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Developing a Theoretical Model of Clinician Information Usage Propensity

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Abstract. Based on qualitative research, we developed the theoretical construct "clinician information usage propensity" as a hypothetical indicator of attitudes and behaviour towards clinical information and systems. We devised a survey to validate the construct and had 146 responses. Principal components analysis extracted four factors accounting for 47.2% of the variance: beliefs about clinical judgement, beliefs about information quality, cultural resistance and cognitive approach. The components were reasonably consistent with the model but two factors (beliefs about information quality, cognitive approach) had low reliability ($\alpha < 0.6$). Cultural resistance was the main factor and correlated with gender, grade and age group. Female clinicians showed significantly higher cultural resistance and preference for narrative; hospital doctors generally had higher cultural resistance than general practitioners. As only 47.2% of the variance was explained, further work is needed to refine the instrument to remove redundancy, improve sensitivity on the identified components and allow the construct to be explored as a form of technology adoption model. We posit that beliefs about clinical judgement merit further attention in medical informatics research.

Keywords. model, behaviour, attitude, survey

1. Introduction

This paper reports the development and validation of a survey instrument to assess "clinician information usage propensity" (CIUP), a hypothetical indicator of attitudes and behaviour towards clinical information and systems. We employ Wyatt & Liu's definition, that "clinical information" is organised patient data or medical knowledge used to make clinical decisions [1].

We conducted qualitative research into clinician attitudes, beliefs and behaviours towards healthcare information and systems using focus groups and observations [2] and developed the CIUP concept from grounded theory analysis. The construct had four hypothetical components: beliefs about clinical judgement, cognitive approach, beliefs about information quality, cultural resistance.

"Beliefs about clinical judgement" was intended to encapsulate the clinician's beliefs about the degree to which clinical judgement can or cannot be represented as an algorithmic process [3], the extent of interpretive inference in decision-making and whether the clinician thinks in terms of a patient or a "case". "Cognitive approach" was to express the level of dominance of either propositional (structured) or narrative thinking [4] and preference for coding versus natural language. "Beliefs about

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information quality" was meant to gauge the clinician's attitudes towards incompleteness, inaccuracy and attenuation of patient information. "Cultural resistance" was envisaged to combine beliefs about the relative advantages and disadvantages of informatics innovation with attitudes towards the ritual or performative aspects of medical practice. Each of these components was conceived as a continuum of attitude rather than a strict dichotomy.

We had conducted a literature review of theory in medical informatics (a summary is available at [5]). We found eight sociotechnical models, but none included the aspect of beliefs about clinical judgement which our qualitative research had highlighted. None of the technology acceptance models we reviewed had specific clinical components [6–8]. Following a pragmatist mixed methods research strategy, we decided to design a survey to validate the hypothetical construct. The aim was to build a mixed instrument that would capture both quantitative and qualitative data.

2. Methods

The approach broadly followed that of similar instrument validation studies [9, 10]. A draft survey was piloted with a small group of clinicians (n=10) to test the format and clarity of question wording. No statistical analysis was performed on the pilot data.

The survey was administered to a population of hospital doctors and general practitioners (GPs) in the NHS in Hampshire. A website was constructed to deliver the survey and a database was populated with clinicians' email addresses. We obtained 594 email addresses for hospital doctors and 250 for GPs (from regional totals of 866 and 375 respectively). Ethical approval was granted by an NHS Research Ethics Committee and the local research and development office.

The survey had 19 items relating to the hypothetical construct, four demographic questions (gender, age group, medical specialty and grade) and five other exploratory questions about what information sources were used. Each of the 19 construct-related questions used a five-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree or Always, Often, Sometimes, Rarely, Never, scored from 1 as strongest agreement to 5 as strongest disagreement) with a "No opinion" option and a free-text box to allow qualifying comments to be made.

Quantitative statistical analysis was performed using SPSS [11]. The data were analyzed using principal components analysis to extract clusters of correlated items to compare against the hypothesized components. Sampling adequacy was prospectively estimated using the guideline of minimally five to ten participants per variable [12], requiring n=135-190 for the construct-related data set, and retrospectively checked using the Kaiser-Mayer-Olkin (KMO) measure. Cronbach's alpha was calculated to test the reliability (internal consistency) of each extracted component. Factors were tested for correlation against the demographics using Spearman's coefficient.

3. Results

One hundred and forty-six participants completed the survey (Table 1), an overall response rate of 17% (20% for hospital doctors, 10% for GPs). Responses of "No opinion" were excluded from the analysis by flagging them as missing values in SPSS. Missing values were excluded pairwise to minimize data loss. The KMO measure was

0.69, which indicates that the sample size was adequate for principal components analysis. Bartlett's test of sphericity was significant ($p<0.001$), showing that the data did contain inter-related clusters of variables.

Table 1. Sample characteristics

Grade	**n**
Hospital consultant	71
Junior hospital doctor	49
General practitioner	26
Gender	
Female	54
Male	92
Total	**146**

Age group	**N**
20–29	31
30–39	37
40–49	41
50–59	31
60–69	5
Other	1
Total	**146**

Using the Kaiser criterion, six components were extracted, accounting for 58.6% of the variance. The scree plot was inconclusive as the point of inflexion of the curve could be interpreted to support either four or six components. Therefore an alternative analysis specifying four components was performed for comparison. The alternative four-component model explained 47.2% of the variance. The component matrices were used to explore constructs from the correlated survey items on each model. Factor loadings > 0.4 were considered significant as substantively contributing to each component. The composition of the extracted components can be seen at [13]. Both models gave patterns of correlation consistent with the four hypothesized components. The additional two factors derived using the Kaiser criterion had no obviously meaningful interpretation so the four-component model was preferred.

Two of the factors had adequate reliability ($\alpha = 0.65, 0.76$) but two components ("Cognitive approach" and "Beliefs about information quality") had low reliability ($\alpha < 0.6$). Factor scores were calculated using the regression method and tested for correlation with gender, age group, specialty and medical grade (Table 2). Medical specialty did not significantly correlate with any of the factors so is omitted from the table. Blank cells denote no significant correlation.

Table 2. Correlation with demographics (* $p<0.05$, $^{\#}$ $p=0.055$, † $p=0.03$)

Factor	**Description**	**Gender**	**Grade**	**Age group**
1	Cultural resistance	0.21*	0.19$^{\#}$	0.24*
2	Beliefs about clinical judgement			
3	Cognitive approach	0.20*		
4	Beliefs about information quality		0.28†	
Sum of factor scores			0.20*	

The qualitative results revealed a consensus on clinical judgement as a mix of algorithm and expertise, but with some strong contradictory opinions. Distinct beliefs were evident as to whether clinical judgement was an art, a science or a pragmatic mix

of both aspects. The strength of feeling often expressed by participants suggests that it is a very important factor that will profoundly affect information usage propensity.

4. Discussion

We interpret the factor scoring to mean that lower scores indicate higher cultural resistance to information technology (factor 1), stronger anti-algorithmic view of medicine (factor 2), greater preference for narrative over structured documents (factor 3) and stronger belief in poor information quality (factor 4). We argue that the sum of scores gives a measure of clinical propensity to adopt information systems.

We had anticipated significant variation between specialties, given our inferences from the qualitative work and the reported association between specialty choice and personality traits [14], but our sample did not support this conjecture. We were also surprised that beliefs about clinical judgement were not differentiated by any of the demographic criteria but appeared to be purely idiosyncratic.

Cultural resistance was the main factor, explaining most variance and having the highest reliability. This component correlated with gender, grade and age group and is comparable to the "Behavioural intention" factor reported by Phansalkar et al. [9]. The factor we named "Beliefs about information quality" showed correlation with medical grade and is similar to Phansalkar's "Attitude towards information quality" factor.

Female participants scored significantly lower than males on both cultural resistance (mean difference=0.45, SE=0.18; $t(103)=-2.48$, $p<0.05$) and on cognitive approach (mean difference=0.41, SE=0.19; $t(103)=-2.14$, $p<0.05$). We take this to suggest a somewhat higher cultural resistance to information systems and preference for narrative among the female clinicians in this sample.

We also found a dichotomy between primary and secondary care. Hospital doctors scored significantly lower on cultural resistance than GPs (mean difference=0.49, SE=0.22; $t(103)=2.28$, $p<0.05$). Among hospital doctors, juniors scored slightly lower on cultural resistance than seniors (mean difference=0.15, SE=0.21) but the difference was not significant ($t(87)=0.76$, $p=0.45$). We interpret this to show a markedly higher cultural resistance among hospital doctors than GPs. The correlation with total score also provides some support for aggregating the four components into an overall scale.

5. Limitations

The results were subject to selection bias as all invitations to participate were sent by email only and the survey was administered online, tending to select participants more adapted to everyday use of information technology. However this only affects the substantive scores rather than the constructs.

The sample size was adequate for principal components analysis but at the low end of acceptability, with KMO > 0.7 judged as good. Two factors had poor reliability. The four-factor model only explained 47.2% of the variance, so the proposed CIUP construct and survey instrument would need further work to offer fuller explanatory and practical utility.

The survey was conducted in a UK district hospital and its associated primary care community and the findings cannot be generalized to other populations without repetition of the study or use of confirmatory factor analysis techniques.

6. Conclusions

This study has provided some evidence for the hypothetical concept of clinician information usage propensity. We suggest that the construct has potential to be explored as a technology adoption model, to assess readiness for change related to healthcare information systems, to offer insights for software design and to inform the development of informatics evaluation methods. Further work would extend the model and refine the instrument to remove redundancy and improve its sensitivity. We posit that beliefs about clinical judgement merit further attention in medical informatics research.

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