians expressed the need for the content of the protocols to be explicit enough to aid comprehension. They needed explicit instructions in order to make their own assumptions in following the protocol. The items in this construct enable understanding of the characteristics related to the content, maintenance and quality of protocols which help distinguish useful protocols from those that clinicians have no intention of using.

Secondly, the construct of Environment was renamed as Environmental Support. The items under this construct related to the characteristics of support from the environment, such as, support from the computer department, co-workers and administrators that were most important to the clinicians. Support appears to be particularly salient when using computerized protocols that require intense coordination between providers.

Two new factors were developed from the construct we previously called, Beliefs regarding Normative Expectations. The factor loadings showed that items on this construct correlated to two distinct factors, one about Social Pressure and the other dealing with the Culture of the organization. The factor named Culture included items that reflected whether the culture of the workplace was perceived to be conducive to the use of computerized protocols. The items in the Social Pressure factor specifically dealt with the perception that there was a degree of pressure from co-workers, administrators, etc. to conform to the use of computerized protocols. This finding is supported by recent studies in psychology [44] where social norms and social support have been shown to contribute independently to the intention to perform a behavior. More items need to be developed for the scales of Social Pressure and Culture to be able to measure these factors adequately. In addition, the concept of social norms may take on a unique flavor in the situation of using explicit computerized protocols which use highly controlled data entry and bed-side decisions.

Finally, our model is unique in its emphasis on Role Relevance and Work Importance when assessing adoption. This concept arose qualitatively out of the interviews of experienced clinicians and may be more salient in a situation where explicit computerized protocols are used due to the dependencies between disciplines required. Role Relevance may be particularly salient when actions among a team of providers require the degree of coordination that occurs with the use of explicit computerized protocols.

As explained previously, the Behavioral Intention scale had excellent internal consistency (0.92). Thus, this instrument gives us a reliable measure of whether clinicians intend to use computerized protocols. Upon examination of the correlations it is apparent that the other 8 scales show a high correlation with Behavioral Intention, thus validating the fact that the intention to use is indeed highly associated with the predicted factors. While intent and commitment are expected components of Behavioral Intention, the component of interest drew our attention. Interest is defined as, "a psychological state that involves focused attention, increased cognitive functioning, persistence and affective involvement" [45]. Hidi states that although focusing attention and continuing cognitive engagement normally requires increased effort; when interest is high, these activities feel relatively effortless [45]. Interest is associated with increased likelihood of choosing and persisting at a variety of activities [5,46]. A previous study by Weir et al. examining adoption of a provider order entry system also found that the item assessing interest correlated highly with intention and subsequent adoption behaviors [47]. This is of relevance to implementation of interventions aimed at increasing the clinicians' interest in protocols. Enhancing clinicians' interest would motivate them to persist using the protocols beyond the training period as well as to be creative and effective in their use. Future work could expand on the construct of interest in order to explore its contribution to adoption of explicit computerized protocols.

Results from this study focus on the individual clinician as an end-user of explicit computerized protocols. However, as Grol noted, the obstacles to change do not reside only at the social or organizational level but at the level of individual clinician as well [10]. Making the individual clinician understand why using the protocol will improve patient care, what changes will take place in their clinical routine and not making clinicians feel alienated from the development and implementation process, will enhance positive intentions for protocol use. Even if the use of the protocol is mandatory, adopting the protocol in routine clinical practice requires the individual clinician to perceive it positively. This can be achieved by making clinicians feel competent in using it, feel like they have the knowledge about its functionalities, and feel satisfied that using the protocols will improve performance. Despite mandatory policies users can develop deliberate work-arounds [48,49]. Clinician resistance can also lead to complete abandonment of systems in hospitals where clinicians perceive the systems as slow and inefficient to meet their clinical needs [50]. Previous studies have identified the significance of broad involvement of users [51,52] and the importance of tailoring the system to individual needs to enhance workflow [53]. These dynamics of change take place at the level of the individual clinician and hence justify using the individual clinician as the unit of analysis in this study.

5. Limitations

Certain limitations of this study could have potentially biased our findings. Some items were eliminated following factor analysis, owing to various reasons. The items "trust among clinicians" (Item 33) and "ability to customize the protocols" (Item 13) did not load onto any factor. We think that both these items might depend heavily on clinicians' hands-on experience with use of computerized protocols. Clinicians, who were experienced in using these protocols in routine practice, clearly emphasized the trust factor in the qualitative interviews [22,54]. The re-evaluation of this item post-implementation of computerized protocols would reveal whether the actual use of these protocols would change the result. Additionally, during administration of the instrument

to the clinicians it became apparent that the meaning of Item 14 regarding "ease of *declining* computerized instructions" was unclear.

We decided to include the constructs of Culture and Work Importance even though they did not have adequate values for Cronbach's alpha. We included these constructs because they were identified as important predictors in the qualitative interviews. Both these constructs were described only by two items and future development of the questionnaire would include more work in this area.

The inclusion of three hospital settings that have completely different organizational cultures and three-specialty groups of clinicians, namely physicians, nurses and respiratory therapists, enhances the generalizability and usefulness of our findings. However, validation of the instrument in other hospital institutions remains to be tested. Utah has a very strong culture and history in the use of information systems in health-care. Despite this, there are differences in the level of penetration of information systems in the three health-care institutions, thus making the instrument more generalizable. While the strength of the relationships of the constructs might vary owing to specific organizational characteristics, we think, that the factors identified should be generalizable to the use of computerized protocols in other institutions as well.

Future work can utilize the developed instrument to determine which of the variables actually are associated with adoption. Additional factors, such as age, gender, domain specialty and education could be included in a model to address adoption. Future studies will examine how manipulating the identified constructs can enhance actual adoption.

6. Conclusions

The analysis of clinicians' perceptions about use of computerized protocols in clinical practice has provided useful insights into those factors that may influence intention to adopt computerized protocols. The key to enhancing clinicians' behavioral intention to adopt computerized protocols will be to recognize the implications of these factors and tailor the design and implementation so as to meet the needs of end-users. Associated with the need to understand these factors is a deeper need for studies focusing on how these factors vary between organizations, professions and clinician specialties and how they might be related to the effectiveness of the protocol in improving care.

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Summary points

What was known before the study?

- Computerized guidelines providing decision support are increasingly being used in various domains of routine clinical practice. Despite their proven value in decreasing practice variation between clinicians, standardizing patient care, and improving patient outcomes, clinicians' adoption of guidelines has had limited success.
- Explicit computerized protocols are specifically developed to provide more standardized decision-making for patient care; these protocols thus provide even less flexibility for clinician judgment than non-explicit computerized guidelines. The socio-behavioral impact of explicit computerized protocols on clinicians may differ from that of non-explicit computerized guidelines and needs to be studied.
- Previous studies have expressed the need for research on factors affecting adoption that are specific to the technology under consideration, so as to improve their predictive ability. Thus, there is a need to identify the specific cognitive and attitudinal factors associated with clinicians' adoption of explicit computerized protocols.

What has the study added to the body of knowledge?

- Our study added to the current literature by specifying constructs with relevance to explicit computerized protocols.
- Nine factors that explained 65.8% of the total variance of intention to adopt computerized protocols were identified. Factors identified were: Beliefs regarding Self-Efficacy, Environmental Support, Role Relevance, Work Importance, Beliefs regarding Control, Attitude towards Information Quality, Social Pressure, Culture, and Behavioral Intention.
- Two new factors were developed, one about Social Pressure and the other dealing with the Culture of the organization. The factor named Culture included items that reflected whether the culture of the workplace was perceived to be conducive to the use of computerized protocols. The items in the Social Pressure factor specifically dealt with the perception that there was a degree of pressure from co-workers, administrators, etc. to conform to the use of computerized protocols.

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