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Utility of the AIDA Diabetes Simulator as an Interactive Educational Teaching Tool for General Practitioners (Primary Care Physicians)

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ABSTRACT

In previous "Diabetes Information Technology & WebWatch" columns, various user experience with an interactive educational "virtual diabetes patient" simulator called AIDA have been documented. The simulator is available free of charge from http://www.2aida.org on the Web, and user comments that have been received to date about the program have highlighted some of the many and varied ways in which a range of people have been applying the diabetes simulations in their own particular situations and practices. Inevitably, up to now, a great deal of attention has focused on use by individuals with diabetes and their relatives, as well as by health-care professionals such as diabetologists/endocrinologists and diabetes educators. However, an important group of health-carers involved in the provision of day-to-day care for many people with diabetes are primary care physicians (general practitioners). The current "Diabetes Information Technology & WebWatch" column addresses this area, overviewing a workshop which was held in September 2000 in Italy to gain experience with application of the AIDA diabetes simulation approach as a teaching tool for general practitioners (GPs). Feedback obtained from participants attending the workshop was very positive, with GPs reporting the simulation approach to be both of interest and use. Further workshops involving other healthcare professionals—in particular, nurses—are planned.

INTRODUCTION

THE BURDEN OF CARE for people with diabetes in Italy, as in many other countries, falls somewhat irregularly on general practitioners (GPs) and diabetes centers, without necessarily a close or regular cooperation existing between the two. Although in the last 10 years there has been a tendency to expand diabetes centers, more recently economic and social pressures have been pushing towards a different solution with diabetic patients being managed as much as possible in primary care (general practice).

The Endocrinology and Diabetes Unit of the Ospedale di Marino (Rome, Italy) recently started a shared care project with the involvement of GPs in the routine treatment of patients with diabetes. This joint project between the Endocrine Unit and GPs requires that the GP is able to provide some basic information about

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A

Name MARIA ROSSI Weight 68.0 kg Case Number: 0042 AIDA v4.3
Free Text 40 years old, pre-menopausal female who uses 2 doses of premixed insulin. Her glycemic control is unsatisfactory. See if you can improve her blood glucose control.

MEALS:	Breakfast	Snack	Lunch	Snack	Supper	Snack
Time (hhmm):	0845		1330		2000	
Carbohydrate (g):	40		40		70	

INSULIN INJECTIONS:		Number 1	Number 2	Number 3	Number 4
Preparations	Time (hhmm):	0815	1930		
PenMix 30/70	dose (U):	10	10		

GLUCOSTIX MEASUREMENTS:

Time (hhmm):	0845	1330	1745	2330
Glucose (mg/dl):	171	180	203	207

HYPOGLYCAEMIC EPISODES: Number 1 Number 2 Number 3 Number 4
Time (hhmm):

CLINICAL VARIABLES: RTG: 162 mg/dl CCR: 100 ml/min

INSULIN SENSITIVITIES: Hepatic (Sh): 0.5 Peripheral (Sp): 1.0
Esc=Simulator F1=Help F3=Quit F5=Info F6=Graphics F7=Options F10=Cases

FIG. 1. (**A**) Provides a representation of an AIDA data entry screen showing clinical data for a 40-year-old pre-menopausal woman who takes two injections of a premixed (biphasic), PenMix 30/70 insulin preparation each day. However, despite this, her blood glucose control is not ideal. (**B**) Sample graphical display from AIDA v4.3 showing the baseline simulation of the case scenario given in A. As can be seen, the patient tends to a high blood glucose level in the middle of the afternoon with a peak blood glucose of 263 mg/dL (14.6 mmol/L) predicted at around 16:15 h (4:15 p.m.). A user definable normoglycemic range (72–180 mg/dL [4–10 mmol/L]) is shown superimposed (18 mg/dL = 1 mmol/L). (**C**) Interactive simulation of the case scenario from A and B, showing how increasing the twice daily insulin dose from 10 units to 15 units leads to a reduction in the simulated blood glucose profile. The current blood glucose simulation is shown as the bold black line, with the previous glucose simulation as the less dark line. Further examples of AIDA diabetes simulations can be found elsewhere in the literature[1,4] or on the Web at http://www.2aida.org/demo

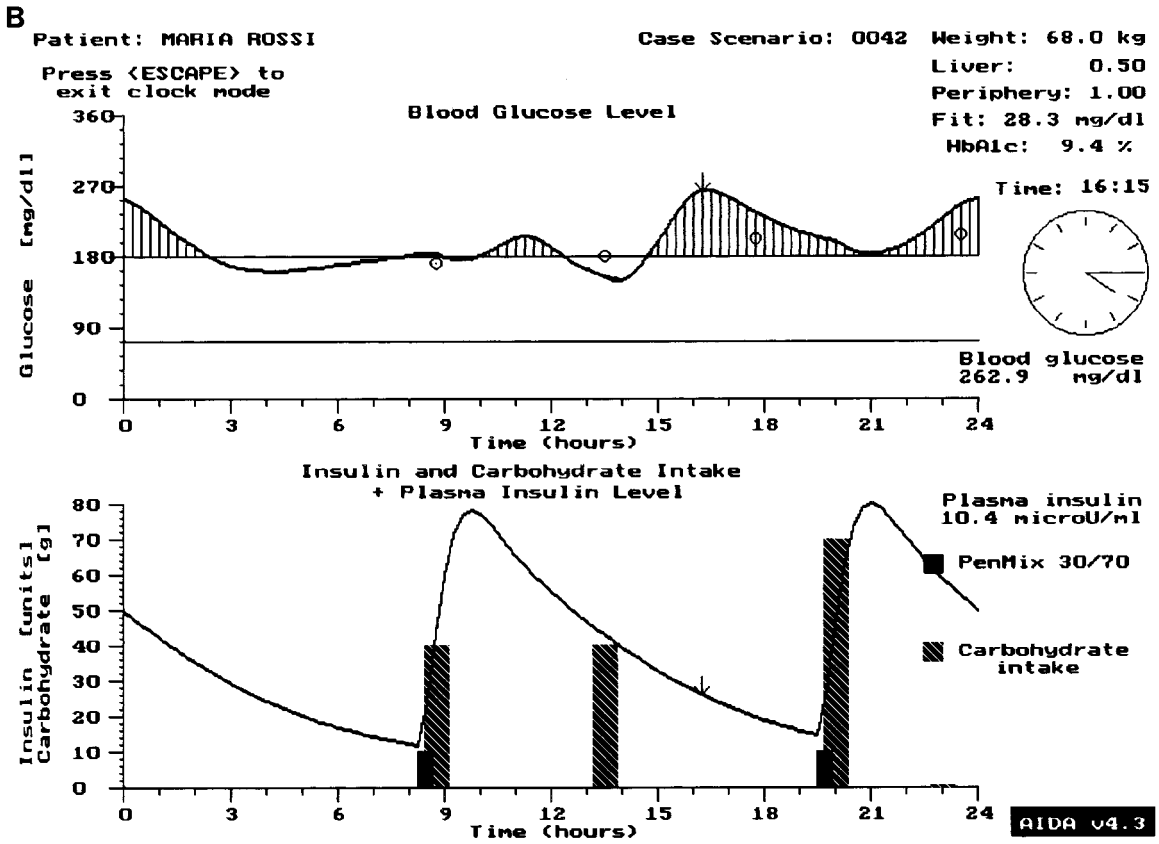
adjusting the insulin dose in insulin-dependent (type 1) diabetes mellitus. Furthermore, the GP must be able to cope with diabetic emergencies, such as hyper- and hypoglycemia.

Within this framework, we decided to use a free interactive educational diabetes simulator, codeveloped by one of us (E.D.L.),[1] for the training of GPs involved in the project. We both have already had a positive experience with using AIDA as a teaching tool for diabetic patients,[2] and we have also been piloting a randomized controlled clinical trial approach for formally testing out the educational efficacy of diabetes simulation programs like AIDA.[3] Therefore, we tried to capitalize on this previously gained experience, as well as on user feedback about the software,[4–8] by exploring the use of the simulator with primary care physicians (general practitioners).

WORKSHOP REPORT

On 23rd September 2000, a preliminary 1-day training workshop on diabetes simulation was run in Ostia, Italy (near Rome) for 60 primary care physicians (GPs).

The objectives of the workshop were: (1) to provide the participants with an overview of metabolic management in diabetes; (2) to offer a rationale for different sorts of control schemes for diabetes therapy; and (3) to highlight some



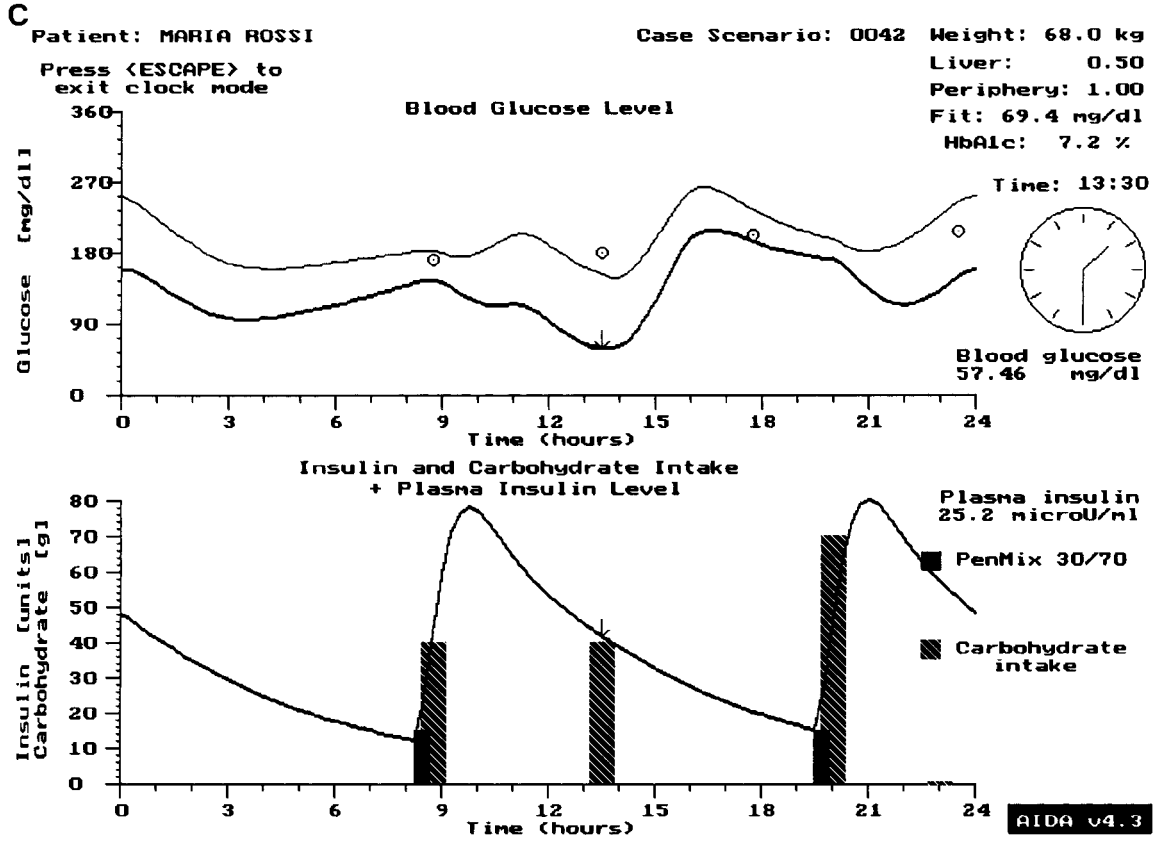


FIG. 1. *Continued*

of the complexities of insulin, diet, and activity interaction in diabetes—and show how these can be simulated with a program like AIDA (the effect of activity was simulated within the program by increasing and decreasing the peripheral insulin sensitivity).

The workshop consisted of two sessions. During the first session of 3 h, three different physicians presented some background information about diabetes and overviewed the results of the Diabetes Control and Complications Trial (DCCT).[9] Schemes of insulin therapy, ranging from the most simple to intensive were also reviewed. The third presenter (P.T.) then reviewed the essential pathophysiology of insulin-dependent (type 1) diabetes and introduced the theory behind the use of simulations in medicine. He then went on to present some displays from AIDA (Fig. 1A), and spent some time explaining the meaning of each abbreviation and each simulation curve (Fig. 1B). At this stage, some very brief demonstration simulations were run for the entire audience, to raise interest amongst the participants.

Figure 1A shows a representation of the main data entry screen for AIDA v4.3. Details of the example patient regimen, including the insulin dose and meal carbohydrate details, are provided. Figure 1B shows a baseline simulation of this case. Blood glucose information is given in the top graph, while insulin and carbohydrate details are given in the lower graph. A user-definable normoglycemic range (72–180 mg/dL [4–10 mmol/L]) is shown superimposed highlighting the hyperglycemia which is expected to occur in the middle of the afternoon with a peak blood glucose of 263 mg/dL (14.6 mmol/L) at 16:15 h (4:15 p.m.). As has been described previously elsewhere,[1,4] the main utility of the AIDA diabetes simulation approach comes from being able to make changes to the regimen and then resimulate the effects of the changes on the blood glucose profile. Therefore, for instance, in Figure 1C we can see the glycemic effect being simulated of increasing the dose of the patient's twice daily premixed (biphasic) PenMix 30/70 insulin injections (before breakfast and supper) from 10 units to 15 units. As can be seen, this is predicted to lead to a substantial reduction in the simulated blood glucose profile with a minimum blood glucose level of around 57 mg/dL (3.2 mmol/L) predicted to occur at 13:30 h (1:30 p.m.). If this sort of glycemic control was maintained longer term, the AIDA v4.3 model predicts that a glycosylated hemoglobin (HbA_{1c}) level of around 7.2% would result (as compared with an HbA_{1c} level of 9.4% for the previous example shown in Fig. 1B). Further examples of the type of simulations that AIDA can offer can be found elsewhere in the literature,[1,4] as well as at http://www.2aida.org/demo on the Web.

For the workshop, case scenarios for simulation were prepared in advance, and the ability to translate screen displays into the native language of the participants (Italian) was exploited as far as possible. The shadowed areas in Figure 2 highlight the fields that can be changed to accommodate a different language.

After a break, during the second session of the workshop (lasting approximately 2.5 h), the participants were split into groups, and each group started working on the same diabetes case scenarios, but at different computer terminals located in different rooms. Each group had a doctor who was experienced with the use of AIDA and who had been trained to be a "facilitator." The groups of participants were arranged around a U-shaped table, giving everyone a good view of the computer display, which was projected onto a large screen. The role of the facilitator was essentially to stimulate the participants, even the most shy, to take part. However, this task proved not so crucial, as participation was observed to be spontaneous. Another important task was to focus the attention of the group on some possible solutions that were not spotted initially.

It is worth mentioning that the proportion of participants who returned after the break was very high, which is most unusual for a medical meeting held on a Saturday afternoon towards the end of the summer in Italy by the sea! Three cases which had been prepared in advance and had been translated into Italian (as far as possible) were used by all three groups.

As previous experience with simulator-based lessons involving patients with diabetes has suggested,[2] each participant was assigned the task of monitoring one of the key parame-

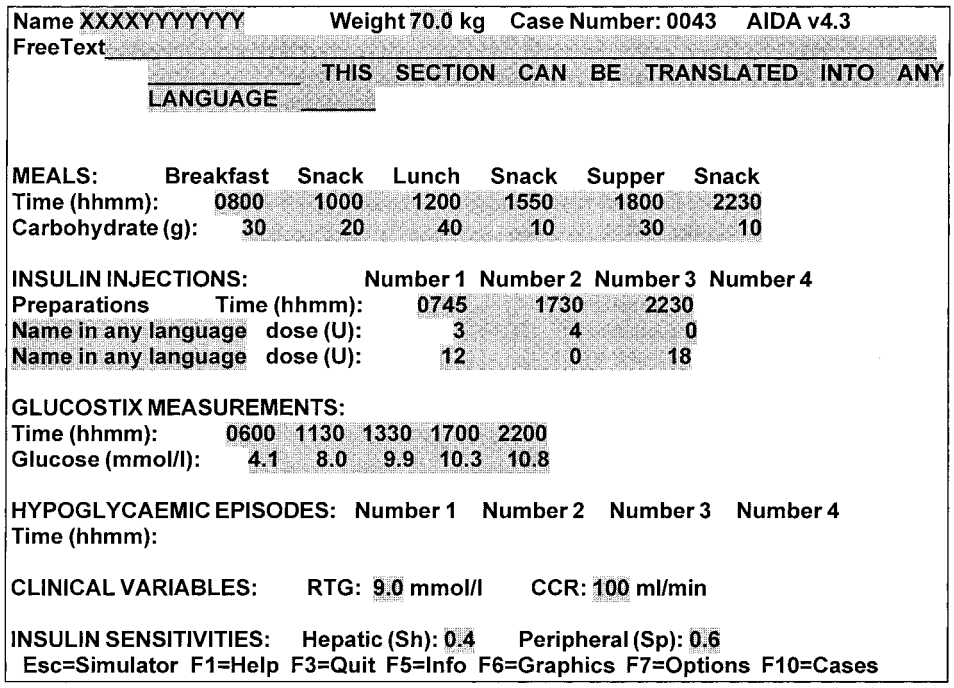


FIG. 2. Annotated representation of an AIDA data entry screen (for a different case than shown in Fig. 1), highlighting in gray the fields that can be modified, as required for the regimen, and/or translated into other languages. The program handles blood glucose data in units of both mmol/L and mg/dL.

ters of the simulation. In fact, due to the great number of participants it was necessary to assign one parameter to each pair of GPs.

The cases were examined simultaneously, and a friendly "competition" was favored. None of the participants left before the end of the sessions, and it is to be remarked that the participation was spontaneous—that is, no certification of attendance for Continued Medical Education (CME) was provided.

A particular feature of AIDA that was exploited to favor competition was to tell participants that the number of simulations being run were being monitored. The "competition" was based on the simulated glycosylated hemoglobin (HbA_{1c}) levels reached, as well as the number of simulated hypoglycemic (<70 mg/dL [3.9 mmol/L]) and hyperglycemic (>200 mg/dL [11.1 mmol/L] episodes that occurred. For instance, in one of the groups 38 simulations were run, and 15 hypoglycemic episodes ("hypos") and 36 hyperglycemic episodes were observed (with more than one "hypo" and high blood glucose level per simulation). The average simulated HbA_{1c} level attained in this group was 6.3%. By contrast, in another group, 26 simulations were run, with a total of 28 "hypos" and 46 hyperglycemic episodes; the average simulated HbA_{1c} level achieved was 7.4%.

RESULTS

After the simulation session, some on the spot feedback was elicited. From this, it appears that the involvement, participation, and appreciation of the GPs was high. The participants reported that the objectives of the workshop had been met. In particular, it appears that the session with the simulator gave the participants a new way of thinking about such diabetes problems, and the ability to begin being involved in insulin therapy management. Also it seems to have helped the GPs gain some useful experience and knowledge.

It was observed by a number of participants that the simulation approach had "great potential". Furthermore, the most frequently heard comment from GPs was that the simulator "opened their mind to a new aspect of medicine," with the suggestion that users moved from a merely quantitative view of insulin ther-

apy to a more dynamic appreciation of the problems of achieving good diabetes control, including some understanding of the kinetics of insulin and food absorption. All those who reported having a computer at the beginning of the meeting asked for the Web address (http://www.2aida.org) to download the freeware simulator. Two of those involved also planned to give this Web address to their patients with diabetes, possibly pinning the information to the wall of the waiting room of their office. However no one planned to give lessons with AIDA as a teaching tool in their general practice at that time. This is quite understandable because in Italy no reimbursement is provided at the moment for any teaching activities provided by GPs. Such patient education is currently left to a few specialist diabetes centers.

Another important feedback point was that many participants asked if it was possible to develop "something similar" in other fields of medicine, since they felt this could help them. One GP observed that if he had AIDA when he was at medical school, he would have saved a lot of time and understood things much better, with this kind of "live medicine."

FUTURE WORK

This first workshop is of course just a preliminary attempt at this sort of computer-based interactive meeting approach. In the near future, some further features may be added to improve the potential benefits of such sessions. Firstly, a questionnaire should be adopted to formalise the feedback from the participants. An example questionnaire is shown in Figure 3. This is currently being used for feedback from patients in a randomised controlled trial (RCT) investigating the possible educational benefits of the diabetes simulator,[3] and these 11 basic questions have also been included within a feedback form which constitutes part of the AIDA software download. Therefore over time it should become possible to compare feedback from downloaders of the program, patients in RCTs,[3] as well as GPs.

For future workshops, the three cases presented could be made more like those that commonly confront doctors in general practice (primary care). In future we might also try having small groups of doctors working in pairs directly on a computer, only referring to the tutor/facilitator in case of difficulties. However this approach would clearly require access to multiple computers for such a hands-on workshop.

In future workshops, the time for the first session (lectures) could also probably be reduced, so that the time spent with the diabetes simulator could be increased. The optimal number of subjects per group has been found with patients[2] to be six, and this number should continue to be respected, since this facilitates the involvement of all the GPs in the session.

Furthermore, the more rigorous collection of data about the number of "hypos," hyperglycemic episodes, overall number of simulations run, and HbA_{1c} levels achieved, as well as facilitating some friendly competition, may also offer some useful insight into how the participants are actually making use of the simulation program.

DISCUSSION

In our opinion, the qualitative feedback obtained so far highlights the fact that the participants' caught the general mood of the workshop and the concept of simulation as a potential tool, far beyond their mere enjoyment of the session. In this respect, the interest of the audience seems to have been high.

However, we do not expect GPs to use the simulator as a teaching tool for their patients, since this will probably be limited to diabetes centers where education is a core part of the routine activity (and where this is presently reimbursed). Nevertheless, the feedback obtained suggests that the simulator can be of use for teaching the GPs themselves and improving their diabetes management skills. However it will be self-evident that randomised controlled trials to establish the efficacy of the diabetes simulation approach for this purpose are clearly required. Connected with this we have developed a randomised controlled trial protocol which can be used to evaluate the utility of such diabetes simulation software for educational use with patients.[3] Preliminary pilot

Questions for participants exposed to the AIDA simulator

a) Have you found AIDA of interest as an educational/demonstration tool? ☐ YES ☐ NO

b) (i) Do you think AIDA has some utility? ☐ YES ☐ NO

(ii) If yes, can you outline briefly how you might see AIDA being used: _____

_____

c) Are you interested in continuing to use AIDA? ☐ YES ☐ NO

d) Do you think local / national diabetes associations might be interested in finding out more about AIDA? ☐ YES ☐ NO

e) Do you think AIDA is worthy of wider distribution? ☐ YES ☐ NO

f) If they had computer / Internet access, would you tell friends / colleagues or diabetic patients about AIDA? ☐ YES ☐ NO

g) Do you think AIDA is in any way dangerous? ☐ YES ☐ NO

h) Do you think the caveats provided with AIDA make clear its limitations? ☐ YES ☐ NO

i) What other features would you like to see in later releases of AIDA? _____

_____

j) Have you come across any tools like AIDA for diabetes self-education? ☐ YES ☐ NO

k) Please write any free text comments that you may have about AIDA, below / overleaf.

FIG. 3. Questionnaire showing some standard questions that can be asked of people exposed to the AIDA diabetes simulator to formalize obtaining their feedback. To date, these 11 basic questions have been included within a feedback form that constitutes part of the AIDA software download. The questions are also currently being used in a randomized controlled trial[3] evaluating the utility of AIDA in patient education sessions.

study results from teaching sessions with 24 diabetic patients have established the feasibility of this approach. Further information about this can be found at http://www.2aida.org/evaluate on the Web.

In summary, the workshop appears to have been a success and popular with the participating GPs. Furthermore, we think that, with some improvements along the lines described above, such an approach could lead to enhanced support of GPs caring for patients with diabetes outside specialized centers. Connected with this, it appears that the use of AIDA as a teaching tool for GPs is a new av-

enue which could be explored to capitalise on the potential utility of the software. Further workshops involving other healthcare professionals—in particular nurses—are planned.

In the next Diabetes Information Technology & WebWatch column, two other diabetes questionnaires that can be used to help obtain an objective assessment of *patient* benefits from educational lessons with diabetes simulation programs like AIDA will be documented. It is intended that such questionnaires should be used together with standard clinical (metabolic) indices—such as HbA_{1c} levels, self-monitoring blood glucose (SMBG) data, and details of any symptomatic hypoglycemic episodes—to permit an overall assessment to be made of the possible educational benefits of this sort of diabetes simulation approach.

SYSTEM AVAILABILITY

The latest release of AIDA (v4.3) can be downloaded, without charge, from http://www.2aida.org on the Internet. The program runs on IBM PC or compatible 80386/80486/Pentium-based machines and requires approximately 3 Mb of hard disk storage space. The software can also be used on Apple Macintosh computers running PC emulators such as Virtual PC or SoftWindows. People who wish to be automatically informed about future updates and enhancements to the AIDA diabetes software range can subscribe (for free) to the AIDA diabetes simulator announcement list by sending a blank email note to: subscribe@2aida.org.

Any readers who might be interested in collaborating by applying a standardised randomised controlled trial protocol[3] themselves in an evaluation of AIDA in their own units for clinician/specialist nurse/educator-led patient teaching sessions are invited to contact one of the authors. Further information about the evaluation of AIDA for patient use can be found at http://www.2aida.org/evaluate on the Web.

FURTHER TOPICS

If you would like to suggest further topics or Websites for future "Diabetes Information Technology & WebWatch" columns, please email information—with a brief description of the site/suggestion—to Dr. E.D. Lehmann: info-www@2aida.org (please write "Diabetes WebWatch" in the subject line). You can also fax information to (503) 218-0828, indicating "Diabetes Information Technology & WebWatch" as the subject.

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