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Development and implementation of a computer-generated "virtual" patient program

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Abstract

Authentic assessment of clinical knowledge can be undertaken using case studies. Individual clinical case-study assignments for undergraduate pharmacy students have been developed using a purpose-designed computer program with "virtual patients" to whom a clinical scenario can be applied. The computer program contains over 200 virtual patients constructed using a defined database of medical conditions, medications and personal characteristics. The database is flexible; new patients can be developed from existing data and medications can be added and removed. Clinical scenarios can be added to the virtual patients according to pre-determined criteria.

The easy-to-administer program has been used to generate up to 360 individual student assignments. Development of student-specific assignments decreases the opportunity for plagiarism. The development of this program has provided quick and easy access to a valuable database of standardised virtual patients that is used to provide authentic assessment for undergraduate pharmacy students.

Keywords: *Assessment, case-based, computer, pharmacy students, "virtual" patients*

Introduction

Case studies are a simulation of a real or life-like situation or scenario. They generally describe a patient and their symptoms, results of any investigations and the patient's observations of their own condition and history. The use of case studies encourages critical thinking about clinical situations rather than memorising facts alone (Wass, Van der Vleuten, Shatzer, & Jones, 2001b).

Using case studies for assessment of clinical knowledge allows learning to be assessed in an authentic context (Maclellan, 2004). This method of assessment can be used to provide both formative and summative assessment. While the use of real patients for assessment may be beneficial, (Dammers, Spencer, & Thomas, 2001) large class sizes usually preclude their use because of the numbers of people that need to be sourced, trained and managed. Standardised or simulated patients, who may be real patients who have been trained to respond in a certain manner, or actors who are trained to respond to certain questions or prompts, can also be used, however the training required varies according to their expertise and may be extensive and therefore time-consuming. There is therefore a considerable cost involved in their training and use (Gates, Fitzwater, & Telintelo, 2001). The amount of time spent developing cases and the complexity associated with assessing the task can be prohibitive (Gates et al., 2001; Wass et al., 2001b). Training, extended patient-examination sessions or visits by multiple students may also place an unfair burden on real patients (Wass, Jones, & Van der Vleuten, 2001a).

In 2002, a manually administered case-based assessment program was introduced for undergraduate pharmacy students at the Victorian College of Pharmacy. The assessment required students to respond to a scenario describing a clinical problem that had been manually applied to a standardised patient. The scenario was allocated to the patient by

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reading each patient's details and assigning an appropriate scenario according to their current symptoms, disease states or age. Scenarios were allocated to more than one patient, but because the patient history was unique, the assignment was always different. This not only provided diversity of learning but also decreased opportunities for plagiarism. The process of allocating scenarios to patients and then allocating patients to individual students was labour intensive for class sizes in excess of 200 students.

Although the case-based assessment process had obvious disadvantages associated with workload, the creation of a unique assignment for each student using an individual, standardised patient with an allocated clinical scenario made persisting with this form of assessment worthwhile. To enable it to be retained, while decreasing the time commitment required for its management, computer experts were enlisted to develop a computer program to automatically allocate scenarios to patients and to create a user-friendly interface for data fields containing the relevant patient information, allowing the development of a range of "virtual" patients. This paper describes the program that was developed, its operation and implementation.

Method

Computer programming experts from within Monash University, Australia were employed to develop a computer program so that students could select an individual patient from a list of standardised "virtual" patients, and to allow a clinical scenario from a selected series to be applied to each patient. It was also determined that students should be able to retain their patient so that a further scenario could be added at a later date for other undergraduate units. The programmers were provided with a list of specifications for inclusion in the program. These specifications required that program users had the ability to:

- add and edit data
- allocate additional scenarios to patients
- add scenarios from a range of clinical areas
- view patient's scenario allocation details by class grouping
- view patient–student allocation details
- provide students access to the patient list
- delete existing allocation records at end of semester or course.

Four databases (medications, medical conditions, test results, allergies) were developed to hold the majority of the required patient information. Other fields with a more limited range of information (i.e. male–female gender, smoker/non-smoker, age) were also developed. The parameters for patients were developed as a result of a prior assignment that required students to source a patient during a clinical patient. Review of these patients informed the development of virtual patients for appropriate numbers of medical conditions suffered by people with chronic disease and average numbers of medications taken.

Each of the databases was originally empty and information was entered to create a repository of data for constructing standardised virtual patients. All the data fields were accessed to construct individual "virtual" patients with the following details defined:

- patient demographics (randomly allocated first name, age, gender, smoking status, allergies)
- medical conditions (up to four chronic conditions)
- medications (up to six regular or "when require" medications)
- results of relevant pathology tests that can be individualised for each patient
- allergies including a description of the nature of the allergic reaction
- smoking history including past smoking history (packs per day, when quit, etc).

Brief scenarios describing common problems from two clinical areas (22 respiratory, 23 dermatology) prepared by a clinical pharmacist and reviewed by a range of pharmacy practice academics were added to the program. An additional 50 general scenarios, prepared by two clinical and academic pharmacists have since been added. The scenarios, of about 100–200 words, are randomly allocated to patients in the database according to a set of pre-determined criteria, such as age, gender, existing medical condition or medication. These criteria were set at the time of writing the scenario to accurately represent the population who would be expected to suffer from the specific condition. Set criteria included age, required or excluded disease state and smoking history. The smoking history criteria was important as some conditions (e.g. chronic obstructive pulmonary disease) needed to be restricted to specific patients (e.g. older) with a positive smoking history. Setting limitations upon allocation was necessary to prohibit patients being assigned age- or gender-inappropriate conditions.

Results

A computer program has been developed that contains the required fields to allow over 175 medical conditions and over 300 medications to be added to the databases. This enabled the initial development of 200 standardised "virtual" patients, each of which has up to four medical conditions and up to six medications, an assigned gender, smoking history, some have a history of common allergies to food or

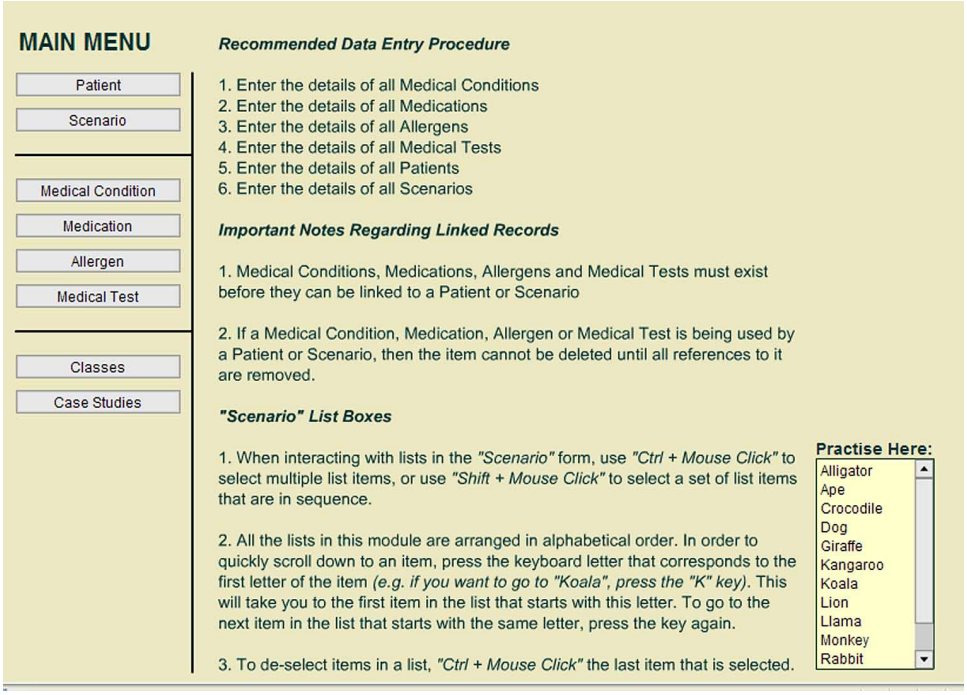

Figure 1. Main Menu screen: main administrator screen for virtual patient program.

medication (such as peanuts or penicillin) and some have test results (such as blood pressure or HBA1c readings) if appropriate. Extra patients have since been added to increase the database to 250 patients.

The program consists of three main access screens for data entry: Main Menu, Patient Browser and Case Study Maintenance.

Main Menu screen

The Main Menu provides access to the four main databases, the student classes and the clinical scenarios (Figure 1). The interface is user-friendly with a logical display. The Main Menu allows the administrator to undertake all the tasks required to administer and update the program.

Medication can be added to the data field using either generic or brand names, however generic names are preferred, and where these differ internationally, the alternative generic name can be included with the description of the drug's action. As much information as is deemed relevant can be included in the description of medication or medical condition, however, currently only brief descriptions of the condition are included to encourage students to undertake their own research in this area, but could be expanded if required. Students can only view information for the medications relating to their virtual patient. They cannot access the complete list of medication or medical conditions, and cannot make any changes to their patient or any of the related databases.

Patient Browser screen

The Patient Browser is more complex than the Main Menu (Figure 2). Virtual patients are created in the Patient Browser by adding a new patient name, and then allocating age, gender and smoking history to the virtual patient. Medical conditions are then selected and added to further compile the patient history, along with appropriate medications for treatment of the specified conditions and relevant test results. Doses and frequencies and other information relating to individual medications can be added to build a realistic patient profile.

Scenarios can be developed to reflect the level of knowledge of the student group or to cover specific topics to be covered or examined in the teaching unit. New scenarios can be added to a selected group of patients or developed about additional topics. For each scenario limits can be specified to restrict allocation of the scenario according to defined patient criteria. The age, gender and smoking history can be set to provide parameters for the appropriate allocation of the scenario. For example, a scenario intended to lead to a diagnosis of impetigo (school sores) will have age limits set so that it is only applied to appropriately aged children. Likewise emphysema is limited to patients over 55 years of age who have a history of smoking.

Case Study Maintenance screen

Clicking the "generate new case studies" button in the Case Study Maintenance screen randomly allocates

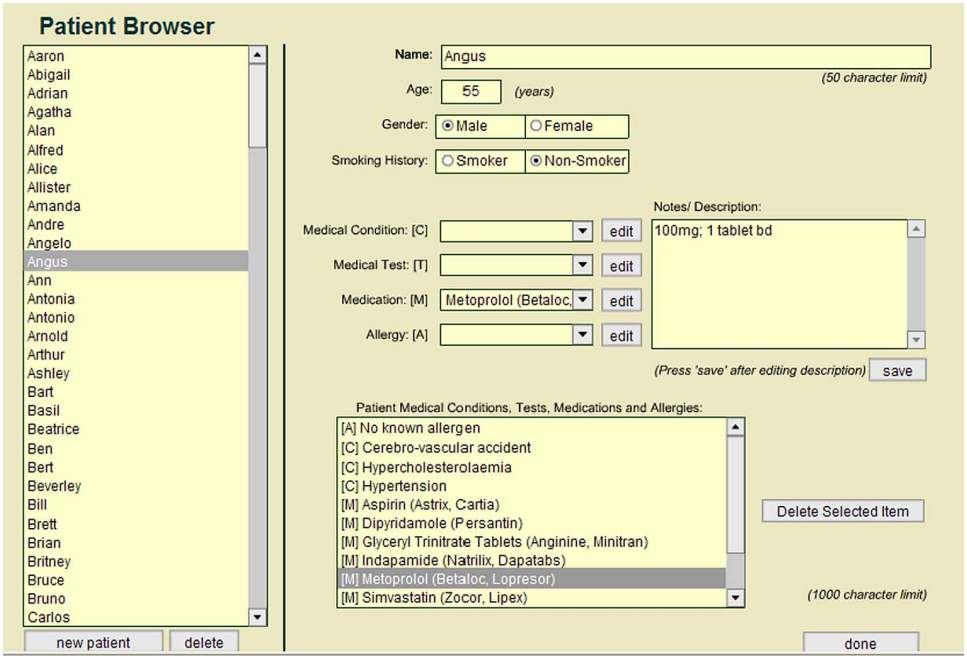

Figure 2. Patient Browser screen: virtual patient entry point.

selected clinical scenarios to all patients in the virtual patient database (Figure 3). This screen also allows the administrator to view the student–patient allocation and the scenario–patient allocation. To apply a group of scenarios to patients for a particular student group, a unique identifier is entered into the class list and the required group of scenarios (for example, dermatology) is selected. At this stage, if the patient is to receive a further scenario, the previous identifier for that class is selected and the patient remains allocated to the original student when the next scenario is allocated.

Students, who interact with the program via a different interface to the administrator, initially have access to the list of available patients, the patient's medical conditions and the patient's medication list (Figure 4). Virtual patients become unavailable for further selection once an initial student has selected

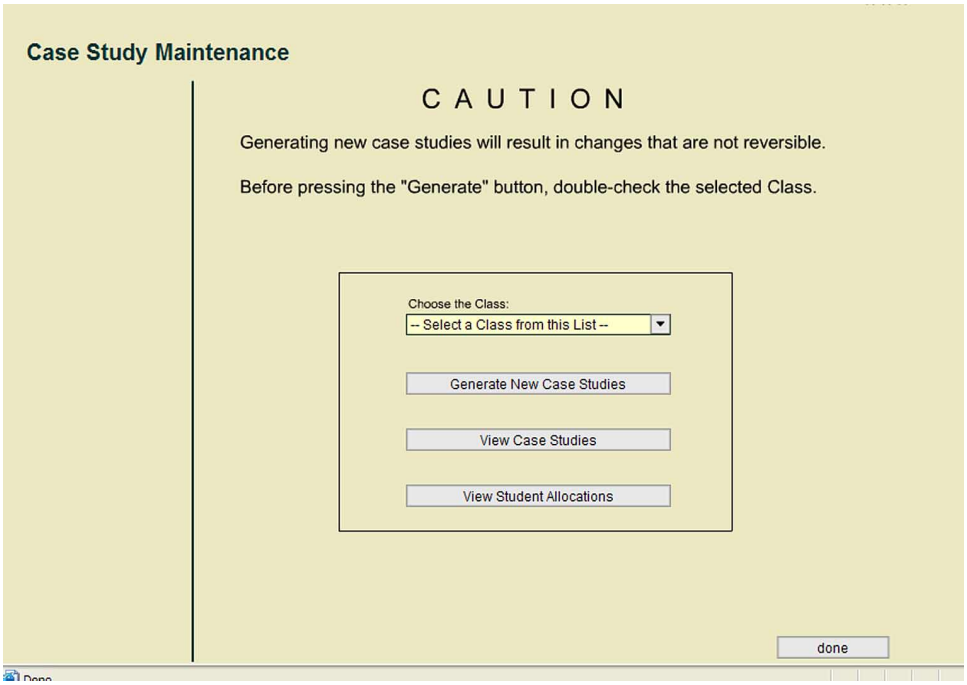

Figure 3. Screen for randomly allocating clinical scenarios to patients for a particular class.

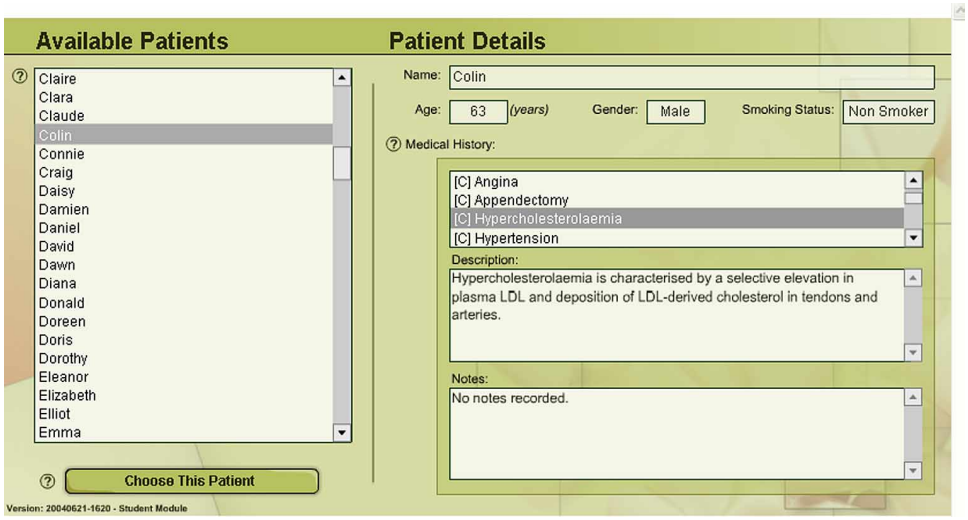

Figure 4. Student view of patient details.

them and are removed from the patient list. After choosing a patient, students can access the scenario that has been applied to that patient; they can only access their own scenario, not those of other students and are not able to make any changes, either to the scenario or to their patient details. Students can print the information regarding their patient and the scenario, or log out and revisit the site, repeatedly if desired, but on return visits they can only view their selected patient. The program is not used to submit assignments or grade students—its function is to provide student access to a virtual patient that is randomly allocated a clinical scenario.

Discussion

The use of this program enables an individual assignment to be allocated to up to 250 students in each of two year levels to assess applied skills in clinical pharmacy. The assignment that is generated as a result of this program assignment is multi-faceted in that it assesses the student's ability to make a diagnosis based on a set of symptoms, determine treatment appropriate to that diagnosis but tailored to an individual patient's needs, their ability to present this information clearly and concisely and to justify their decisions. Both formative assessment, in terms of tutor and peer feedback provided at the time of the case presentation and afterward using a formal feedback process and summative assessment in terms of a numerical mark assigned using a criterion-referenced assessment tool are provided to the student. The provision of formative assessment allows the student to improve their skills in clinical assessment and management and in case presentation over the course of four semesters.

The time required to manage the allocation of scenarios to the virtual patients has been reduced from 3 to 4 days when the program was managed manually to 30 min using the new computer program. The program has been used to generate up to 360 individual assignments at any one time without malfunctioning. When the assignment was released to students more than 100 students accessed the program and chose their patient within the first hour, indicating the capacity of the program to deal with high student numbers.

Plagiarism by university students is a widespread problem (Apiwan, 2003; Ng, Davies, Bates, & Avellone, 2003; Bates, Davies, Murphy, & Bone, 2005; Harries & Rutter, 2005). One of the suggestions that has been made to decrease plagiarism is to provide individual questions (or assignments) to each student (Apiwan, 2003). The development of individual assignments for each student using this program is therefore likely to decrease the opportunity for plagiarism. Even though scenarios may at times be allocated to a number of patients, the student's patients differ in their age, gender, medical conditions and medication; these criteria may affect the suitable treatment options for the allocated scenario making it difficult for students to copy from one another or "cut and paste" from other resources.

Virtual patients are easy to access and update for the teacher or tutor and provide an authentic context within which to assess the clinical skills of undergraduate pharmacy students. The different medical conditions assigned to each virtual patient allow students to explore a wide range of treatment issues and encourages them to exercise their clinical judgement in choosing treatment for patients with chronic illness taking multiple medications.

Limitations

The limitation of the program is that it is only able to provide information from a database of standardised patients and randomly allocate clinical scenarios according to pre-set criteria. It is not able to provide additional information concerning patients or their symptoms. Consequently, students are unable to ask the patient additional questions to confirm their diagnosis. Students are unable to submit their assignments via the program.

Currently the program is only accessible to staff and students at Monash University as it is located on a secure server. Plans are underway to enable access to the program to non-Monash academics at no charge other than providing information to update and enlarge the patient and scenario databases.

Conclusion

The development of this program has provided quick and easy access to a flexible list of virtual patients that is used to provide an authentic assessment assignment for undergraduate pharmacy students.

The potential to add to the data fields and the number of virtual patients makes it suitable for assessment of large numbers of students, with individual assignments generated for each student. The time required to allocate assignments to students has markedly decreased. This program, and the current patient list managed by the program, has the potential for use by other pharmacy schools or other health disciplines who could tailor the clinical scenarios that are added to the standardised patients according to their discipline needs.

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