

Diabetes Information Technology & WebWatch

Interactive Educational Diabetes/Insulin Tutorial at www.2aida.info

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ABSTRACT

The World Wide Web now hosts a multitude of diabetes educational materials in various formats. Of particular interest is the diabetes/insulin tutorial available at the AIDA Website (accessible directly at: www.2aida.info). The tutorial combines textual or “static” information with an interactive diabetes simulator—AIDA online—to provide an engaging and effective educational tool. AIDA online (accessible directly at: www.2aida.net) enables the simulation of plasma insulin and blood glucose levels from user-defined insulin injection and carbohydrate intake data. A haemoglobin A_{1c} value is also computed, giving an indication of overall blood glucose control in the virtual patient with diabetes. The diabetes/insulin tutorial is currently composed of four sections: the first two cover in considerable depth insulin injection regimens and insulin dosage adjustment; the third section introduces the principles of carbohydrate counting and, specifically, matching insulin doses to carbohydrate intake; and the fourth section illustrates the relationship between blood glucose levels and renal excretion of glucose. The simulator runs alongside the tutorial, and allows various concepts described in the text to be explored freely by the user and simulated interactively. This introduces a novel way of learning how injected insulin and dietary carbohydrate interact in various insulin injection regimens. A fifth section—for which any offers of assistance would be gratefully received—is planned. This will consider the use of insulin pumps and rapidly acting and very long-acting insulin analogues. Further improvements that may strengthen the existing tutorial and/or use of the online simulator are discussed in this column.

INTRODUCTION

AS THE INTERNET HAS BECOME more accessible to the general population, so Web-based educational material has increased in

popularity. There is no shortage of information about diabetes or insulin treatment on the World Wide Web. This column overviews an interactive educational diabetes/insulin tutorial, which is freely available at the AIDA Web-

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The AIDA software referred to in this report is an independent, non-commercial development that is being made available free-of-charge via the Internet—at a dot org (.org) not-for-profit Website—as a non-commercial contribution to continuing diabetes education. Dr. Lehmann is a co-developer of the AIDA diabetes simulator and AIDA online, and Webmaster of the www.2aida.org and www.2aida.net Websites.

site (accessible directly at: www.2aida.info). The tutorial utilises the Web-based version of the diabetes simulation software, AIDA, which is a freeware computer program that enables interactive simulation of plasma insulin and blood glucose levels for educational purposes. Whilst many diabetes educational Websites are highly informative, most are static in nature, being made up mainly of textual material. In this respect, the diabetes/insulin tutorial featured at the AIDA Website stands out as being a more dynamic approach to Web-based learning.

The diabetes simulator software and the AIDA Website have been reviewed previously elsewhere.¹⁻⁷ In this column, detailed consideration is given to the diabetes/insulin tutorial. Ways in which it may be further developed, and its educational utility enhanced, are explored.

AIMS OF THE TUTORIAL

AIDA online (accessible directly at: www.2aida.net) is based on the interactions that take place in the human body among injected insulin, dietary carbohydrate, and blood glucose levels in people with insulin-requiring diabetes. The informational content of the tutorial is accordingly centred around insulin treatment for diabetes. Balancing injected insulin with the body's requirements for insulin, taking diet and other factors into account, forms the backbone of diabetes management in people with insulin-dependent (type 1) diabetes mellitus. The tutorial, which has been based in part on an introductory course for people with type 1 diabetes,⁸ aims to demonstrate how insulin and dietary regimens work, and how they can be adapted to optimise blood glucose control.

As with all applications that involve the use of such diabetes simulation software, some caveats apply that need to be read and understood.⁷ These are largely based on the limitations of the model upon which AIDA has been based,⁹ and relate to the fact that the model is not sufficiently refined for individual patient simulation.¹⁰ No aspect of AIDA should therefore be applied for personal use or individual

therapeutic planning; this is emphasised throughout the tutorial pages, and patients are encouraged to consult with their health-care professional before making any changes to their own treatment regimen.

A further caution that warrants note is that recommended treatment approaches may vary between clinic settings, and especially between countries. Thus the tutorial is not intended to provide a specific or didactic plan for using insulin. Rather, it aims to give insight into how various treatment options work, and how they might be fine-tuned for optimum blood glucose control. Integrating the diabetes simulator with the tutorial pages enables the principles of insulin treatment to be learned in an applied fashion, without the need to experiment on real patients.

THE TUTORIAL AND DIABETES SIMULATOR IN ACTION

The tutorial can be accessed either by selecting "Insulin Tutorial" from the bottom menu frame bar of the home page at the AIDA Website (www.2aida.org), or directly at: www.2aida.info

The key feature of the tutorial is that the textual or "static" information is linked-in with simulations of selected case scenarios, which are run in parallel in a second Web browser window. The interactive nature of the online simulator brings the informational content of the tutorial to life and greatly enhances the learning experience.

Four sections of the tutorial are currently available online, and a fifth section—for which any offers of assistance would be gratefully received—is planned (Table 1). The first two sections form the bulk of the present material, and concentrate on the ins and outs of various insulin injection regimens and insulin dosage adjustments. The third section integrates meal planning and carbohydrate counting, and the fourth section looks at the relationship between the kidney and blood glucose levels.

Interactive simulations engage the user

Throughout the tutorial, HyperText Markup Language (HTML) links invite the user to sim-

TABLE 1. OUTLINE OF CONTENT OF THE DIABETES/INSULIN TUTORIAL AT: WWW.2AIDA.INFO

Section 1: Insulin-dosage adjustment (basics)—15 Web pages	
•	Insulin action profiles and uses; “regular,” “long-acting,” and “premixed” insulins are considered
•	Insulin treatment: injection regimens
•	Intensive and conventional insulin therapy
•	Basal/bolus insulin therapy
•	“Honeymoon period”
•	“Dawn phenomenon”
Section 2: Choosing the insulin dose—15 Web pages	
•	Concept of blood glucose control
•	General algorithms for changing insulin doses
•	Numerous examples of patient test records illustrating various concepts of insulin-dosage adjustment for a number of different insulin regimens
•	Deals with anticipatory and corrective insulin dose adjustments
Section 3: Timing of meals and diet planning—5 Web pages	
•	Carbohydrate counting; matching insulin dose to carbohydrate intake
•	Basic dietary considerations (“healthy eating”)
•	Special occasions
•	Extra carbohydrate to counter effects of exercise
Section 4: Glucose and the kidney—6 Web pages	
•	Filtering of glucose by the kidney
•	Renal threshold (analogy of a dam)
•	Glucosuria
Section 5: Rapidly and very long-acting insulins and insulin pumps—16 Web pages (planned—although assistance with this section would be gratefully received)	

ulate relevant case examples. The simulator runs alongside the tutorial in a second Web browser window, and the user is free to switch from one window to the other, as desired. In practice some users may find it easier to split the windows—i.e., arrange the two browser windows on the screen so that both are visible at the same time (Fig. 1).

In each case, the simulation window displays two graphs covering a 24-h period. The first graph shows blood glucose levels throughout the day, and indicates the time and quantity of carbohydrate intake. The second graph shows the time and dosage of insulin injections, and the resultant plasma insulin level. A glycosylated haemoglobin (HbA_{1c}) value for the simulation is also computed using the formula given in Lehmann.¹¹

The preselected case scenario is then described, along with some hints and suggestions, which help to direct the necessary thought processes. This is followed by the data entry form, in which users can change variables and re-run the simulation to see the effects of the changes on the two graphs. For example, Figure 2 shows the baseline simulation from Figure 1 following an increase in the morning Humulin S dose from 3 units to 10 units. The

resultant lowering of the blood glucose profile until after lunch is clear to see. Usefully, the blood glucose and plasma insulin levels in the previous run are also indicated on the re-run graphs, enabling the effects of the changes to be easily visualised. A new HbA_{1c} value is also computed [in the example in Fig. 2 showing a reduction in HbA_{1c} from 10.6% (see Fig. 1) to 10.2%].

At this stage the user may wish to continue to explore variations with the case scenario, running further simulations, or to return to the textual/informational pages and continue with the tutorial. It is also possible to choose an alternative case scenario from the simulator; however, it is pertinent to remain focussed on the subject matter of the tutorial. It is the experience of one of us (K.R.) that visitors can easily be sidetracked from the tutorial, becoming engrossed with the simulator, so attention needs to be redirected back!

Insulin injection regimens

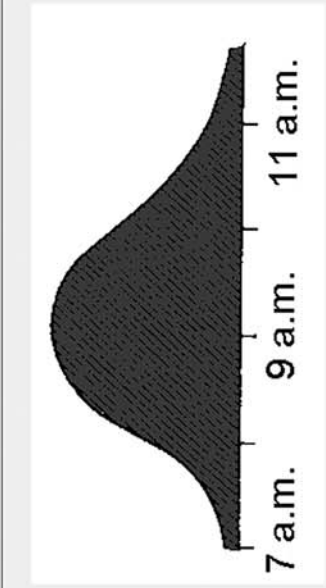
In order to keep things simple, the textual information in the tutorial refers to the action of “regular,” “long-acting,” or “premixed” insulin preparations when describing insulin reg-

diabetic software blood glucose simulator program - Diabetes / Insulin Tutorial 1-1 - Mozilla

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1. Regular insulin
Regular insulin has an effect which comes on rapidly but lasts for only a short time.

Action characteristics:
Onset of action: ½ to 1 hour after injection.
Peak activity: 2 to 3 hours after injection.
Duration of action: 4 to 6 hours after injection.



When this kind of insulin is injected at 7 a.m., the effect will look like this.

Regular insulin is given whenever a rapid insulin effect is required.
Regular insulin is used in emergencies, e.g., diabetic ketoacidosis.
Regular insulin can also be combined with **long-acting insulin**.
Regular insulin can be mixed in the syringe with any other kind of insulin.

However, insulins used for this purpose should always be of the same species (i.e. insulin or porcine insulin) and should be from the same manufacturer.

[Click here to simulate an example case using this type of insulin](#)

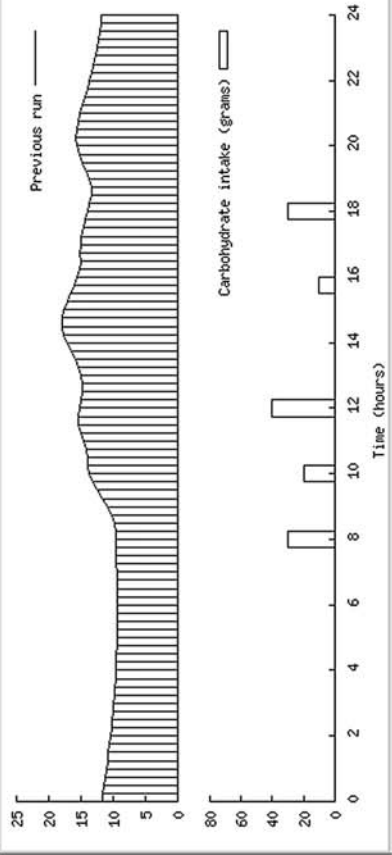
AIDA on-line2 @ http://www.Zaida.net - Web based diabetes simulations - Mozilla Firefox

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Blood Glucose (mmol/l)

HbA1c = 10.6 %

Current Run



Plasma Insulin Level (mU/l)

Current Run

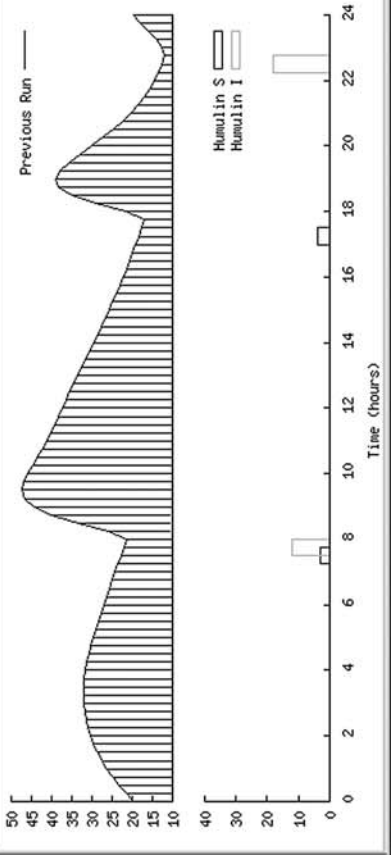


FIG. 1. Screenshot from the AIDA diabetes/insulin tutorial at: www.Zaida.info showing two browser windows open side by side. In the left-hand window textual and static graphical information about regular insulin is provided. In the right-hand window an example case scenario using this type of insulin (Humulin S) is provided for interactive simulation.

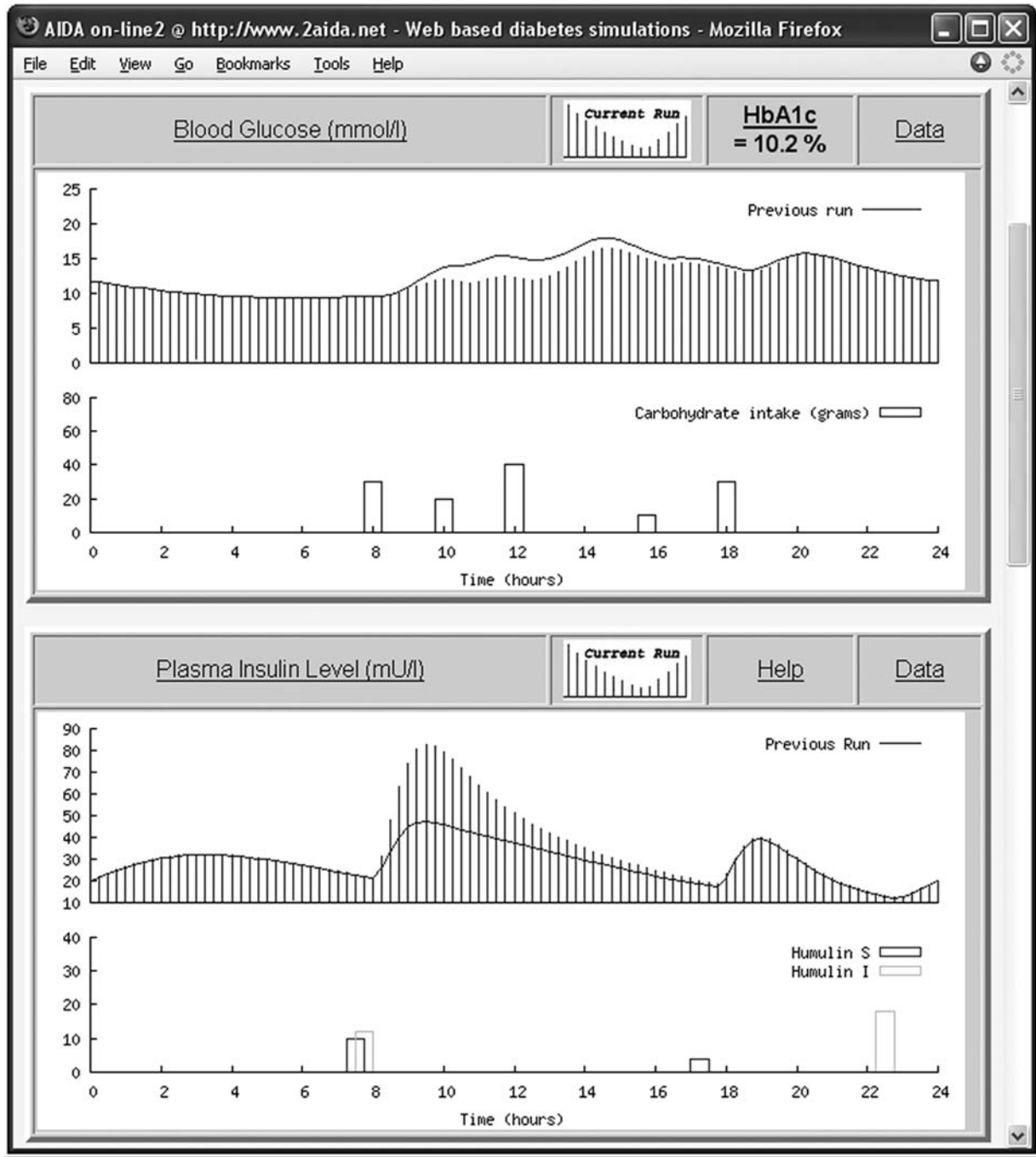


FIG. 2. Baseline simulation from the right-hand window from Figure 1 following an increase in the morning Humulin S dose from 3 units to 10 units. The resultant lowering of the blood glucose profile until after lunch is clear to see. A new HbA_{1c} value has also been computed showing reduction in the HbA_{1c} from 10.6% (see Fig. 1) to 10.2%.

imens. This allows concepts to be described without complicating matters by introducing specific insulin types, manufacturers, or "brand names." However, running the simulator alongside the tutorial text enables the user to explore and compare the effects of various insulin

preparations, including premixed (biphasic) formulations.

Each example case scenario chosen to run alongside individual pages in the tutorial is different, and collectively they demonstrate the wide variation of insulin regimens that are

used today. Advantages and disadvantages are noted, and illustrated, and in each case the simulator can be used to illustrate how injected insulin, plasma insulin, carbohydrate intake, and blood glucose levels relate to each other and interact in the “virtual patient with diabetes.” This leads easily into the features of “conventional” and “intensive” insulin therapy, and an understanding of the concepts of basal and bolus (the latter referred to as “booster rate”) insulin dosing.

Concepts that patients may have difficulty in understanding are dealt with in a relevant manner. For example, the “dawn phenomenon” is described and explained in detail, with a sound practical approach to determining the most appropriate insulin regimen for optimal nocturnal/early morning blood glucose control.

Insulin-dosage adjustment

The second section of the tutorial begins with an invitation for users to consider their understanding of the concept of blood glucose control, and how this may be achieved. This provides an excellent opening for the ensuing discussion of insulin-dosage adjustment. Several examples of hypothetical patients’ test results are presented, covering a wide range of different insulin regimens. In each case, the simulator allows the user to explore the principles described in the tutorial text, by changing parameters and re-running simulations. Thus learning is enhanced through individual experimentation. The scenarios that are examined address both anticipatory and corrective insulin-dosage adjustments.

Carbohydrate intake

The third section of the tutorial introduces the concept of insulin-dose adjustment for changes in dietary intake of carbohydrate. Although no direct links to simulations are provided in this section of the tutorial, the online simulator is still accessible via the AIDA Website. If Section 2 has just been completed—and the user is working through the tutorial section-by-section, as is advised by the authors—then the simulation window should already be open, and the user should at this stage be suf-

ficiently familiar with the simulator software to be able to investigate the effects of varying carbohydrate intake in various case scenarios. If the user is “entering” the tutorial at Section 3, then the simulator may be launched from the small pop-up window that opens when the user first visits the AIDA Website. If this window has previously been closed, then it can be re-launched by re-loading the frames version of the Website.

The interactive simulator allows for variation in carbohydrate intake (both quantity and timing), and the effects of meal timing in relation to insulin timing, to be investigated. Other aspects of diabetes management, such as coping with changes in daily routines, “special occasions,” and exercise, are also considered here. The simulator currently does not specifically allow for changes in metabolism occurring during strenuous activity; however, the principles relating to increasing dietary intake to avoid hypoglycaemia are still explained.

This section could be expanded to fully embody the principles of DAFNE (Dose Adjustment For Normal Eating), which is a specific program of training in insulin-dosage adjustment for patients with type 1 diabetes, that is currently being piloted in the United Kingdom and parts of Australia (vide infra).¹²

Blood glucose and the kidney

The fourth section of the tutorial considers the relationship between the kidney and blood glucose levels. The filtering of glucose by the kidney is described, and the analogy of a dam is used to explain the concept of the renal threshold for glucose (Fig. 3). The user is invited to run a simulation that demonstrates how blood glucose levels, renal threshold, and glucose in the urine inter-relate. The user can then change the renal threshold (possible settings are low, normal, or high) and observe the effects.

The “Advanced Display” option of the online simulator can also be used to look at various glucose fluxes in more detail; thus changes in renal excretion of glucose (in mmol/h) can be monitored, as the user tries changing various parameters. This is a good example of an intelligent applied use of the diabetes simulator.

Renal threshold = a dam for glucose

Do you understand the relationship between the kidney and the blood sugar level?

Lots of people find this difficult to understand. But because it is so important we shall try to explain it once more in a different way.

Imagine that we are standing beside a large river at the end of which a dam has been built. The dam holds back the water in the river. Only when the water in the river rises very high can it flow over the dam.

The kidney is like the dam

The "renal dam" or "renal threshold" is roughly 160 mg/dl (8.9 mmol/l) high. Although the exact height does vary from person to person.

FIG. 3. Demonstration of how the analogy of a dam is used to explain the renal threshold of glucose, and the renal excretion of glucose into the urine, in section 4 of the diabetes/insulin tutorial. Derived in part from Hurter and Travis.⁸

Additionally, the use of time frames in the simulations reinforces the fact that measuring urine glucose only provides an indication of earlier blood glucose levels, and this may not reflect the current status. Thus, this last section of the tutorial illustrates the limitations of using spot urine glucose measurements as opposed to blood glucose monitoring, as a tool to aid insulin-dosage adjustment.

FUTURE DEVELOPMENTS AND POTENTIAL IMPROVEMENTS

The AIDA simulator, Website, and diabetes/insulin tutorial are all ongoing projects and hold much potential for future development. New features that may be incorporated into AIDA in the future—such as the consideration of insulin analogues, and exercise and stress levels—would undoubtedly add to the potential of the tutorial itself. Indeed, work has been planned on a fifth section—which aims to cover insulin preparations such as Humalog/lispro, as well as the use of insulin pumps—although assistance with developing such an additional section would be appreciated. There are also a number of other possibilities for the development of the tutorial, which may further broaden the scope of this innovative educational resource. Some of these are outlined below.

Newer insulin preparations

New very long-acting insulin analogues have become available relatively recently, and these are becoming increasingly popular with patients and diabetes health-care professionals alike. Since these have markedly different action profiles to previously available “long-acting insulins,” it will be important that these are considered—in both the tutorial and the simulator.

Glossary of terms

As it stands, the tutorial is concise and succinctly written. However, there are a number of terms and concepts that could usefully be expanded upon for the less educated user. HTML links to a small pop-up window style glossary may be a feasible option.

Menu structure

The different sections of the tutorial have been designed to be completed in their entirety, and in order. However, a menu structure that enabled users to independently access summary pages for each section, allowing users to “dip in and out” of the tutorial, could be of value to returning visitors.

Specific audiences

The AIDA Website has been designed to be used freely by patients, relatives, carers, students, researchers, and health-care professionals alike. Accordingly, the Website content aims to cover all bases. The tutorial, which is currently primarily aimed at “general” patient education, could also be tailored to suit various different audiences; for example, a specific version for the education of health-care professionals and students would conceivably be of value.

An adapted version of the current tutorial may be of use specifically for pre-conception education of young women who are considering starting a family. This is a crucial time when blood glucose control should be optimised and the patient needs to be fully informed about intensive treatment and insulin-dosage adjustment. The tutorial may also be adapted specifically to be used in diabetes management skills-based training programmes, such as DAFNE.¹²

The DAFNE approach to insulin treatment, which originally evolved in Germany, but is now widely adopted in many countries, is centred on flexible insulin-dosage adjustment to match carbohydrate intake with a free diet. Initial randomised controlled trial results are promising,¹² and further research is in progress. Of particular interest are the studies being conducted into adapting the DAFNE material for the education of school-age children.¹³ It is recognised that this population has specific educational needs and learning styles, and the interactive nature of the simulation-aided tutorial may have added appeal for the younger generation.

While it is noted that AIDA is based on an adult model, the simulator can still be used effectively as an educational tool to demonstrate

the principles of insulin-dosage adjustment to young people. An adapted version of the simulation tutorial may also be of value in training DAFNE educators.

Downloadable version

A DOS-based version of AIDA¹⁻⁴ is available at the AIDA Website free-of-charge. This has proved to be a popular resource, with well over 190,000 copies of the program having been downloaded to date.¹⁴ It is conceivable that an accompanying downloadable tutorial could also be of interest to both health-care professionals and patients.

Collaboration and increased availability to external websites

In order to increase the availability of AIDA and promote intelligent use of the tutorial, collaboration is actively sought. Webmasters of diabetes Websites may be interested in making use of some of the diabetes/insulin tutorial HTML pages and graphics at their own Website. The AIDA developers have created a version of the tutorial that can operate externally from the AIDA Website. The interactive diabetes simulations (which require some dedicated server programs and set-up) can operate across the Internet in a separate pop-up/new window. A standard HTML template is available from the AIDA Website developers to help ensure that material is in the appropriate format. Further information is available from: www.2aida.org/contact

Examples of third-party use of the tutorial material can be found in operation across the Internet; a case in point is illustrated at: www.mendosa.com/www-2aida-org/tutorial.htm (Fig. 4), and the material has even been translated into other languages. For instance, a Russian language version can be found at: www.diabet.ru/aida2/rus/tutorial.htm (Fig. 5).

Invitation for help

The AIDA Website developers openly express their hope that the tutorial will become a dynamic resource and, over time, will expand and grow. Health-care professionals who are interested in contributing material are invited to get in contact using the online AIDA contact

form (at: www.2aida.org/contact). For instance, assistance with the provision of teaching materials related to rapidly acting and very long-acting insulins, and the use of insulin pumps would be gratefully received. Similarly, readers who would like to help with translating the tutorial into other languages are also invited to make contact. All contributions to AIDA and/or the tutorial are fully acknowledged at the Website.

Stay informed

To be informed by e-mail as soon as new free-to-use sections/lessons for the tutorial become available at the AIDA Website, visitors are invited to register for the very low volume AIDA e-mail announcement list; this can be done at: www.2aida.org/register, or by sending a blank e-mail note to: subscribe@2aida.org

DISCUSSION

This Web-based tutorial endeavours to “teach a little bit about balancing insulin and diet in diabetes” and modestly purports to “offer some information about different insulin-dosage adjustment regimens.” In fact, it already accomplishes far more than this, and with further development it has the potential to achieve even more.

In working one’s way through the tutorial, it becomes evident that one is learning about insulin action and blood glucose control in very realistic circumstances. The text itself is not dissimilar to other published descriptions of insulin action and insulin regimens; however, when it is combined with virtual patient simulations of blood glucose response to insulin and carbohydrate intake, it makes much more sense.

The amount of information given in any one page is well considered so that the tutorial is comfortably paced; the content has been carefully subdivided into manageable sections, which helps with the assimilation of what amounts to quite a lot of information. The interaction between the static informational pages and the diabetes simulator works well, and makes the tutorial both interesting and enjoyable.

A good working knowledge of insulin action and a thorough understanding of the interac-

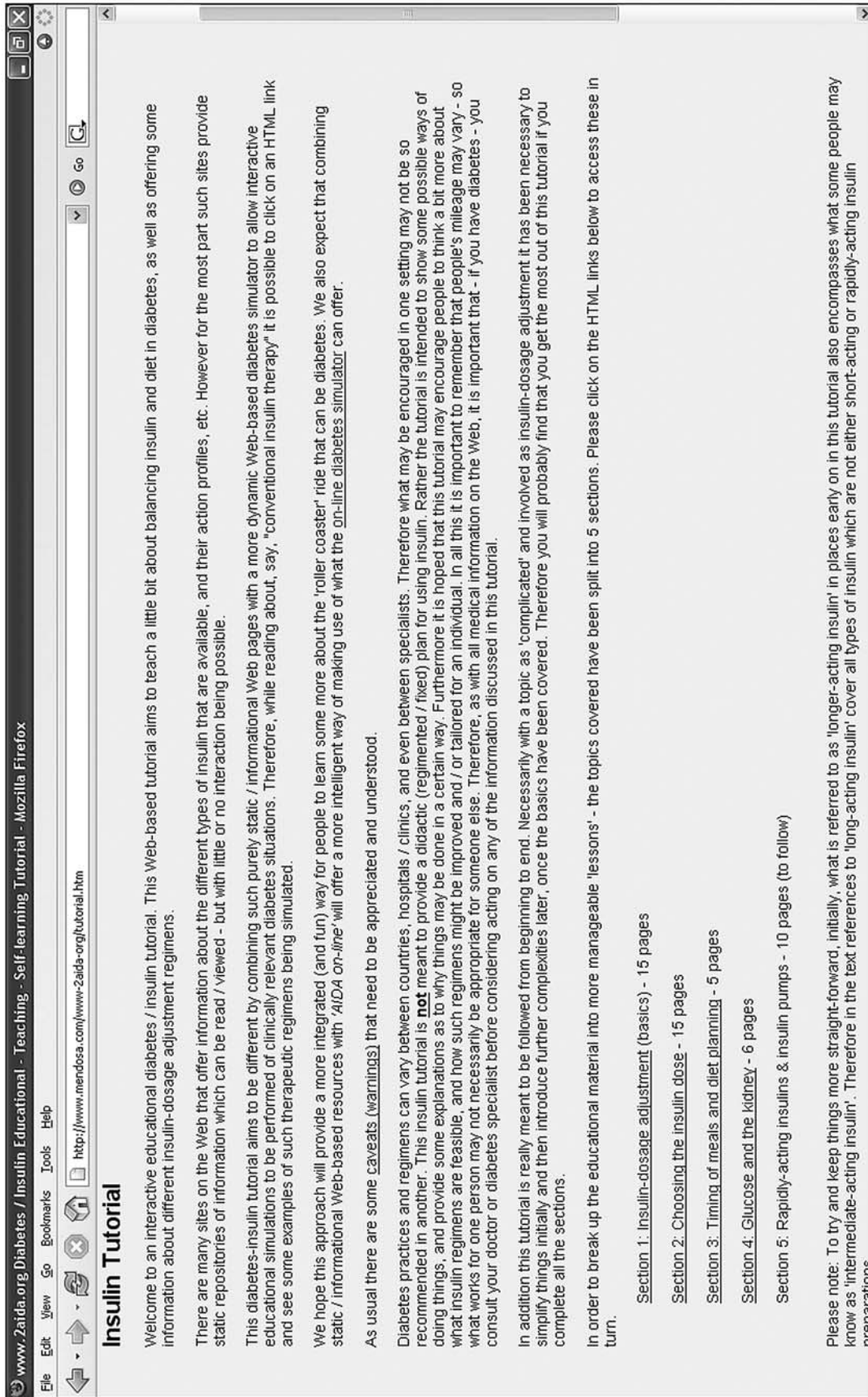


FIG. 4. Screenshot showing the textual information from the diabetes/insulin tutorial operating at: www.mendosa.com/www-2aida-org/tutorial.htm. In order to display the interactive diabetes simulations, calls are made across the Internet to the online simulator at the www.2aida.org Website. Website owners who may be interested in hosting further copies of the diabetes/insulin tutorial at their Website(s), with interactive links to the online diabetes simulator, are invited to make contact via the www.2aida.org/contact Web page.

www.Zaida.org Diabetes / Insulin Educational - Teaching - Self-learning Tutorial - Mozilla Firefox

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http://www.diabet.ru/aida2/rus/tutorial.htm

Информация, представленная в инсулиновом тренажере, предназначена только для целей обучения и не может использоваться для оптимизации лечения реального, а не виртуального больного диабетом и ни в коем случае инсулиновый тренажер не заменяет врача. Если у Вас возникнут вопросы, связанные с обучением на инсулиновом тренажере, или после обучения на нем у Вас появится желание изменить свое лечение, то прежде чем принимать какое-либо решение, посоветуйтесь с вашим лечащим врачом.

Инсулиновый тренажер

Дорого пожаловать в интерактивную обучающую программу по сахарному диабету - инсулиновый тренажер. Этот Интернет-тренажер предназначен для получения представления о взаимоотношении инсулина и диеты при диабете, а также различных схемах инсулинотерапии.

На многих Сайтах представлена информация о различных препаратах инсулина, их действия и т.п. Однако на большинстве Сайтов это статическая информация, которую можно только прочитать или просмотреть, но отсутствует интерактивное ее представление.

Наш инсулиновый тренажер отличается тем, что он включает кроме статической и интерактивную часть, которая позволяет имитировать часто встречающиеся клинические ситуации при диабете. Следовательно, когда вы знакомитесь с материалом, посвященном "традиционной инсулинотерапии" вы также можете выйти на страницу Сайта, на которой имитируются такие режимы лечения.

Мы надеемся, что такая возможность позволит более полное представление о динамическом лечении диабета. Мы также полагаем, что сочетание статической/информационной составляющей с программой *'AIDA on-line'* позволит более полно использовать преимущества имитации диабета on-line.

Очевидно, имеется ряд ограничений в нашем подходе, которые следует учитывать и понимать.

Практика лечения диабета и схемы инсулинотерапии могут отличаться в разных странах, клиниках и даже между специалистами. Отсюда, одни и те же схемы лечения в одном случае могут рекомендоваться, а в другом - запрещаться. Наш инсулиновый тренажер **не предназначен** для оптимизации лечения конкретного больного. Прежде всего тренажер показывает некоторые возможные решения проблем и позволяет получить представление о вариантах такого решения. Более того, мы надеемся, что тренажер будет стимулировать внимание больного диабетом на важность оптимизации режимов инсулинотерапии и позволит получить представление о том, как улучшить режимы инсулинотерапии в конкретных ситуациях. Но, во всяком случае, важно иметь в виду, что у каждого человека свои представления о пользе - то что хорошо одному может не подходить другому. Более того, прежде чем использовать для своего лечения любую медицинскую информацию, размещенную в Интернете (в том числе и на этом Сайте), нужно проконсультироваться у своего врача или диabetолога.

Кроме того, предполагается, что эта обучающая программа будет осваиваться строго последовательно - с начала и до конца, без пропусков изложенного материала. Разделы, которые обозначены как "сложные" введены для того, чтобы на начальном этапе обучения дать общие представления об инсулинотерапии, а затем - более сложные навыки лечения. Таким образом, наибольшая польза от этой программы будет достигнута лишь в том случае, если будут освоены все ее разделы без пропусков.

Для структурирования обучающего материала в виде "уроков" мы выделили 5 разделов. "Кликнув" мышкой на каждом из них, вы попадете в соответствующий раздел:

[Раздел 1: Подбор дозы инсулина \(начальные представления\)](#) - 15 страниц

[Раздел 2: Выбор дозы инсулина](#) - 15 страниц

[Раздел 3: Время приема пищи и планирование диеты](#) - 5 страниц

FIG. 5. Russian language version of the diabetes/insulin tutorial hosted from Moscow at: www.diabet.ru/aida2/rus/tutorial.htm. As in the example shown in Figure 4, in order to display the interactive diabetes simulations, calls are made across the Internet to the online simulator at the www.Zaida.org Website. Readers who may be interested in translating the diabetes/insulin tutorial into other languages, with interactive links to the online diabetes simulator, are invited to make contact via the www.Zaida.org/contact Web page.

tions among injected insulin, dietary intake, and resulting blood glucose are essential for anyone living with, or treating a patient with, insulin-requiring diabetes. However, insulin dose is not the “be all and end all” in diabetes management, and this comes across appropriately in the tutorial; it is rightly pointed out that carbohydrate intake may equally be adjusted in some cases in order to correct inadequacies in blood glucose control. It is also notably reassuring that the dangers of “chasing one’s tail” when correcting blood glucose levels are highlighted.

The principles underlying insulin treatment are not easily learned in a single teaching session¹⁵; however, the application of the interactive simulator with this tutorial allows immediate experimentation and enables the user to learn with a more “hands-on” approach.

CONCLUSION

The diabetes/insulin tutorial at the AIDA Website at: www.2aida.info is a stimulating and effective Web-based learning resource with potential for further development. It introduces a unique interactive element to the learning experience, which allows the user to explore the concepts underlying blood glucose management at an individual pace. This enterprising tutorial demonstrates an intelligent way of applying the interactive diabetes simulator in conjunction with textual information, and we recommend it to be investigated by anyone with an interest in patient education resources for diabetes.

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REFERENCES

1. Lehmann ED, Deutsch T: A physiological model of glucose-insulin interaction in type 1 diabetes mellitus. *J Biomed Eng* 1992;14:235–242.
2. Lehmann ED, Deutsch T: AIDA²: A Mk. II automated insulin dosage advisor. *J Biomed Eng* 1993;15:201–211.
3. Lehmann ED: Development, evaluation, and usage of ‘AIDA’—an interactive educational diabetes simulator [Ph.D. Thesis]. London: University of London/Imperial College of Science, Technology and Medicine, 2004.
4. Lehmann ED: Experience with the Internet release of AIDA v4—an interactive educational diabetes simulator. *Diabetes Technol Ther* 1999;1:41–54.
5. Lehmann ED: User reviews of AIDA online: a Web-based interactive educational diabetes simulator. *Diabetes Technol Ther* 2000;2:329–342.
6. Lehmann ED, DeWolf DK, Novotny CA, Gotwals RR Jr, Rohrbach RP, Blanchard SM: Dynamic interactive educational diabetes simulations using the World Wide Web [abstract]. *Diabetes Technol Ther* 2001;3: A17–A20.
7. Reed K, Lehmann ED: Diabetes website review: www.2aida.org. *Diabetes Technol Ther* 2005;7:741–754.
8. Hurter P, Travis LB: *Introductory Course for Insulin-Dependent Diabetics*, 6th ed. Frankfurt: Gerhards, 1991.
9. Lehmann ED, Deutsch T: Compartmental models for glycaemic prediction and decision-support in clinical diabetes care: promise and reality. *Comput Methods Programs Biomed* 1998;56:193–204.
10. Lehmann ED, Hermanyi I, Deutsch T: Retrospective validation of a physiological model of glucose-insulin interaction in type 1 diabetes mellitus. *Med Eng Phys* 1994;16:193–202. [Published erratum in *Med Eng Phys* 1994;16:351–352.]
11. Lehmann ED: Simulating glycosylated hemoglobin (HbA_{1c}) levels in diabetes using an interactive educational virtual diabetes patient simulator. *Diabetes Technol Ther* 2001;3:517–524.
12. DAFNE Study Group: Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. *BMJ* 2002;325:746–751.
13. Knowles J, Waller H, Eiser C, Heller S, Lewis M, Price K: Paediatric DAFNE: development of a skills training curriculum for 11–16 year olds with type 1 diabetes [abstract P316]. *Diabet Med* 2005;22(Suppl 2):104–115.
14. Lehmann ED: Development, Evaluation and Usage of www.2aida.org. An Interactive Educational Diabetes Simulator. London: AIDA Publications, (in press).
15. Lehmann ED: Computer-assisted diabetes education and information technology in diabetes care. In: DeFronzo R, Ferrannini E, Keen H, Zimmet P, eds. *International Textbook of Diabetes Mellitus*, 3rd ed. Chichester, UK: Wiley, 2004:1639–1665.

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