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Design & Implementation of an Automated Questionnaire

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This paper describes a system which allows the patient to answer a structured questionnaire in private, at their own speed and without pressure using a touch-screen personal computer. A clinical report is generated immediately and used to help guide a clinician in a face to face consultation with the patient. Trials in a clinical setting have shown a positive response by both patients and clinicians.

Introduction

The *Smart Questionnaire* suite of programs supports the authoring and administering of structured clinical questionnaires. As well as providing a range of standard reports. Smart Q stores answers to questions in a standard relational database for subsequent analysis. The program runs in Windows on a standard IBM compatible PC. The suite is comprised of three personal computer programs: QAuthor, QAdmin and Q.

QAuthor is the authoring program. It is used to create questionnaires based on structures of multi-choice questions and also to define the rules for reporting, scoring and recommending actions based on answers to questions.

QAdmin is used to set up, monitor, and report on interview sessions using the questionnaires.

Q carries out the interviews in a clinical setting. It is intended to be used independently by the interviewee who answers the questions directly into a personal computer, using a touch screen. *On-line Help* files provide detailed support for users of QAuthor or QAdmin.

Example of use in clinical practice

The following description shows how the Smart Questionnaire was used in a preoperative Clinic.

Physical design

The automated questionnaire operates on a standard, IBM-compatible computer. To avoid the problem of computer phobia, the PC is disguised by the omission of identifying elements such as the keyboard and mouse. All interaction with the computer takes place on a touch-sensitive screen, where questions are presented and answered.

Simplicity of use is the key design element. The majority of patients can answer the questionnaire, at their own pace, without any assistance from nursing or medical staff. A series of questions are presented, one at a time on the screen, in a large bold font. The patient answers the questions by touching virtual buttons on the screen, immediately below the text of the question. When a virtual button is touched, the graphical representation of the button changes to simulate a physical depression of the button. The answer can be changed before moving to the next question, or the patient can go back to a preceding question to change the answer.

The patient sees a linear list of questions and no navigation is required, unlike some paper-based questionnaires (e.g. "if the answer to Q17 is "Yes" then go to Q23 page 4). In fact, the question set is a complex, branching, tree structure and positive responses to stem questions lead to further questions on the same subject. The question set has built-in redundancy so that patients are given several opportunities to volunteer information about certain conditions. For instance, a patient may answer "No" to the question about wheeze but later answer "Yes" to the question about the use of bronchodilators. A positive response to either of these questions triggers the same subset of questions about obstructive airways disease.

Which questions are asked depends also on the age, gender, body mass index and racial identity of the patient (to reflect the variation in prevalence of disease states with these factors), and the intended medical procedure.

Functions are generalised so any questionnaire can be created including a series, for example where the first few questions asked about interviewees are age, gender, rank etc. these can be used to gather data on a population of interviewees.

Components of software in Qadmin

Interview types

There are two types of interviews: the personal interview and interviews within a series. A personal interview is one in which the interviewee is identified by name. The interview administrator enters various personal details of the interviewee before a personal interview begins.An interview series is not really an interview at all. It is the template for a series of interviews in which the interviewees are unidentified. Such series generate statistical data for research purposes. Once the series is initiated, any number of people may be interviewed by the system without any further input from the session administrator.

Interview session whiteboard

The interview session whiteboard appears as soon as the program begins and remains visible while the program is running. A list of interview sessions is displayed on the body of the whiteboard. This list is either a Current Interview List or a Selected Interview List. A questionnaire is selected from a drop down list which includes all available questionnaires. The current interview list on the Interview Session Whiteboard contains every personal interview and interview series which are of current interest to the administrator. Interview lists can be selected by date, giving all interviews carried out on that particular date. Also a list may be selected by keying in the interview number or by name selection. Sessions can be set up as new, modified or viewed. The status of interview sessions in the Current Interview List may be 'Hold', 'Ready' or 'Finished'. The status of interview sessions in the Selected Interview List also may be 'Closed'.

Interview Registration form

The Interview Registration Form is displayed on the Interview Session Whiteboard. It is used either to create a new interview, or to view and modify the details of an existing one. The Form can also be obtained for an incomplete interview.

Interviewee details are used to identify the interviewee. demographic details (family name, other names, NHI (unique national health number), date of birth, gender, and ethnicity) plus weight, height blood pressure, and intended medical procedure. This data is used to help guide the line of questioning.

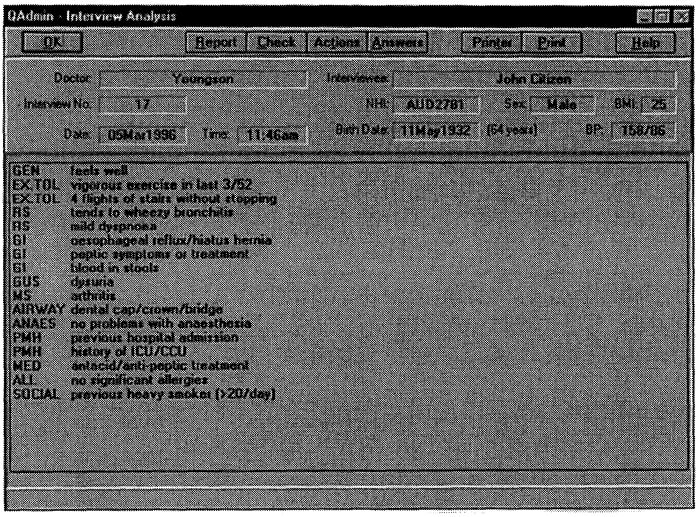

Figure 1: Q Admin Interview Analysis Screen

Medical Reports in QAdmin:
Clinical report displays the clinical comment associated with particular answers to questions in the questionnaire, grouped by category of question. It also displays the interviewee's score for each category as derived from the scores associated with an answer to each question. The reporting functions of the Smart Questionnaire calculate an overall score for each category from the answers given to questions in that category. To facilitate this, the "details" form provides the opportunity to specify a score to be associated with each possible answer to the question.
Inconsistency report gives warning of patients who are answering the questionnaire unreliably. A scoring system keeps check of the consistency of answers to questions on related subjects. For instance, if the patient answers "No" to the question about previous hospital admissions, then "Yes" to the question about major surgery, a logical inconsistency is detected.

Recommended actions report show action indicators which list clinical actions, the need for which may be indicated by the interviewee's answers to questions in the questionnaire. Answers Report lists each question that was asked and the answer that was given.

Q
Unlike the other programs within the Smart Questionnaire suite, Q is intended to be used without a keyboard. All operations can be carried out with a low resolution pointing device, preferably a touch-sensitive screen. It is used by the interviewee to answer questions displayed in turn by the program.

Selecting a questionnaire
The required interview is identified by asking the interviewee to confirm their name which should be presented on the screen of the terminal to which they are directed.
The questions can cover all of the subject matter of a comprehensive medical history. However, a positive response to a stem question triggers only a limited exploration of a given symptom or event, much less detailed than the searching inquiry of an experienced clinician.

Because the process is fully automated, and patients must answer every question presented to them, the automated questionnaire is a very effective screening device.
The question set is organised under the traditional headings of a medical history. Subject matter includes general health and mobility, exercise tolerance, social history, a detailed review of systems, major medical events such as hospital admission or intensive care, important medications, allergies, and screening questions to identify common diagnoses e.g. hypertension.

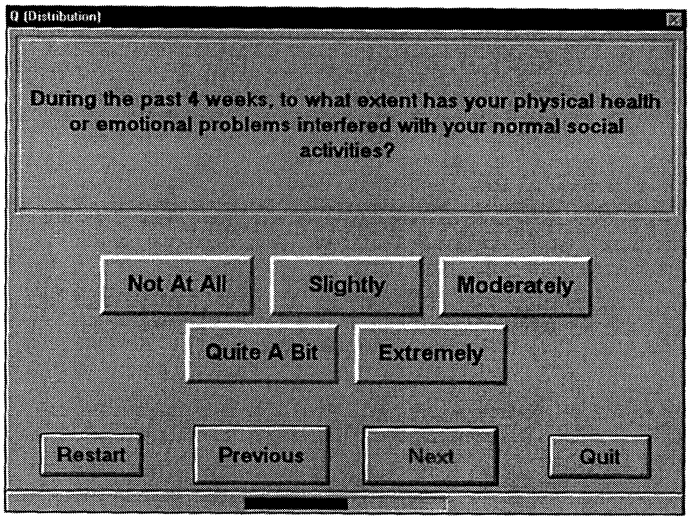

Figure 2: Q Display Screen

Running the program
Q is intended to be run on one or more terminals on the same network as the terminal used by the interview session administrator. Once started, Q is intended to run continuously. When one interview is completed, the program sets itself up for the next. Personal Interviews and Interview Series may be inter-mixed. The operation of the program is self-evident. All questions are multiple choice (up to 12 answers to each question) with the valid answers automatically presented on the face of the appropriate number of large pushbuttons. The program is intended to be run using a touch-screen, but can also be used with a keyboard.

QAuthor
The questionnaire authoring worksheet appears as soon as the program begins and remains visible until the program ends. The worksheet is used to create and modify all aspects of the questionnaire.

A menu bar gives access via drop-down menus to the functions of QAuthor. A tool bar gives direct access to the main functions. The questions comprising the questionnaire itself are displayed on the body of the worksheet. Advice, guidance and progress information are accessible as necessary. A questionnaire is loaded automatically when QAuthor starts if the code for that questionnaire is requested. An existing or new questionnaire is available through selection from a drop down list or combo box.

The medical screening questionnaire must be designed carefully using tools provided by QAuthor. Principles of a good medical screening questionnaire are clear, simple language, logical links between questions, inconsistency checks, algorithms for actions are independent of the software which allows these functions to be undertaken.

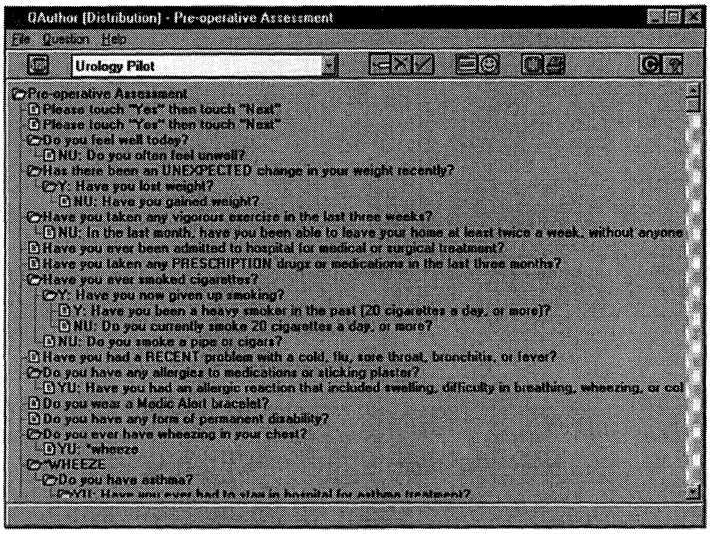

Figure 3: Q Pre Operative Assessment Screen

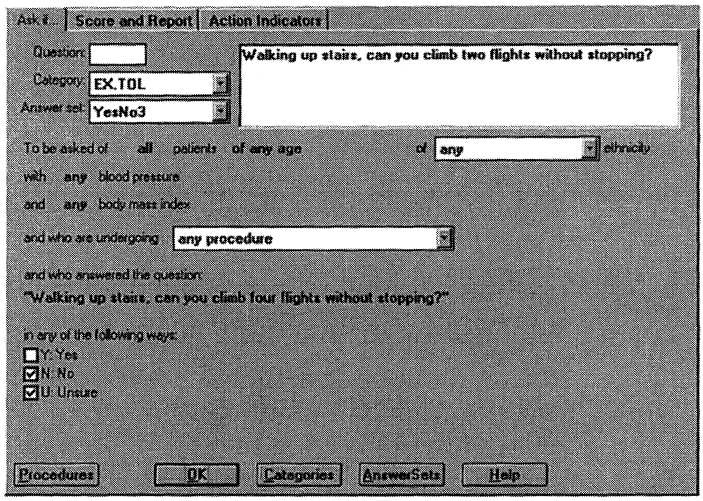

Figure 4: QAuthor Decision Screen

Implementation in a pre-op clinic.
The system is set up in the clinical area where the patient and health professional meet. Computer phobia has been identified as a potential problem with computerised questionnaires and Q has been designed to be operated using a touch screen. To put the patient at ease only the screen in a frame is visible. Keyboard and central processing unit are removed from sight. The person responsible for the QAdmin function has access to a computer with keyboard and mouse.

Training the clinicians.
The SmartQ system is very user friendly. The training can be done through the On-line Help provided by the system for the Author and Administrator.

User Documentation.
An information and set up pamphlet provides an initial overview of the system. "Quick Cards" are available as a quick reference tool in all areas of the system.

Clinical trials of automated questionnaires in preoperative assessment
The only substantial body of recent work on the subject is published by Roizen[1],showing that patients respond very positively to an automated questionnaire. 97% of patients who could read English completed the questionnaire without inconsistencies The automated questionnaire is as reliable as a personal interview. Comparison of the automated questionnaire with personal interviews showed the same discrepancy rate (3%) between patient's responses that occurred with repeated personal interview using the same questions[1].
The automated questionnaire is better than anaesthesiologists or surgeons at predicting abnormalities in laboratory test results [2].

Results of Clinical Trial
Patients used the system easily, and to our surprise, none of the patients displayed 'computer phobia' and all answered the questionnaire without supervision. The time taken to answer the questionnaire varied between 6 and 28 minutes. The patients who gave unreliable answers were identified by an "inconsistency report". Reliability checks detect confused patients (inconsistency scores, number of "Not Sure" responses, time taken to do interview).

The automated selection of tests substantially reduced the number and cost of tests compared with the previous ordering patterns. Smart Q saved clinicians valuable time while proving highly cost-effective.The software provides a highly effective screening process which enables the patients requiring priority care to be identified early.

Summary
This paper has identified an opportunity for patients, in their own time and at their own speed, to assist the clinician to assess the state of their health. The resultant operational experience has enhanced patient trust in the health providers while releasing the clinician for premium use of available consultation time.

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