ABSTRACT

Background: By self-reporting outcome procedure the patients themselves record disease symptoms outside medical centers and then report them to medical staff in specific periods of time. One of the self-reporting methods is the application of interactive voice response (IVR), in which some pre-designed questions in the form of voice tracks would be played and then the caller responds the questions by pressing phone's keypad bottoms. Aim: The present research explains the main framework of such system designing according to IVR technology that is for the first time designed and administered in Iran. Methods: Interactive Voice Response system was composed by two main parts of hardware and software. Hardware section includes one or several digital phone lines, a modem card with voice playing capability and a PC. IVR software on the other hand, acts as an intelligent control center, records call information and controls incoming data. Results: One of the main features of the system is its capability to be administered in common PCs, utilizing simple and cheap modems, high speed to take responses and it’s appropriateness to low literate patients. The system is applicable for monitoring chronic diseases, cancer and also in psychological diseases and can be suitable for taking care of elders and Children who require long term cares. Other features include user-friendly, decrease in direct and indirect costs of disease treatment and enjoying from high level of security to access patients’ profiles. Conclusions: Intelligent multilingual patient reported outcome system (IMPROS) by controlling diseases gives the opportunity to patients to have more participation during treatment and it improves mutual interaction between patient and medical staff. Moreover it increases the quality of medical services, Additional to empowering patients and their followers.

Key words: Self Reports, Patient Participation, Chronic Diseases, Interaction, Interactive voice response

1. INTRODUCTION

In recent years patient-reported outcomes systems have been designed and implemented for the sake of giving patient more chance to participate in managing cares (1). Throughout the process of self-reporting, it is expected to have the patients, record their disease symptoms outside care center and then report to medical staffs in specific time periods. Such reports can be either improvement or aggravation of symptoms like nausea, vomiting and tiredness or psychological disorders (2, 3). By the progress in technology and ease of access to care tools inside home, patients are able to measure some clinical parameters such as blood sugar, or analyze urine using test taps, etc. Then they can report the measurements to medical staff using self-reported procedure (2). Recently there is an increasing trend to use novel methods such as computer based technologies to promote health and participation of patients in terms of assessing and management of their own diseases (3, 4). Using these methods it is now possible that, patients directly send digital reports about their disease to medical staffs. Patients-reported outcomes process can have different form like paper based questionnaires that patients give answer using pen or computer-based questionnaires in which patients use Internet to transfer response or it can be voice questionnaires that gets the responses by IVR (5). Studies show that people respond more and honestly in computer based systems than face to face interviews. They are also more eager to use the former type (6). IVR is a computer-based telephone system in which we have a sequence of pre-arranged questions that are played
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in sound format and calling individual responses by digital bottoms of phone (4, 7). Today, IVR is applicable in various industries. For instance in banking systems IVR is used for telephone banking, automatic payment, banking cards activation, customers access to information like account info, balance or money transfer. Moreover, in big corporations it is used in automatic response, voice mailbox, fax, call divert and orders recording. At the beginning, applications of voice response were only restricted to industries, education and banking (8). But, recently, we can see its presence in healthcare. However, published documents suggest the first IVR application in the health care dates back to the early of 1989 in United States. From 1994 onward, published articles regarding the technology are rapidly increasing. It is obvious that health industry is eagerly trying to discover and develop health promoting technologies (9). Contemporaneous to electronic government, the number of telephone banks in Iran has been increased remarkably. Almost in Iranian organizations and corporations, voice response system is used for operations such as automatic payment, cards activation, complaint recording, appointment reservation, hotel reservation, predicting weather and etc. In education, it is used for getting informing about unit (credit) selection date, unit omission or supplementation (adding and dropping) or examination dates. Investigations about telephone back applications, however, show that it leads to low costs, time saving and customer’s satisfaction and loyalty. But voice response application in Iran is only restricted to prescription services (physicians record recipe and then patients listen to it from anywhere), recipe order from pharmacy by drug codes, reminding patients to see the doctors on time and buying medicines, visit canceling or booking an appointment (8).

1. Global Application of IVR

IVR in health care has been widely used all over the world. Up to now there are many studies regarding the effects of voice response in health. Studies about monitoring the symptoms in cardiovascular patients (10), phone reminding of child vaccination (11), automatic reminder to attending tuberculosis clinics (12), monitoring diabetic patients (13), cholesterol lowering programs (14, 15), private HIV diagnosis test (16), irritable bowel syndrome monitoring (17), hepatitis B risk evaluation (18), evaluation of psychological conditions (19-21), evaluation of breast cancer (22) risk and chronic pain reduction (4). Most of the IVR applications go back to daily check of activities such as programs for quitting smoking, alcoholic drinks and drugs abuse, and monitor of psychological disorders like anxiety, depression and obsession. One of the important characteristics regarding the IVR technology is the privacy and anonymity of the caller. This feature helps to apply it in diagnosis of behaviors and sensitive diseases like HIV. It provides a safe ground for those who avoid medical centers because of their disrepute diseases. Moreover, IVR can decrease shyness among patients with psychological conditions and increase their participation (9, 23). The IVR technology provides the safe, private and comfortable communication from home to care center. This technology is the best way for elderly people who are vulnerable and can’t go to care center regularly. The studies show the technology increases patient’s satisfaction and their tendency to use it for self-management and self-care purposes. After discharge of patients from hospital it can also be regarded as a cheap way to maintain communication line between patient and care providers (6, 24). It makes therapeutic interventions in real time before the disease reaches to critical condition (1). It also helps physicians to detect patients’ needs and design therapeutic goals and plans (2).

The users don’t need any kind of academic knowledge and skills to use the technology and even low literacy individuals can easily cope with it (24). The technology is beneficial to both, caregivers and patients. Some advantages to the patients are: simplicity of use, 24 hours access to medical care, success in self-care and self-control, honest reporting of disease condition, saving in direct cost (like traffic) and indirect cost (like time), etc. For caregivers it also has advantages such as: decrease in data gathering costs, more valid data (because patient will report its diseases condition truly in privacy), decrease in occurring medical error compared to traditional methods like paper reporting, daily monitoring of clinical indicators and providing timely medical interventions (1, 2, 4, 7). Also when caregivers give feedback of what happened during IVR reports, these feedbacks motivates patients to have more cooperation and participation. Carried out studies reveal the facilitation of interactions, discussion and conversation between physicians and patients in their appointments by the time they use IVR technology (24).

1.2. The future of Interactive Voice Response in Iran

IVR can be administered in Iran. Because almost 70% of Iranians have cell phones and telephone lines in their own home. Even in the villages people have access to telephone (25). In 2011, individuals under 35 years comprised almost the half of Iranian population. In upcoming two decades, the age structure of the Iranian population will change from reductions of young population toward notable increased numbers of older. It is expected that the changing structure of population can change the epidemiological profile of disease and society and will shift burden of diseases toward chronic diseases such as cardiovascular disorders and cancers (26). There is not any kind of support regarding diseases self-management using IVR technology in Iran. In addition, we witness the change in disease patterns and their tendency toward chronic problems. Therefore the need to have IVR system seems to be highlighted considering the facts that knowledge level is increasing and there is public availability of telephone systems.

The present study explains the main framework for designing of multilingual self-reporting voice response system that is designed and carried out for the first time in Iran.

2. METHODS

2.1. IMPROS includes

A) Hardware

All the main activities are controlled by a computer. In this project we used Microsoft Windows platform because of its widely availability and programming language used for developing software part of the project. Using a modem, the computer communicates to the outside. There is a variety of modems in market that are classified based on speed of data transfer, sending and receiving data, faxing and voice. In this study we used a modem with voice capability. Voice modem receives incoming calls automatically and plays recorded
voice massages. Some modems only have one port while others have several ports that can attach to several analog or digital phone lines. Digital lines can transfer specific information when patient pushes numbers on phone keyboard. Here the phone should be switched to tone mode.

B) Software

IMPROS software acts as an intelligent control center. It can record all call information and monitor calls and incoming data.

C) Various kinds of information are recorded in system that are:

1) Patients' demographic information

Information refer to general issues such as: patients name, surname, gender, education, default language, living place and type of residence, physicians name, age, type of insurance, phone number, type of disease and care, etc. After the registration system gives each patient an identification (ID) number and a password. ID number can be the number of patients profile or it can be the number of called phone line in order to be memorized easily.

2) Medical Staff Information

Nurses are as default medical staffs who work with IMPROS. The selected nurse should have enough knowledge about patients and be able to analyze statistical charts and information obtained from patient reports. The medical staff has the responsibility to follow-up patients periodically and to monitor symptoms that are reported by patients. On the case of complexity or a case beyond the knowledge of medical staff, he/she should refer patient to physician. The staff's primary information (demographical information) such as: name, surname, educational certificate and patients' list are registered in system. A unique user ID and a password would be given to medical staff to use for logging into system.

D) Training

Every instrument needs its own special training. Therefore all patients and medical staff involved in the project would receive through training courses before and during use of IMPROS. Also educational pamphlets and booklets will be provided for both patients and medical staff.

E) The Logic behind System Function

IMPROS is designed in a way to play welcome message in all predefined languages (including Persian, Azeri and other local spoken languages). Then it is supposed to automatically recognize the calling individual. The software, being supported by an existing caller ID technology, recognizes the calling person if the called number is registered in patients' medical profile. But in the case if different phone number is used, the system requests user ID and password. After successful identification process, the system plays welcome message by patient's default language. For instance, regarding the selection of his native language, if patient had chosen Azeri language during registration, then each time he logsins to the system, it would play welcome message and all questions would be in Azeri language. If a user prefers to change into another language then he can change the default language by pressing the specific bottom on phone's keypad and remaining massages and questions would be played by chosen language.

Patient's full name is the initially played massage. Here the aim is to show and guarantee the patient the correct functionality of the system. By doing so, the patient is ensured about well sequenced arrangement of passed stages and also he becomes certain about the correctness of previously recorded personal information. Then, IMPROS plays questions according to the patient's type of disease and it waits for the response at the end of each question. It should be mentioned that if the response intervals would be lasted for more than 10 seconds, IMPROS would ask the question again supposing that patient did not understand the question. If it would not receive any response, IMPROS considers it as the renunciation of patient or error in communication. Then it plays farewell massage and ends the call ultimately. Responding to all questions by user, is the pre-condition to successful end of self-reporting procedure and if the procedure of data recording would be interrupted by any reason or the user doesn't respond on-time (10 sec for each question) then IMPROS will erase record of this uncompleted call and it's expected that patient has to call again. The credibility of every given data would be compared by its normal range of values. If the presented data would go further from its maximum or minimum level, by playing alert massage related to invalid response, IMPROS asks user to enter his measured value again. IMPROS has a rationalistic intelligence. It dose simultaneous real time processing according to pre-defined values. In the case of difference between given responses and standards of disease treatment, at the end of questions, according to data analysis, an alert massage would be played. The range of such massages is started from simple massages such as short term measuring of vital signs and calling again or more urgent massages like immediate referring to medical centers. Medical staff in charge of patient's treatment is expected to regularly log into the system and nearly analyze patient's present condition. The procedure is in a way that: at first he logsins the system by unique ID number and password then he chooses his patient. Then he checks disease signs and care items (depend on type of disease, it can be obtained per day or per week). Here the medical staff function is divided into several categories:

- If patient does not call on pre-defined schedule or if a problem emerges during treatment, the nurse will call the patient and does the follow-ups.
- If declared values show that patient's clinical conditions get worse, the nurse immediately calls him and directly asks about more information.
- If disease symptoms are in expected range and it can be understood that patient is in good condition then there is no need for additional interaction from medical staff.

2.2. Questions Package

A specific section inside IMPROS is allocated to a collection of groups of questions about diseases and different methods of cares. Experiences show that these questions can be similar in many kinds of diseases and cares (such as measuring temperature). Regarding diseases type and expected treatments and in order to facilitate managing treatment and also creating software logic, the questions are grouped in form of specific packages. For each disease in each question package a specific time schedule is defined and during that time period all the questions in the package will be asked from patient. Moreover from one call to another, these packages will be changed.
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For instance, a child with infection in upper respiratory system is considered to be monitored everyday up to 10 days by IMPROS. The information about general conditions (including consciousness, appetite, nausea, vomiting, temperature and heart rate) is classified under general condition question package. The information about respiratory condition (such as respiratory rate, coughs, mucus) is classified under respiration package. Regarding this patient, we choose questions about body temperature from general package and we choose respiratory rate, coughing and mucus from respiration package. Child’s mother or his other caregiver calls the system based on predefined schedule and enters measured values in respective manner. (Figure 1 shows designed questions algorithm and Figure 2 depicts pattern of question package design). In fact it is the duty of medical staff to define packages, questions group and design administrative sequence of packages under the supervision of related physician.

2.3. Reports

A part of IMPROS is allocated to reports. After that the patient enters data, the system automatically draws results of disease treatment to medical staff in the form of diagrams and tables. Reports can be extracted under three categories:

Management reports: Parameters such as system usage (the way in which system is used), both successful and unsuccessful calls, order and sequence of patients’ calls and values about control of diseases for each patient are extracted in the form of management reports. Reports about which social and educational levels, genders, living places (city or village) and disease types use the system frequently are also included in managing reports. Such reports are results of collective data and the patient’s name is not mentioned for privacy reasons.

Another kind of reports is about the performance of software itself. The percentages of errors occurred during login process, incorrect responses, moving to next question without giving a correct response to previous one, number of repeated questions after 10 seconds of waiting for response and the number of alerts played by system is among this kind of reports. These reports help to improve and further develop the system.

Other reports are about disease progress and its treatment. By selecting patient name, the sequence of reports about his situation, including its treatment and its side effects can be viewed.

Figure 1. It shows designed questions algorithm

Figure 2. It depicts pattern of question package design
treatment in a determined period of time can be extracted automatically. Reports are presented in the form of diagrams and medical staff can see normal and abnormal points in the form of highlighted spots. Regarding the kind of variables, reports are presented in terms of tables for qualitative variables and diagrams (for instance pie, bar and line chart) for both qualitative and quantitative variables (Figure 3 shows instances of diagram).

Figure 3. It shows instances of diagram

3. RESULTS

Capabilities and characteristics of system are as follows:
A) Hardware capabilities

From the beginning, IMPROS is designed in a way that it is capable of being administered on common computers. It needs no complicated hardware. It uses cheap and simple modems which are available in the market. It supports several modems that are installed on one computer. It also makes possible to have several calls at the same time.

B) Software

IMPROS makes it possible to design questions in a way that they have an administratively logical order (it means that there is a logic behind their sequence of administration). It also makes possible to have appropriate responses based on input data which altogether form software intelligence. One of the main advantages of the system is its high speed in obtaining users responses. Here the average time period for a patient to response all questions is about 10 minutes in each call.

C) System use

Even low literacy people (those who can only read and write) can interact with the system in easy way.

D) Extensive range of diseases

IMPROS is designed to promote homecare with the direct supervision of medical staff. Thus this system can monitor an extensive range of diseases such as chronic diseases (diseases that need long term treatment especially among elders and children), cancers (for instance breast and blood cancers), cardiovascular diseases, nutritional treatments, diabetes, medical cares during pregnancy, neonatal care (for instance reminder for vaccination, controlling fever and seizure) logical use of medicines, psychological diseases and in general diseases with average severity.

E) A user friendly software

IMPROS is designed in a way that makes it possible for users and medical staff to learn its functionality in a short period of time. To have user friendly software was a high priority regarding the design of this system. It can be even learned when the patients are waiting in care centers just by means of software modeling, face to face education and training booklets. Designing questions and integrating them in the form of questions packages and the way by which the patients would be followed up and monitored can be taught to medical staffs within few hours.

F) Costs

By application of this system, great bulk of direct and indirect costs of medical care can be reduced. Direct costs such as visit payments, consulting, transportation and hospitalization costs and indirect costs like leaving job, time, energy, etc. can be saved. Even a single medical staff can manage several patients at the same time thus it can reduce cost of services and increase efficiency.

G) Staffs (human resource)

Based on the number of patients, one or more nurses are enough to care and follow up them in time periods. A technical operator is also needed to guarantee the appropriate functionality of system, backing up of data and also maintaining and repairing the system. Therefore according to the structure of the system, if medical staff is familiar with computer and software maintenance, all of the above mentioned duties (medical and technical) can be handled by one individual.

H) Information security

IMPROS has two levels of security for users and medical staff: If the patient calls by phone number which is not registered, the system immediately asks him to enter his ID and password. If another person finds patient’s login ID and password when calls the system, IVR doesn’t give any information about patient’s therapeutic and personal information. It only asks designed questions from questions packages which was supposed to fill in be original patient.

There is a defined level of accessibility for each medical staff. Everyone by his own unique ID and password can see his patient’s profiles. However they cannot transfer, extract or print patients’ information from the software. Data are exclusively depicted in the form of diagrams and tables. Software is totally off-line and cannot be accessed from the web.

4. CONCLUSION

Today, digital phone lines are available in almost cities and villages. Most of the people need no prerequisite knowledge to work with phone. IMPROS can be easily applied in wide range of medical centers. Medical staffs, therefore, will have more time to evaluate and control the diseases and will have more accurate interventions in real time periods. IMPROS actually prepares a ground for patient’s active participation in his treatment. It also improves mutual interaction between patient and medical staffs and ultimately improves the quality of health services.

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Abbreviations

IVR: Interactive voice response, IMPROS: Intelligent multilingual patient reported outcome system, ID: Identification.
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