Simprac – Teaching system for management of chronic illness

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Australia 2006

Abstract. Simprac is web-based medical case simulation for the diagnosis and management of chronic disease. Users have the opportunity to manage patients in the simulated environment over a series of consultations that vary based on the management plan selected at the end of each consultation. It has been designed with learner reflection as a central goal. This is supported by providing the learner with opportunities to review their progress at each consultation as well as at the end of a case compared to an expert or their own peer group.

1. Introduction

Simprac is simulation-based learning environment designed to run on the web. It tackles the problem of medical management of chronic illness. This is an important area of medical activity. Its very nature means that it involves a sequence of consultations. In the first such meeting, the medical practitioner needs to take a history and perform examinations. These provide a basis for a set of possible hypotheses for the underlying illness. The practitioner needs to request tests which can reduce this hypothesis space, especially taking care to exclude serious illness. At the same time, the practitioner needs to formulate a management plan which the patient should follow up to the time of the next consultation. At that time, the patient is reviewed, for several purposes, one of the important ones being to review the management regime and, if necessary, adjust it. With much chronic disease, there will be many consultations over a long period of time. This is typical in the case of such widespread and long-term illnesses as diabetes mellitus and cardiovascular disease.

A simulation-based teaching system is attractive in that it can give medical practitioners an opportunity to practice at their own convenience and in a short period of time. This can serve as an important complementary learning opportunity to be combined with the typical approaches that are widely used: rounds, educational meetings, conferences, refresher courses, programs, seminars, lectures, workshops, and symposia [1].

One of the worrying and striking observations made by Davis et. al. [1] is that traditional formal didactic continuing medical education (CME) had little influence on physician behaviour. At the same time, their work has provided inspiration for the approach taken in Simprac because they suggest that "interactive CME sessions that enhance participant activity and provide the opportunity to practice skills can effect change". In an important area like the management of chronic illness, we conclude that it is not sufficient to provide current information about best practice. This is true even for the case of adaptive hypertext that might be customised to the knowledge and learning preferences of the medical practitioners. It is important to offer an interactive experience.

2. Related Work

There is a considerable body of work on teaching medicine with the aid of simulations [2],[3]. Tellingly, it has also been used for assessment [4]. These are appearing as stand-alone simulations available on a CD-ROM as well as on the web. Actors have been used in research into medical problem solving by clinicians [5]. This offers a high fidelity simulation of a consultation. Our goal has been to identify the salient element of a simulation, capture these in our system and then enhance the whole experience by adding opportunities for learners to reflect and abstract.

Friedman [6] has provided an excellent outline of the features to be considered when developing a computer based clinical simulation. Combining this with the description by Melnick [7] of the system used by the American National Board of Medical Examiners (NBME), a minimum feature set can be developed. Briefly, we can summarise these as:

- Menu vs. Natural Language Requests for Data
- Interpreted vs. Uninterpreted Clinical Information
- Deterministic vs. Probabilistic Progression
- Natural Feedback vs. Instructional Intervention
- Scoring
- Single v multiple consultations

In these terms, Simprac offers limited natural language interaction with the practitioner being able to question the simulated patient in natural language. The clinical information is not interpreted. At this stage, the system is deterministic and it provides natural feedback in the form of the patient's progress and state of health. Rather than employ a scoring system, Simprac has been designed to encourage learner self-assessment and reflection as discussed below. Finally, since Simprac has been designed to explore ways to support learning of chonic illness, it needs to simulate a series of consultations. Simprac's design has been significantly influenced by the observations of Anderson, Reder and Simon [8] that learning is enhanced by combining abstract learning with concrete situations which reify the theory.

3. Overview of one example case

Simprac contains a simulation of a moderately difficult task for general practitioners: the diagnosis and management of hyperlipidaemia in a patient with significant co-mobidities that make management difficult. Figure 1 gives an overview of the case. As shown, it involves four consultations. This case models four possible states which the learner can meet at the second consultation. The full set of four consultations spans six months of simulated time.

The case is realistic and was modelled on anonymised data from a real patient. It is also of considerable practical interest. As the leftmost path in Figure 1 indicates, an incorrect management programme can lead to serious implications for the patient and the doctor.

Simprac simulates normal practice in that the first consultation is when the practitioner takes a patient history and performs initial examinations. From these, the practitioner formulates a set of potential hypotheses about the likely disease processes. These drive both the choice of additional tests and longer term investigations as well as the formulation of a plan for management.

In this case, there is very tight linkage between the patient states modelled. For example, if the user takes a sub-optimal management option at the initial consultation, they might come to the second consultation at the state modelled by the leftmost box of the second row of Figure 1. This reflects *no change from baseline*, meaning that the management programme did not effect any improvement and the serious illness of this patient continues to cause problems. If the learner recognises their error at this stage, they can select the correct management option and move to the optimal state by the third consultation, shown as the third row of the figure. This case exemplifies the tightly connected influence of the various management options with the ongoing disease outcomes. At the first and second consultations, either optimal or non-optimal management options lead to states which can subsequently move to any of the states at the next level. By the third consultation, this changes: from this stage, some of the states of the fourth row are inaccessible.

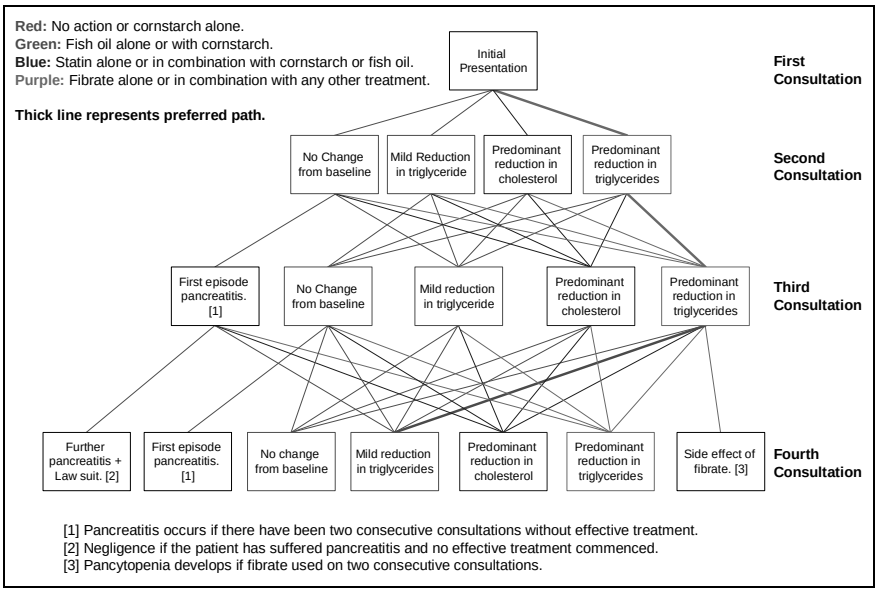

Fig. 1. Overview of four consultation sequence in simulation

4. Overview of interface

The first interface provides the learner with details of the case. From this, the user has several possible actions. The user would normally start by asking questions to collect the medical history.

This involves a limited natural language interface where the free text questions are matched against a coded set of questions. Since this is an inexact process, the user is offered the set of matching questions so that they can select the one which best captures their intent. This is clearly far less desirable than a more sophisticated natural language interface but it has the merit that it is less likely to lead the learner than a pure menu-based system.

The next stage of the first consultation will usually involve a physical examination via the interface illustrated in Figure 2. The practitioner can perform a virtual physical examination by selecting a variety of "tools" or actions and applying these to different parts of the body.

From the beginning of the consultation, the practitioner would make use of the *Medical Notes* interface to record their findings. This is selected at the left of the interface shown in Figure 2. Also, the learner can explicitly record the hypotheses they have formulated.

In addition to the interviews and examinations, the learner can request a wide variety of investigations. Of course, in line with reality, the results of the investigations are

not available until a predetermined time later in the case. For example, results of a CAT scan will only be available at the next consultation.

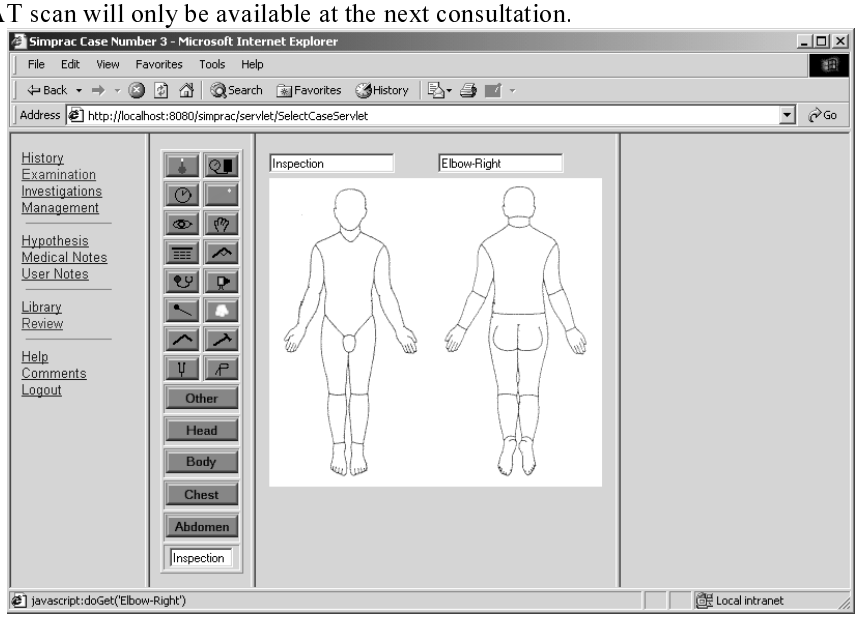

Fig. 2. Example of a screen for performing examinations. In this case the practitioner has chosen menu options to select the patient's right elbow. The system will report what they would be able to see. In some cases, this will provide an image of the area; in others, the user is provided with text stating what they would be able to observe.

Once the consultation is complete, Simprac offers the user the opportunity to review their progress. This takes the following form. The user can review their questions, examinations, investigations and management options they have chosen. They can simply review this as a basis for reflecting about what they have done in this consultation. The current implementation provides this level of support for reflection.

We have designed Simprac so that we will collect data as practitioners use the system. The goal is that the user be able to compare their own performance against their peers or an expert in the domain. We are currently developing the interfaces for this. The options to be supported are illustrated in Figure 3. As these indicate, we propose to enable the learner to compare their own performance with that of an expert. In addition, as we build up models of the diagnostic and management practices of peer groups, we want to allow the learner to compare their performance with their own peer group. This is important for our envisaged plans for the system. We will evaluate it with general practitioners as well as with medical students. Depending on the particular case, a general practitioner may want to judge their own performance in relation to other general practitioners rather than experts. Similarly, the medical student may want to be able to compare their own performance against that of other medical students as well as that of the expert. This range of group models is important for helping the learner make a realistic assessment of their own performance: it may not be reasonable for a learner to expect to perform at expert level on some cases.

A second level of review is available at completion of a full case. This provides a more holistic overview of performance over the full treatment path. At this level too, we envisage that reflection on performance should be based upon both study of the outcomes and of comparisons against expert and peer groups.

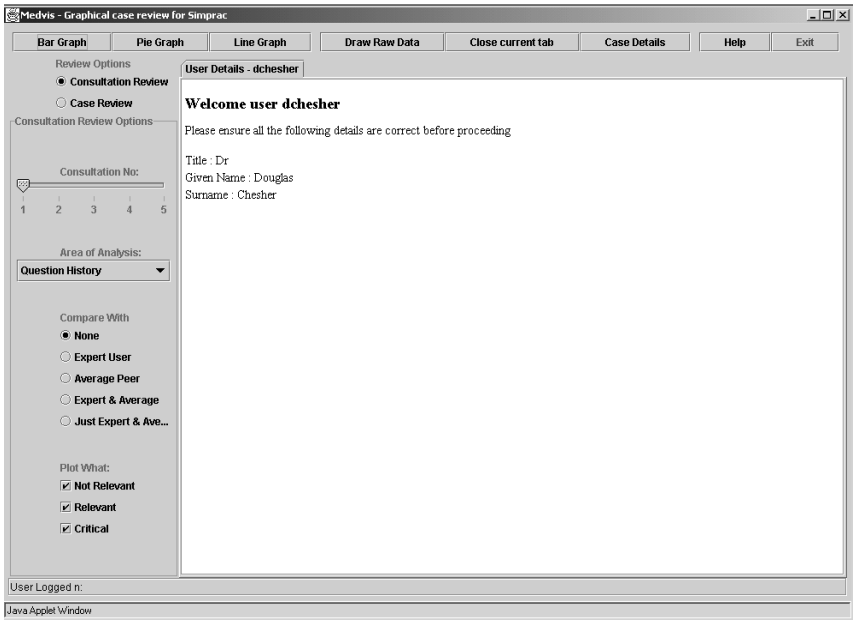

Fig. 3. Screen for selection of comparison options

5. Conclusions

Simprac is an exploration of several innovative aspects in a teaching system. It is web-based so that it can be used flexibly both by students and practicing medical practitioners. It is also significant in its exploration of teaching the management of chronic illness. Finally, it has been designed with learner reflection as a central goal. This is supported by providing the learner with opportunities to review their questions, examinations, investigations and management at each consultation as well as at the end of a case. It is also unusual in its approach to supporting reflection by enabling the learner to compare their own performance with that of an expert as well as against a peer group.

6. References

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