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Optimal Data Entry by Patients: Effects of Interface Structure and Design

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Abstract

Direct electronic acquisition of data from patients possesses accuracy and diagnostic value. The mechanics of how best to capture historical information from patients using electronic interfaces are not well studied. We undertook an iterative usability experiment to answer 2 questions: 1) How can maximal electronic data input from a patient be achieved, and 2) Do varying structures for data entry promote differential documentation of specified data elements? Methods: A series of four trials comprised the testing cycle. Unstructured text entry, directed text entry, and closed ended questions were tested in combination against outcomes of word count, time to task completion, and user preferences. Covariates of interest included participants' technologic experience and ergonomic experience with keyboards, as well as self-report of educational status, literacy, and primary language. Results: Participants clearly preferred the order of initial closed-ended questions followed by unstructured text entry, and this ordering was not associated with decrements in word count or increase in time. When compared to unstructured text entry, directed text entry provided higher documentation of data for past medical history and questions which parents wished to discuss with the clinician. A closed-end question structure, when compared to directed text entry, provided higher capture of parents' questions for discussion. Conclusions: Optimal design of an electronic interview for the capture of medical histories will benefit from a mixed structure of directed text entry and closed-ended questions. For historical or clinically relevant items where maximal capture of data is desired, a structure with closed-ended questions would be preferred.

Keywords:

Data entry; Consumer informatics; User-computer interface

Introduction

Proponents of the electronic medical record promote one of its benefits to be the inclusion of the patient as a direct reporter and participant in the creation and maintenance of health documents.[1-4] "Real time" data entry when a patient experiences an acute illness may be quite different than simply reviewing and editing information during a period of wellness.[5] Structural concerns and interface development for optimal capture of medical data have largely focused on clinicians.[6-8] What interface structures may serve patients' preferences and performance best remains unknown.

We have previously reported on the potential value of unstructured text as entered by parents using an electronic interface.[9] Four thematic categories of information were derived from parents' unstructured text entries: basic symptom report, diagnostic concerns, symptoms reported with relevant past medical history, and symptoms reported with questions directed at treating clinicians who would be providing care. The variance in parents' report of symptoms, potential diagnoses, and other relevant concerns lead to the following two questions: 1) How can maximal data sharing from the parent via an electronic interface be achieved? and 2) Do various structures for data entry promote differential entry of text across specific categories of historical information?

We report on an iterative usability study that explored parents as direct reporters of medical histories using an electronic interview. Our specific aims for the first two iterations were 1) to define parents' preferences regarding both structure of questions (unstructured text entry versus closed ended questions) and ordering of queries, and 2) to compare the amount of data captured across varying structures and ordering schema. In subsequent iterations, our aims were – 1) to establish whether directed text entry could prompt parental data entry across three types of information: diagnoses of concern, past medical history, and questions which the parent wished to discuss with the treating clinician and 2) to establish whether question structure was associated with superior electronic documentation across the three types of information.

Materials and Methods

Subjects were parents with a child less than 5 years of age presenting for a sick visit to the primary care clinic associated with a urban, tertiary care Children's Hospital.

A research assistant recruited parents and verbal consent for participation was obtained (Committee on Clinical Investigation Protocol X99-12-061).

Approximately 20 parents were recruited for testing of the initial three iterations for the interface. A group of 50 parents was recruited for testing of the final version of the electronic interview. Each iteration recruited a separate group of parents and no parent was allowed to participate more than once.

Parents completed the study procedures while waiting to be seen by the clinician.
The language for the interface was English.
All parents used the same laptop running Windows 95 with a 33 cm color monitor screen with its standard keyboard and touch pad. All electronic interviews were programmed using Visual Basic 5.0 (Microsoft, Redmond, Wa).

The first iteration of the interface design explored parents' subjective reaction to entering data using unstructured text fields and investigated navigational obstacles to data entry.[10] Cognitive interviews were completed with the parent after using they completed data entry using a series of free text fields. Parents' spontaneous comments as well as responses to the pre-specified questions were recorded.

The second iteration of the interface design tested the ordering of question structure with parents alternately allocated to an electronic interview with either a) unstructured text fields followed by closed ended questions or b) closed ended questions first followed by a series of unstructured text fields. A unstructured text field was defined as an open-ended request for information about the child's illness and the parents' concerns. A closed-ended question was defined as a direct query with a finite number of a priori choices eligible for selection by the parent. All participants were shown the same number of total screens and the ordering of questions was the only differentiating factor. The medical subject matter included chief complaints of fever and vomiting with a total of 3 closed ended questions in addition to a unstructured text field which allowed parents to enter as much detail about their child's illness and their concerns as they wished. Outcomes of interest were the number of words entered in free text, time to completion of questions, and parents' preference for order ascertained by direct questioning after completion of tasks.

The third iteration built upon data from the first two cycles of testing. The medical subject matter included chief complaints of fever, vomiting, and respiratory complaints. This interface presented a series of closed-ended questions first for all electronic interviews. These screens were followed by one of two pathways - a) one unstructured free text screen or b) a series of four directed text screens inquiring about the patient's symptoms, past medical history, potential diagnoses about which the parent may be concerned, and questions the parent wanted to discuss with the clinician. We defined directed text entry as a screen that prompts the provision of specified information. Parents were alternately allocated to either pathway a or b. Following the electronic interview, the research assistant conducted a separate, verbal interview with the parent. This interview provided a comparison standard by which to judge the presence or absence of relevant past medical history, diagnoses of concern to the parent, and questions for discussion. Mechanics of data entry were further explored with parents' completing a paper-based questionnaire that surveyed their experience and comfort level with keyboards.

The fourth iteration of the interface design consisted of a series of closed end questions followed by one of two pathways to explore past medical history and potential questions parents' may wish to discuss with the clinician. Parents were alternately allocated to either closed-ended questions for these two historical topics or a series of directed text fields covering the same material. Every participant was also shown an unstructured free text screen in which he or she could enter general comments and concerns regarding their child's illness. Again, a separate verbal interview was completed to ascertain potential "false negative" entry of information.

Analysis was completed using SAS version 7.0 (SAS Institute, Cary, NC). Qualitative data was reviewed and thematic categories for parents' responses were established. Univariate testing used Fisher's exact test for categorical comparisons and Wilcoxon rank sum statistics for non-normally distributed continuous data.

Results

20 parents were enrolled for testing of the first iteration for the interface. Upon completion of the electronic interview made up exclusively of 2 free-text fields, parents were asked about the information that they entered.

Nine of twenty parents (45%) professed that they were simply trying to answer the question posed to them by the computer. One quarter of the parents stated that they entered less information than they would have given to the clinician verbally. A bias in constructing their responses was verbalized by one quarter of parents who stated they answered in a way "that the doctor would want." Interestingly, six of 20 parents (30%) cited competing influential factors which governed their entry of data; 3 parents wanting only to provide limited, important elements and the other 3 parents desiring the inclusion of all pertinent details regardless of import. An additional 15% of parents reported that they entered data into the free text field with a specific ordering scheme based on perceived importance of the information.

When queried regarding the format they would prefer, parents provided no clear consensus. Nine of 20 parents (45%) stated that they would have preferred closed-ended questions. Six of 20 parents (30%) liked the unstructured text option the best. Four out of the 20 parents (20%)

wanted both choices and one parent endorsed short answer questions as their optimal format.

Twenty-two parents completed the second iteration of the interface, which studied the effect of question order.

Twenty of 22 parents (91%) reported a preference for closed-ended questions to be presented prior to unstructured text screens. Parents reported that unstructured text entry after closed-ended questions allowed them to summarize their concerns, that less information had to be typed using this order, and that it was less stressful to answer closed-ended questions first.

In quantitative analysis, the ordering of unstructured text and closed ended prompted a mean number of 18 words when the unstructured text screen was shown first and a mean number of 30 words when the unstructured text screen was shown after the closed-ended question (p=NS). Time to complete the electronic interview did vary in that the group of parents who were presented the unstructured text question first took an average of 1 minute longer to finish, although this difference was not statistically significant.

The third iteration tested directed text entry against unstructured text entry as a means to prompt parents to enter relevant observations and concerns. A total of 20 parents completed this phase.

Eleven subjects entered diagnostic concerns into the computer and an additional 4/20 parents reported diagnostic concerns on verbal interview. Five subjects entered questions for discussion into the computer with an additional 6/20 parents reporting questions on verbal interview. For past medical history, 5 subjects entered information into the computer. An additional 8/20 parents only reported this information with verbal prompting.

We further examined this data to explore whether initial group assignment explained the lack of information entry by computer that was subsequently verbally reported to the research assistant. For past medical history, 7of the 8 parents who only reported information verbally were assigned to the unstructured text only screens (p=0.02)

The directed text entry format did increase parents' entry of questions for discussion. No parents in the unstructured text only pathway entered questions and 5/10 parents in the directed text field entered interrogatives (p=0.03). No significant increase or decrease in entry of information for other types of information was noted with the use of directed free text.

Actual keyboard use and parents' self report of comfort and experience with keyboards did not predict entry of data across the categories of past medical history, questions for discussion and potential diagnoses about which a parent was concerned.

The fourth and final interface was tested on a total of 54 subjects. Entry of information via closed-ended questions for past medical history and questions for discussion compared to directed text entry was examined.

Twenty-one of 54 parents reported past medical history during the verbal interview. Directed text entry prompted entry of information from 7/11 respondents (sensitivity=63%). In comparison, the closed-ended question format prompted data entry from 9/10 respondents (sensitivity = 90%) [p=.31].

Thirty-one of 54 parents reported questions for discussion during the verbal interview. Directed text entry prompted entry of this information from 9/18 respondents (sensitivity =50%). In comparison, the closed-ended question format prompted data entry form 11/13 respondents (sensitivity=85%) [p=0.06].

To explore the increased entry of information using forced choices compared to open-ended responses, which required typing, a secondary analysis was completed which compared participants' self-reported comfort with writing in English to their entry of information into the computer. No statistical significance could be attributed to the influence of self-reported comfort with writing.

Discussion

Optimal capture of medical information from patients requires a structure for data entry which preserves the patients' professed desire for informational control. This open-ended approach must be balanced against the ergonomic and cognitive demands which unstructured text entry places upon a potentially stressed patient in the urgent and acute care settings. The series of qualitative and quantitative experiments we conducted affirm the benefits of providing direction and structure to a patient-oriented electronic interview in order to maximize the entry of relevant data. The level of structure (directed text entry versus an a priori list of closed-ended choices) does influence the sensitivity of an electronic interview as a screening device.

The reasons behind why a patient does or does not enter information using an unstructured text format provide insight into what should be inferred from the entered text itself. The cognitive interviews we conducted with parents suggest that they are primarily focused on answering the question presented to them. However, the manner in which they answered the question varied widely, suggesting that diverse information-giving goals underlie the parents' efforts. An electronic interview that relies exclusively on unstructured text entry should ascertain these biases from the patient prior to data analysis to best inform the use of the entered data.

An electronic interview which includes both closed-ended questions and unstructured text screens should place the closed-ended questions first. The placement of closed-

ended questions prior to unstructured text was clearly favored by parents' subjective response in the second iteration of the electronic interview. The group who completed closed-end questions prior to unstructured text typed in more words and finished the electronic interview in less time. User-preference and performance argue for the same conclusion in this instance. [11]

There is a middle ground for data entry between pure unstructured text and closed-ended questions that we label directed narrative text. Directed text entry did improve the capture of past medical history for the child as well as parents' questions that they wanted to discuss with the treating clinician. That the benefit of directed text entry was not uniform across all three types of information studied (no improvement in document of specific diagnoses was found using this technique) reinforces the need for careful assessment of the pros and cons of a given structure for data entry.

No one structure for data entry provides 100% sensitivity for capture of specified informational goals. The final iteration of the electronic interview demonstrated a potential advantage to presenting patients with pre-defined choices in a closed-ended format. The benefit of more complete documentation should be weighed against the constraints that the forced-choice structure places upon the informant. For items such as "questions for discussion with the clinician," a closed-ended structure necessarily limits the potential topics to be covered. This result is at odds with the intent of the informational request, which is to ensure that the patients' agenda maintains a high priority for the clinician.

Ergonomic concerns must be considered as well when proposing data fields which require typing. Within the third iteration of the electronic interview, we examined the participants' self-report of familiarity and comfort level with keyboards as well as their demonstrated proficiency in using the laptop's keyboard as predictors for the entry of medical information. Neither parents' self-report or their demonstrated skill predicted data entry. This finding is limited by the relatively simple nature of the typing tasks studied.

Data entry requires both the skills of reading and writing if free text fields are included in the design of the electronic interview. A patient's comfort with writing may influence the amount of data which they input. As a predictor of data entry for the subgroup who answered directed narrative text, comfort level with writing did not affect the sensitivity of the electronic interview for data capture across the two types of information requested.

We believe our findings are strengthened by targeted study of actual patients arriving for care in an urgent care clinic. They represent a group of information-providers who must simultaneously supervise their ill child while providing information using a format to which they may or may not be accustomed. Human factors such as stress and environmental influences associated with the waiting room would be difficult to replicate in a usability lab temporally and physically separate from the care experience.

The findings we report are limited by several factors. The electronic interview was tested using only one language for entry of information, thus placing an additional burden on those patients for whom English would not be their first written choice for communication. Further, the patients were aware of the electronic interview as a research tool, and thus their responses may be either more or less accurate than if the interface was simply incorporated directly into the care process. This series of experiments was not sufficiently powered to demonstrate statistical differences for sub-analyses and formal conclusions regarding lack of difference would be inappropriate. Patients were not formally assessed on their proficiency in typing or in their literacy skills. However, we believe our testing provides insight nonetheless as we did provide observational as well as patient self-report data to account for these factors. Finally, our comparison of structures for data entry would have benefited from qualitative content analysis for the parent-entered information.

Conclusions

Optimal design of an electronic interview to capture medical information directly from patients will benefit from a mixed structure of directed narrative text as well as closed-ended questions. For historical or clinically-relevant items where a high rate of informational capture remains paramount, closed-ended questions will be preferable. Further attention to the ergonomic and literacy-related factors that may influence patients' entry of information is warranted.

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