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Use of the AIDA Diabetes Simulation Software—www.2aida.org—as an Interactive Educational Tool for Teaching Student Nurses

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ABSTRACT

In previous "Diabetes Information Technology & WebWatch" columns, various user experiences with an interactive educational virtual diabetes patient simulator, called AIDA, have been documented. The simulator is available free of charge from www.2aida.org on the Web. In the 5+ years since the program was first made available on the Internet, over 125,000 people have visited the AIDA Website and over 27,000 copies of the program have been downloaded, *gratis*. User comments that have been received 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 of the program by individuals with diabetes and their relatives, as well as by health-care professionals such as diabetologists/endocrinologists, diabetes educators, and primary care physicians (general practitioners [GPs]).

However, an important group of health-carers involved in the provision of day-to-day care for many people with diabetes are nurses. The current "Diabetes Information Technology & WebWatch" column overviews a workshop held in June 2001 in Italy to gain experience with application of the AIDA diabetes simulation approach as a teaching tool for student nurses. Feedback obtained from participants attending the workshop was generally very positive, with the student nurses reporting the simulation approach to be both of interest and of use. Further workshops involving other health-care students and professionals—in particular, medical students and qualified nurses—are planned.

INTRODUCTION

AIDA is an interactive educational freeware diabetes simulation program available without charge from www.2aida.org on the Web. The software has been overviewed previously elsewhere in this journal.[1] Briefly, the program allows the simulation of clinical diabetes situations for educational, self-learning, and/or demonstration purposes.

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As an extension to our previous experience using the software with primary care physicians (general practitioners [GPs]),[2] for the current study we explored the use of AIDA with a group of student nurses attending the Nursing School of the Hospital of Marino (outside Rome, Italy). The aim of the workshop was to teach the student nurses using AIDA and to collect some feedback from them about how they perceived the role of the software in nursing student education.

MATERIALS AND METHODS

Twenty-four student nurses (aged 22–26 years, 8 males 16 females), in their final year of study prior to graduation, were invited to attend a lesson using a novel teaching method. The aim of the lesson was made clear in advance, and the participants were informed that they would be asked to complete a questionnaire concerning their opinions regarding use of the software as a teaching tool. All the students who were asked volunteered to participate, and the workshop was held in mid-June 2001.

Overall, the workshop/computer-based lesson lasted 2 h. The participants were seated in a classroom in rows of four people. An overhead projector connected to a portable computer running the AIDA software was used for the software presentation. The program was operated by the teacher himself (P.T.). The first 40 min of the lesson were devoted to an explanation of the basic physiology of normal, nondiabetic subjects and the pathophysiology of insulin-dependent (type 1) diabetes mellitus, with the help of a set of slides. Some example illustrations from the presentation are shown in Figure 1.

These illustrations summarize the basic elements of pathophysiology of the postprandial and fasting diabetic state. Sp and Sh represent peripheral and hepatic insulin sensitivities, respectively, as applied within AIDA.[3] The full arrows demonstrate the direction of the main glucose fluxes; the broken arrows represent the direction of the minor (or temporarily absent) glucose fluxes. These illustrations assist in understanding the complex dynamics of glucose in the human body, and as such were felt to help exploit the full potential of AIDA when teaching student nurses.

SOFTWARE PRESENTATION

After a break of 5 min, the diabetes simulation software was presented, along with some very simple clinical examples (translated into Italian as far as possible).

Two case studies were demonstrated with particular emphasis on hypoglycemia and the emergency treatment of hypoglycemic episodes according to the kinetics of the last insulin injection. The risk of overcorrecting the blood glucose profile was made clear, exploiting the potential of the AIDA software to demonstrate this.

For this, a situation was created in which the 'hypo' appeared when the insulin in the blood was disappearing, to show that a 'hypo' at that time is less dangerous than a 'hypo' appearing earlier when there is a larger amount of circulating insulin. A sample simulation taken from the lesson is shown in Figure 2.

In this example, 40 g of carbohydrate ingested when insulin is disappearing may be considered an overcorrection, and a more appropriate correction might involve the administration of only 10–20 g of carbohydrate followed by cautious observation and review.

It was explained to participants that the overcorrection with 40 g of carbohydrate at a time when the insulin level was declining and the food absorption was starting to increase would have contributed to the subsequent hyperglycemia. It was pointed out during the workshop that, had the hypoglycemia appeared at another time, when the insulin was increasing, then the correction might have been more appropriate. Incidentally, the subject not only overcorrected, but also did not recognize the need to increase the subsequent insulin dose, and this also contributed to the late evening hyperglycemia (Fig. 2C).

Another focus of the lesson was on the role of the liver in glucose metabolism, an aspect of the disease that seemed to catch most of the student nurse participants completely unaware. A frequent comment was, "I heard of a

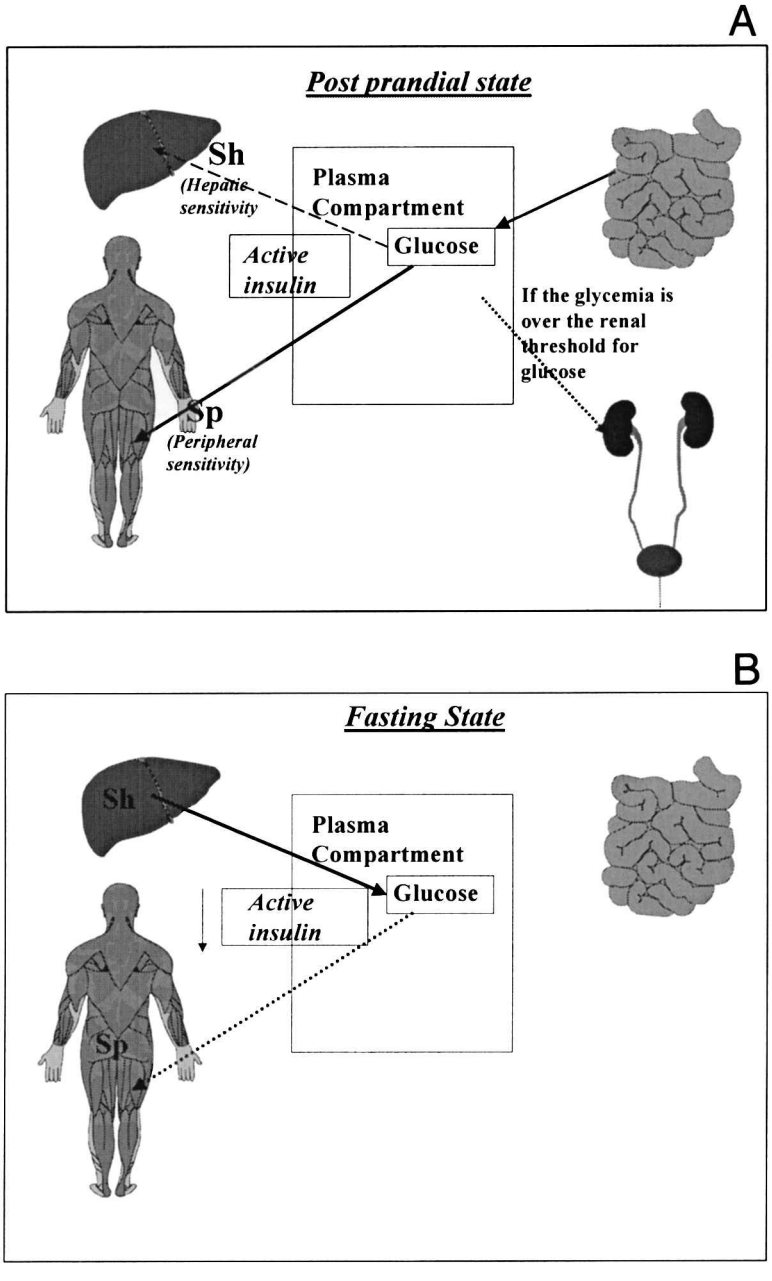

FIG. 1. (**A**) Postprandial state in a nondiabetic subject. In this state, the hyperinsulinemia elicited by the ingestion of food is shown on the right side. The glucose fluxes (arrows) are mainly directed towards the muscle and, to a lesser extent, towards the liver. The extent of the flux is also regulated by the peripheral and hepatic insulin sensitivities (Sp and Sh, respectively). In the diabetic subject, whenever the blood glucose level is above the renal threshold of glucose (RTG), glucose spills over into the urine (right lower quadrant). (**B**) By contrast, during the hypoinsulinemia of the fasting state, the fluxes towards the muscle are reduced and the liver glucose flux is turned into a net output. Using such an illustration, it is possible to explain that in this setting the liver is the only input into the system and, as such, has an exceedingly important role in the hyperglycemia of fasting. Sh, hepatic insulin sensitivity; Sp, peripheral insulin sensitivity.

role for the liver, but only now can I understand it."

A third focus of the lesson was on the timing of insulin injections in relation to carbohydrate ingestion (e.g., the effect of delaying or anticipating the injection of a rapidly acting insulin preparation).

As with the previous AIDA workshop for GPs,[2] the participants were divided into groups, and each group had to follow one of

the simulation parameters during the software presentation (e.g., the glycosylated hemoglobin [HbA_{1c}] level or the blood glucose profile). The cases elicited a vivid discussion and were each solved by the participants in about 20 min.

At the end of the second hour of the lesson, the student nurses completed a simple questionnaire. This was based around that previously described[2] and was used to reveal their opinions regarding the software. Both open and closed questions were used.

RESULTS

The closed questions and the answers given by the participants are listed in Table 1. Also of interest are the participants' answers to the open questions (translated from Italian as literally as possible). These are given in Table 2.

Connected with this, it is interesting to note that the aim of the simulator was not stated *a priori* as "patient oriented," but just as an alternative way of teaching. Nevertheless, the

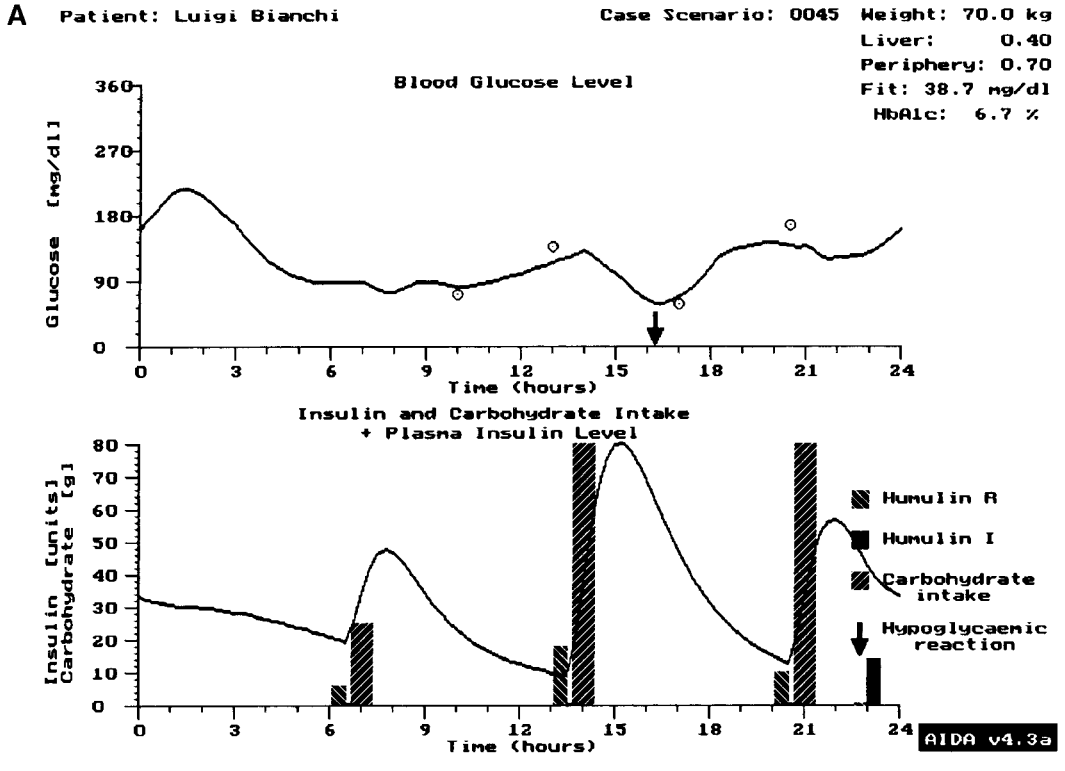

FIG. 2. (**A**) Baseline 24-h simulation from the AIDA simulator for an example patient with insulin-dependent (type 1) diabetes mellitus on a four times daily short-acting, regular (Humulin R) and intermediate acting (Humulin I) insulin regimen. *Lower panel:* Insulin and carbohydrate intake with predicted 24-h plasma insulin curve. *Upper panel:* Predicted 24-h steady-state blood glucose profile computed on the basis of the insulin and carbohydrate intake. As can be seen, the simulated patient experienced a symptomatic hypoglycemic episode at 16:15 h (4:15 p.m.). (**B**) Simulation shown in A in Fluxes mode allowing the different glucose fluxes within the model to be viewed interactively. Uptake, grouped peripheral, central nervous and red blood cell utilization of glucose; nhgb, net hepatic glucose balance; glucose absorption, systemic appearance of glucose from the gut; renal excretion, loss of glucose via the kidneys into the urine. As can be seen, at 16:15 h (the time of the symptomatic hypoglycemic episode in A—not marked here for clarity), glucose absorption from the gut is actually rising. Therefore, the ingestion of a large quantity of carbohydrate, after the blood glucose test (○) at 17:00 h, will actually create an overcorrection and a raised blood glucose level in the evening (as shown in C). (**C**) Based on the case scenario example shown in A and B—with the extra administration of 40 g of carbohydrate at 17:15—in an attempt to correct the hypoglycemic episode at 16:15 h. Current simulation shown as the bold, dark line—with the previous (baseline) simulation from A shown as the lighter gray line. As can be seen, eating 40 g of carbohydrate at this time in fact is expected to cause an overcorrection in the blood glucose profile—with a predicted blood glucose level of 270 mg/dL (15.0 mmol/L) at 20:00 h (8 p.m.).

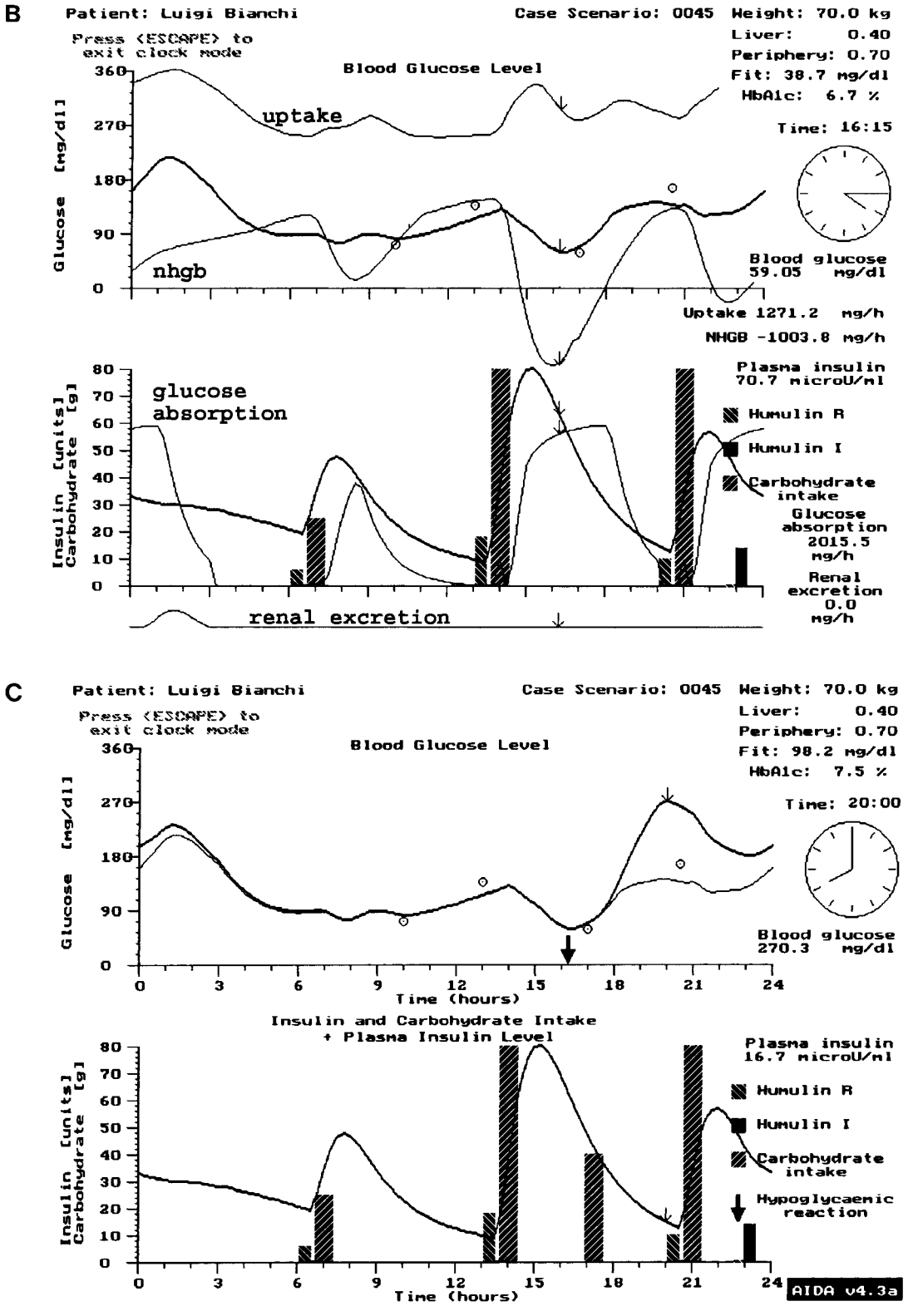

FIG. 2. *Continued.*

Table 1. Responses of the Student Nurse Participants to Closed Questions Based on the Standard Questionnaire[2]

Question	*Yes*, n *(%)*	*No*, n *(%)*	*No answer (left blank)*, n *(%)*	*Do not know*, n *(%)*
Do you think AIDA is a promising educational tool?	23 (95.7%)	—	1 (4.3%)	—
Do you think AIDA is useful?	23 (95.7%)	—	1 (4.3%)	—
Do you think you will keep on using AIDA?	4 (17.4%)	14 (56.5%)	2 (8.7%)	4 (17.4%)
Do you think AIDA is worthy of more widespread distribution?	20 (82.6%)	2 (8.7%)	1 (4.3%)	1 (4.3%)
If they had computer/Internet access, would you tell friends and colleagues about AIDA?	1 (4.3%)	20 (82.6%)	2 (8.7%)	1 (4.3%)
Do you think AIDA can be in any way dangerous?	23 (95.7%)	—	1 (4.3%)	—
Have you ever come across any tools like AIDA for diabetes self-education?	2 (8.7%)	20 (82.6%)	2 (8.7%)	—

students seemed to find a practical interest for the patient in the simulations and correctly identified AIDA just as a teaching tool, not as a way to give therapy advice or determine insulin dose adjustments. Overall, about 50% of the respondents thought that the software should be applied in a patient-oriented manner, 25% thought it should be used in the nursing school setting, and 25% felt it should be oriented to both patients and students.

Of interest also were the features that participants wanted to see added to future versions of the program (Table 2). Here, the greatest concern seemed to be with a local language (Italian) version, although many of the other participants thought the software was com-

Table 2. Responses of the Student Nurse Participants to Open Questions from the Standard Questionnaire[2]

How do you think AIDA can be used?
"Useful for teaching, more so for patients" ($n = 8$)
"Clarifies diseases simply. Should be used for teaching" ($n = 1$)
"Helps evaluate things easily-useful for patients" ($n = 1$)
"For teaching, to communicate, to improve control" ($n = 1$)
"Useful to understand the pathophysiology" ($n = 1$)
"Helps understanding in the clinical setting" ($n = 1$)
"In the office, in the wards, in the school" ($n = 1$)
"Should be a complement to traditional study methods" ($n = 1$)
"Should be used with standard lessons" ($n = 1$)
Which other features would you add to AIDA?
"I do not know AIDA enough" ($n = 1$)
"An Italian version" ($n = 6$)
"Nothing, it is complete" ($n = 6$)
"Improve graphics" ($n = 2$)
"Graphics should be more easily understandable" ($n = 1$)
"A voice to explain the graphs" ($n = 3$)
"The case scenarios should include more extreme cases (e.g., coma)" ($n = 1$)
Write any free text comments
"A fascinating instrument" ($n = 1$)
"Useful for teaching and in medical practice" ($n = 2$)
"Could avoid dangerous mistakes. I would promote a course to use it" ($n = 1$)
"Stimulates thinking and discourages automatic learning" ($n = 1$)
"Interesting tool—needs a good explanation before use" ($n = 1$)
"Interesting tool—good graphic display" ($n = 1$)
"Very useful to understand the pathophysiology of the disease" ($n = 1$)
"Good teaching method" ($n = 2$)

Numbers in brackets are the number of respondents who gave each answer.

plete. Some though found the output a little difficult to understand and wanted improvements to the graphics.

The responses to the final question giving participants an opportunity to write free text comments are self-explanatory (Table 2)—although it is interesting to see how different and wide ranging the feedback is.

DISCUSSION

This is only the second workshop to be held using AIDA, and we are still gaining experience about how best to apply the software in an interactive meeting setting. It is clearly important that the computer be operated by someone experienced with the software. Also, a questionnaire has been adopted to formalize obtaining feedback from the participants.[2] This may need slight modification and translating, depending on the emphasis/participants and country where the workshop is held (and the language used for the lessons), but nevertheless having a semistandardized questionnaire[2] should aid the running and evaluation of future workshops.

Notwithstanding the potential concerns raised by one closed question (Table 1), the answers to the open questions (Table 2) were informative and generally very encouraging. In addition the interest of the entire audience seems to have been high—with all participants returning for the software presentation after the mid-workshop break.

It is our growing experience that, in a workshop setting, the AIDA simulation software may be most useful if introduced by some information about the general pathophysiology of diabetes. We are finding that basic physiological information—although clearly known to diabetologists/endocrinologists and other experts—may not be so well understood by students and nonexpert GPs. We plan to include a basic pathophysiology introduction in all future diabetes simulation workshops/lessons and also will be seeking—in due course—to place this information on the Internet, at the AIDA Website (www.2aida.org).

Overall, judging by the responses to the questionnaires (Tables 1 and 2), AIDA seems to be an interesting and attractive tool for student nurses. This observation is also consistent with previously documented experience using the program with patients,[4–6] GPs,[2] and other health-carers.[7]

In the current study, the majority of participants ($n = 23$; 96%) reported finding AIDA promising as an educational tool and thought the software was useful (Table 1). Over half of those who attended the workshop/lesson ($n = 14$; 57%) expected to carry on using AIDA, with a large number of attendees ($n = 20$; 83%) thinking that AIDA was worthy of more widespread distribution. However, interestingly, most of those questioned ($n = 20$; 83%) did not plan to tell friends or colleagues about the program. Also the majority of participants ($n = 23$; 96%) expressed reservations that the software might be perceived as dangerous (Table 1). The questionnaire did not permit the thought processes underlying this perceived concern to be explored—although it is interesting that these views were not expressed in any of the free text comments (Table 2).

Nevertheless, this issue does warrant further investigation and analysis in future lessons/workshops. However, it is interesting to note that, in a larger survey of 200 AIDA users (including patients, students, and health-care professionals) who were able to use the software on their own for as long as they required, when asked the same question the majority (73%) did not regard AIDA as in any way dangerous, with 10% answering "do not know" and only 17% believing that the software might be of some danger (Dr. E.D. Lehmann, unpublished observations).

Obviously, any program or educational tool can be misused, and this is one of the reasons for the clear caveats/warnings provided at the start of the software (Fig. 3A), to make users aware that the simulator is not intended for individual patient blood glucose prediction or for insulin-dosage adjustment/therapy planning (Fig. 3B). Furthermore, to reinforce this point, it is actually explicitly stated in the caveats at the start of the program that "it could be dangerous for insulin-dependent diabetic patients to follow the 'advice' given or act on the results of the simulated data" (Fig. 3B).

However, it is our preliminary experience

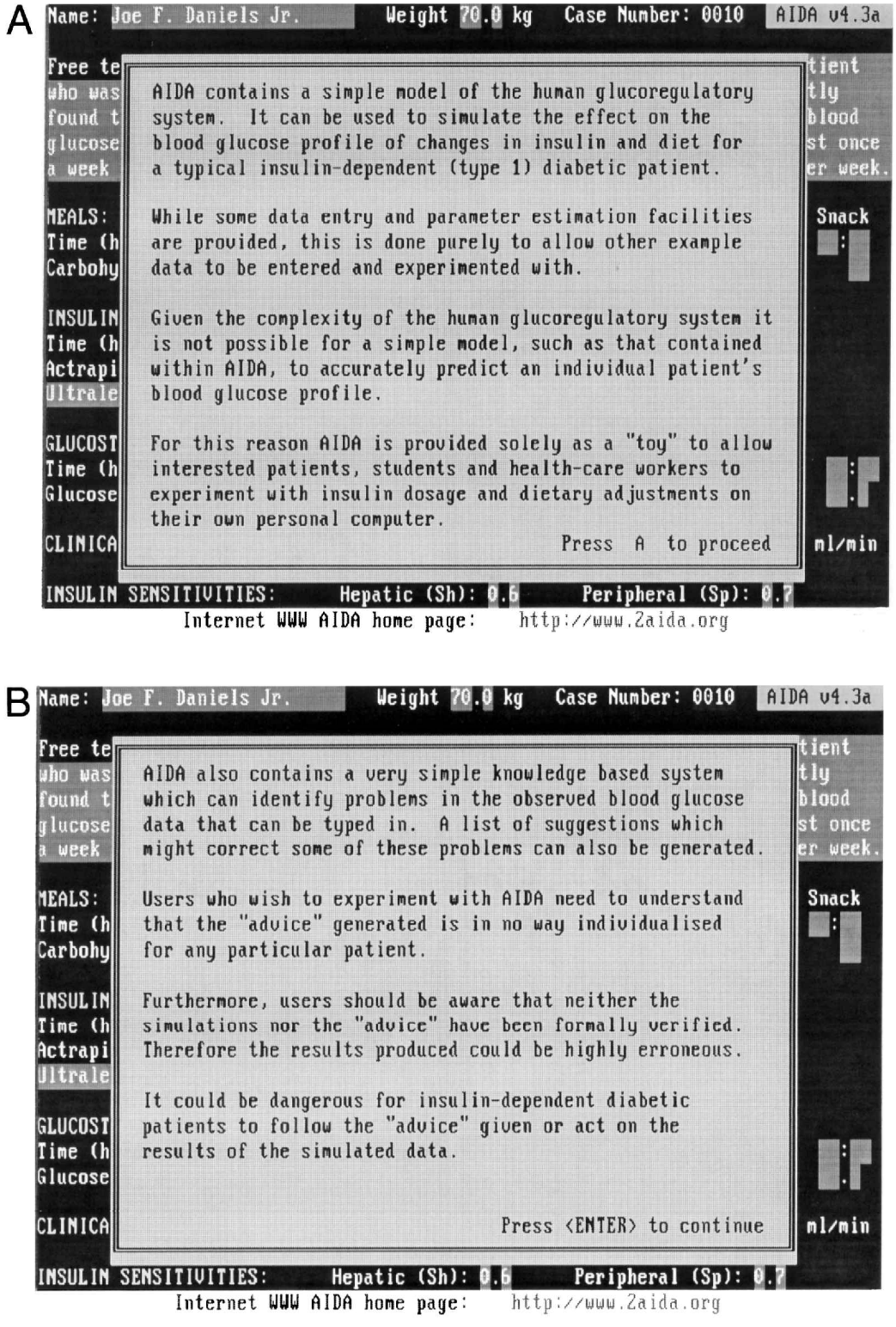

FIG. 3. (**A**) Opening caveat/warning screen for the AIDA diabetes simulation software. It is not possible to run the AIDA simulator without viewing this screen and pressing a key to move onto the next screen. (**B**) Second caveat/warning screen for the AIDA diabetes simulation software. It is not possible to run the AIDA simulator without viewing this screen and pressing a key to move onto the next display.

that, if applied properly with a short course of lessons,[8] the program may actually help to improve HbA_{1c} levels and reduce the number of hypoglycemic episodes.[9] This initial experience is based on a small, pilot study just involving 24 patients with diabetes, so clearly substantial proof of efficacy will need to await the results of larger-scale studies.

In this respect, it is important to make clear that workshops, such as the current one, or that involving GPs,[2] do not provide any proof of effectiveness in improving overall outcome in diabetes, nor in enhancing the quality of life. Randomized-controlled trials (RCTs) are required for this.

Connected with this, we have developed a standardized RCT protocol that can be used to evaluate the utility of such diabetes simulation software for educational use with patients.[8] As highlighted above, preliminary pilot study results from teaching sessions with 24 diabetic patients have established the feasibility of this approach.[9] Further information about this can be found at www.2aida.org/evaluate on the Web.

CONCLUSION

This workshop appears to have been a success and popular with the participating student nurses. Furthermore, it appears that the use of AIDA as a teaching tool for student nurses is a new avenue that could be explored to capitalize on the potential utility of the software. Further workshops involving other health-care students and professionals, in particular medical students and qualified nurses, are planned.

With the idea of further diabetes workshops making use of AIDA for teaching students, patients, and fellow health-care professionals—and the plan to run RCTs to evaluate the educational efficacy of such simulation software in small group diabetes teaching sessions—the issue of how to train teachers/demonstrators to use AIDA becomes of increasing importance.

In a future issue of the journal, this topic will be considered, providing some recommendations and guidelines for fellow health-care professionals who wish to teach using AIDA.

SYSTEM AVAILABILITY

The latest release of AIDA (v4.3a) can be downloaded, without charge, from 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. A fully Internet-based version of AIDA, called AIDA online, is also available for use free-of-charge at www.2aida.org/online on the Web. This allows AIDA's diabetes simulations to be run from any computer, anywhere, provided it has an Internet connection and a graphical display.

An interactive educational Diabetes/Insulin Tutorial that has been integrated with AIDA online can also be accessed without charge at www.2aida.org/tutorial on the Web. This allows visitors to dynamically simulate some of what they have learnt in the tutorial about balancing insulin and diet in diabetes using AIDA online.

People who wish to be automatically informed about future updates and enhancements to the AIDA/AIDA online diabetes software range can subscribe (for free) to the AIDA diabetes simulator announcement list by sending a blank e-mail note to subscribe@2aida.org

Any readers who might be interested in collaborating by teaching in their clinics using AIDA or by applying a standardized randomized controlled trial protocol[8] in an evaluation of AIDA in clinician-, specialist nurse–, or 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 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 e-mail 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, quoting Diabetes Information Technology & WebWatch.

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