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Information Technology in Clinical Diabetes Care—A Look to the Future

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ABSTRACT

In the last Diabetes Information Technology & WebWatch column (*Diabetes Technol Ther* 2004;6:422–429) various hurdles to the implementation of computerised decision-support tools in clinical diabetes care were highlighted. In this column a look is made to the future, considering ways in which information technology tools may be applied in diabetes clinics, and elsewhere, in years to come. Particular attention is focused on discussion of the ways in which *existing* technologies are likely to become better integrated—in the short to medium term—to provide benefits to people with diabetes, their relatives, and carers.

INTRODUCTION

In the previous Diabetes Information Technology & WebWatch column[1] hurdles to the use of computerised decision-support tools in clinical diabetes care were considered. The clinical background with respect to insulin-dependent (type 1) diabetes mellitus and the Diabetes Control and Complications Trial (DCCT)[2] was reviewed, and an overview was given of various computer applications. The use of decision-support tools was discussed, and the importance of identifying the proposed user—*e.g.*, health-care professional (HCP), student, or patient—was highlighted. Validation/evaluation issues were considered as important topics that remain to be properly addressed for many decision-support prototypes. The previous column[1] concluded by highlighting that in this era of evidence-based medicine well-conducted, rigorous evaluation and validation studies are required to inform decisions about whether or not to make use of current computerised decision-support prototypes. If the last column appeared "negative," or depressing, a slightly more positive outlook is given in the current article, looking to the future.

LOOKING TO THE FUTURE . . .

So, what can we expect from diabetes-computing in the future? Undoubtedly the greatest technological developments will be seen first in countries like the United States—with less wealthy nations following thereafter. However, a tangible effect of the application of information technology (IT) in clinical diabetes

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care should be seen relatively soon when the computer running the clinic appointments, and the database medical records system, and the laboratory results bulletin board all communicate with each other—transparently. When patients can hand in their smart cards or electronic logs at the reception desk, and while waiting for their appointment (some things may never change) have their self-monitoring blood glucose (BG) data downloaded, and a preliminary analysis automatically performed—with the computer highlighting hypoglycemic and hyperglycemic episodes as well as other features of the BG profile that its knowledge-based system (KBS) is unable to "explain." These unaccounted-for events could then be flagged for discussion with an HCP during the main consultation. The physician or diabetes specialist nurse would also be able to use the data to interactively simulate the effects of changes in the patient's insulin, diet, or exercise regimen—the aim being to reinforce the patient's own interpretation of his or her glycemic control and diabetes management. The medical records system would automatically remind the physician when various checks, *e.g.*, visual acuity or fundoscopy, were required.

Building established clinical guidelines alongside electronic medical records is one of the ways in which medical information systems will develop considerably in the future. For example, a KBS closely linked to a database could be used to highlight the presence of proteinuria. With a normal urine microscopy result and a normal renal ultrasound scan, the KBS would be able to suggest diabetic nephropathy as a cause, and in the presence of raised blood pressure recommend antihypertensive therapy with an angiotensin converting enzyme inhibitor. In the future well-established "good practice" and accepted clinical guidelines incorporated into such systems could offer considerable added value to users of such technology.

Should the patient have failed to attend the clinic a letter by way of reminder could automatically be sent by electronic mail, text message, fax, or post to the patient's mobile phone or home providing a new appointment. Patients who did not attend could be flagged on the system and reminders automatically copied to their primary care physician (general practitioner) in an attempt to ensure that patients—particularly those assessed to be at risk—were not lost to follow-up.

In-between clinic visits the patient could use a hand-held BG meter incorporating memory chips and suitable algorithms that could advise on the time and dose range of the next pen insulin injection, as well as on the time and approximate size of the next meal, with such advice being set within broad limits agreed upon after discussions between the doctor, patient, dietician, and other HCPs. The pocket unit would also be able to identify, based on previous "learnt experience" of that individual's diabetes control, trends in the BG profile suggestive that hypoglycemia might be imminent. Using this "knowledge" the unit could advise the patient sooner if medical assistance might be required or if some more carbohydrate should be taken.

For interested patients, their electronic log would have the facility to download its data to their personal computer at home, enabling an analysis of the self-monitored BG data to be performed there as well. With interactive simulation tools integrated into the same software the patient could use the computer to experiment with changes in the treatment regimen without running the risks of hypoglycemia. Questions arising from such simulations could be either raised at the next clinic visit, or communicated to a HCP across the telephone network, or via electronic mail.

In addition, the use of the Internet has the potential to serve as a vast repository of information and as a communication medium for both patients and HCPs.

Furthermore, with the miniaturisation of electronics and the extension of mobile telephone networks, and telematics facilities, it is easy to consider a day when a BG meter will incorporate a mobile telephone and be able to automatically dial a central computer, transmitting data after each BG measurement or when a problem in the patient's BG profile is identified. The central computer's advice could be transmitted back and shown on the BG meter's display. By having the possibility of human review and intervention at the central computer, many of the concerns about patients

acting solely on the basis of advice from a stand-alone, hand-held machine may be mitigated. As well as providing monitoring facilities, such an approach could also offer an automatic means of summoning help—particularly if the patient was hypoglycemic and confused or unconscious—unable to respond to, or comply with, simple instructions from the computer.

DISCUSSION

Is this all a flight of fancy? Some of it may be—but in fact the technology for all this is available today. Reports can be found in the literature describing many of the individual components required for such a system.[3–14] Indeed, much of the hardware is already being marketed by various companies—for other (non–diabetes-related) uses. However, to date much of the research work, and even more of the software development, has been fragmented. Therefore what appears to be lacking is a concerted effort to bring these endeavours together to produce not just separate individual computer programs, but rather an integrated, easy-to-use *system* that is patient and health-carer friendly. Such a system if properly validated and evaluated might permit the achievements of studies like the DCCT to be made much more widely available to motivated patients.

Certainly things appear to be changing with respect to the application of computers in diabetes care. Financial concerns, together with the results of the DCCT, appear to be driving greater interest in the application of IT to the provision of diabetes care. The DCCT showed that tight control matters,[2] but it costs money. Furthermore, long-term funding issues for diabetes care (separate from any moral or social costs) are driving health-care providers to look closely at financial considerations.

However, in all this new-found enthusiasm for IT it is important that patients receive real *medical* benefit from the application of IT—and that it is not just the financial bottom-line that is improved. As much attention needs to be directed to whether a given approach really works, as to decreasing hospital visits and cost, *i.e.*, does the proposed intervention improve glycosylated hemoglobin (HbA_{1c}) levels and decrease the number of hypoglycemic episodes ("hypos"). In this respect cost-effectiveness (and decreasing length of stays in hospital) are clearly different outcome measures to HbA_{1c} levels and reductions in the number of "hypos."

As the capital costs of computerisation are great, IT could turn out to be a false economy and prove an enormous drain on resources—unless the systems that are developed and adopted really do offer *medical* benefits to patients.

To demonstrate this clinical/medical benefit it remains vital that rigorous validation studies are undertaken. The need for more evaluation studies is not just of academic interest. Rather such studies could help to avoid the costs of developing expensive "white elephants"—that do not quite manage the job required. In recent years there have been examples where the application of IT to medicine has led to vastly expensive mistakes being made—with the resultant computer systems eventually either not being used—or being even more expensive to put right.

For this reason it is also important that the usage of all IT systems should form part of a long-term ongoing evaluation—not simply be installed and used—without any data being collected to demonstrate real utility.

With initiatives like the European St. Vincent Declaration[15] quality assurance (QA) processes have been proposed for the provision of diabetes care—with the aim being to improve the quality of the care given by making the delivery of care follow a more clearly defined, rigorous path. Similar QA principles also need to be adopted for much of today's software development work. To date such projects have often appeared to progress in a haphazard manner. However, the development cycle of such systems—particularly those intended for clinical application that have implications for patient management—must adopt rigorous QA principles.

Such principles are commonplace in industry but rarely seem to be applied in diabetes-computing projects, which often appear to have grown out of a promising small-scale project of some enthusiast(s). However, without the

adoption of QA techniques, confidence in the safety of the final software or computer system will necessarily be open to question. In addition, while the software/computing industry has considerable experience with safety-critical program development, it appears that few, if any, of these approaches have found their way into current diabetes-IT initiatives.

Nevertheless all is not "gloom and doom." The technological advances in computing power in recent years have been phenomenal. However, it is the way that we harness that computing power which needs to considered carefully. In this respect, IT-based systems should be regarded by physicians much like new pharmaceuticals. They hold much promise for helping patients—but can also have side effects (down sides). Just as a clinician would not dream of prescribing a new drug for a patient without being reassured by safety and efficacy trials—so physicians should have some healthy scepticism and be cautious in their use of new IT-based systems that have not been shown to be safe, and to do what is claimed of them.

CONCLUSIONS

It is self-evident that computers and the application of IT techniques are going to play an increasingly important role in the provision of health-care in years to come. Clearly computers can help by supporting repetitive tasks with documentation, record keeping, graphical displays, data analysis, pattern recognition, and feature extraction. This will be as true in the field of diabetes as in other branches of medicine. However, such data processing tools can only assist with the evaluation of relevant information if the data collection and the application of the results are an integral element of routine clinical practice. As was highlighted 13 years ago,[16] the lack of impact of such tools in diabetes care in part relates to the absence of smooth integration of these systems on the same computer platform as well as the need for alterations to standard operating procedures to make such systems work. Unfortunately, this still remains as true now as it was in 1991.[16] Such issues will need to be addressed and modifications made to existing working practices before decision-support tools can be properly applied in clinical diabetes care.

Furthermore, until the time that computer systems are seamlessly integrated into routine clinical practice, IT techniques need to be able to provide the user—whether this be a HCP or patient—with something in return for all the extra time and effort that is often required to use the computer system. Ideally, no extra energy would need to be expended to utilise the IT-based tool; however, at present this is rarely the case—so at present it remains the motivated and interested who seem to make the special effort.

However, in the coming years major advances are likely to arise from the computerisation of patient medical records with all the benefits that will so derive. Further technical work is clearly required to build systems that can reliably provide therapeutic advice for individual patients. However, the growing research interest in this area is likely to come to fruition. Nevertheless a prerequisite for such systems should be that they can explain their reasoning as the decision-making process should always be challengeable. Furthermore, the claims of system developers should be verifiable by independent validation studies.

While some patients and even HCPs may be relatively computer-phobic, and therefore not interested in such developments, a generation of children and teenagers are growing up for whom computers are a totally natural medium. They are far more knowledgeable than their parents about computers and are completely at ease with IT, having none of the fears or reservations that some parents may have. Many of this generation will also be far more receptive to high technology methods of communication than other more "mundane" approaches. Given this, the diabetes community needs to explore whatever novel media are available to assist it in the transfer of information, knowledge, and expertise to both current and future patients, as well as to current and future members of the health-care professions.

As the DCCT investigators[2] concluded, "because the resources needed are not widely available, new strategies are needed to adapt methods of intensive treatment for use in the general community at less cost and effort." The

DCCT investigators were not specifically discussing IT-based approaches, but it seems likely that computers and the application of IT-based techniques are going to play an increasingly important role in the provision of diabetes care in future years.

FURTHER TOPICS

If you would like to suggest further topics or Websites for future "Diabetes Information Technology and 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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