Diabetes electronic medical record system Experience at the M.V. Diabetes Specialities Centre, Chennai, India

V. Mohan, R. Deepa, M. Rema, A. Natarajan and S. Devanathan
M.V. Diabetes Specialities Centre and Madras Diabetes Research Foundation, Gopalapuram, Chennai, India (mvdsc@vsnl.com)

Introduction

The prevalence of diabetes mellitus is increasing in epidemic proportions and recent estimates suggest that approximately 120 million people worldwide have diabetes and this number is expected to double by the year 2025 [1]. The greater part of this increase is contributed by developing nations. India has already been declared as the country with the largest number of diabetic subjects in any given nation in the world (19 million diabetic people) ahead of China and the USA, which are in second and third place, respectively [1]. Furthermore, the projected estimate is that by the year 2025, India will have 57 million diabetics [1]. This clearly indicates that the economic burden due to diabetes and its complications in India will increase dramatically in the near future.

Diabetes, being a chronic metabolic disorder, often leads to potentially fatal complications such as nephropathy leading to renal failure, retinopathy leading to visual loss, neuropathy, peripheral vascular disease and coronary artery disease [2]. These complications are the major cause of diabetic morbidity and mortality. Two large, randomized, multicentre trials [3, 4] have proved beyond doubt that glycaemic control plays a major role in the development of these complications. These studies also showed that improving glycaemic control could help to reduce the risk of long-term complications. However, this can only be achieved by meticulous follow-up and the use of reliable medical records.

Various studies have shown that the health care provided for diabetes is inadequate [5, 6]. It has also been suggested that well-formulated health care strategies can improve the process of care and outcome for people with diabetes [7, 8]. To formulate such strategies, efficient and effective information systems are needed. In this report we describe the development and functioning of the diabetes electronic medical record (DEMR) system at the M.V. Diabetes Specialities Centre (MVDSC) in Chennai (formerly Madras), South India.

Computer-based systems have begun to be set up as a prerequisite for improving diabetes health care [9, 10]. Some of the renowned diabetes clinics worldwide have installed electronic medical record systems and are using them effectively for patient management [11, 12].

Background of our centre

The MVDSC in Chennai is one of the fastest growing diabetes centres in India. Since its inception in 1991, approximately 68,000 diabetic patients have been registered and about 10,500 new patients are added every year. The prevalence of known Type 2 diabetes in Chennai is 7.2% and our centre provides medical assistance to approximately 15% of this known diabetic population. Among the patients attending the centre, 60% are from the metropolitan city of Chennai, 20% from the southern region of India, 10% from the northern part of India and 5% from other countries such as Singapore, Sri Lanka, Malaysia, Saudi Arabia and Dubai.

The DEMR system at MVDSC

Computerization at MVDSC was started in a limited way in 1991 and stand-alone computers were initially used for medical records. The computers were later interlinked by a local area network and were used for appointments and registration of patients. A need was soon felt for an integrated system. Diabetes, being a clinically multifaceted disorder, requires the attention of a specialized team including diabetologists, podiatrists, dietitians, diabetes educators, ophthalmologists and clinical assistants. Thus any diabetes management system should include all these team members for effective, quality health care. Such a conceptual model for information on diabetic subjects was demonstrated by Smith [13].

Scope of the system

The scope of the system was to develop an electronic medical record for diabetic patients including all the areas depicted in *Figure 1*.

Phases of the project

The project started in late 1996 in collaboration with Novo Nordisk, Denmark. Our centre and Novo Nordisk provided the technical know-how, C.G. Maersk Information Technologies, India, developed the software, and the entire project was funded through a generous grant from the Danish Government Private Sector Programme. A project team was formed to identify the key areas to be included in the electronic record. The team included information technology (IT) personnel and professionals from C.G. Maersk Information Technologies, heads of all the departments, the computer personnel and all end-users at our centre.

The team designed the electronic record based on the existing medical records (case sheets). The main aim was to develop manageable, maintainable, upgradable, retrievable and user-friendly software. The language used was SQL server running on Windows NT at the back-end with Power Builder at the front-end. The advantages of this software were that it was user-friendly, multi-user and had a windows-based graphic user interface. The first phase of this project was designing the software and this was completed in early 1998 and further modifications such as inclusion of billing were added shortly afterwards.

Modules

Various modules were developed as shown in *Figure 2*. A brief outline of the functions is given below.

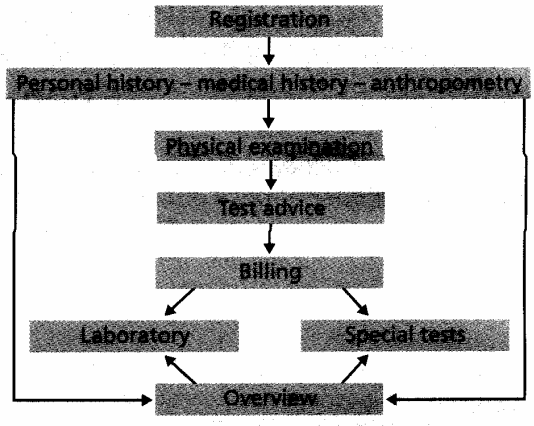

Fig. 1: Flowchart of work at MVDSC.

Registration

This module at the front desk of the centre caters for outpatient/inpatient admission. Registration includes providing the patient with a unique identity number recording the patient's occupation and address.

Medical history/personal history/anthropometry

The dietitians and junior doctors handle this module. Data regarding family history, personal history including smoking status, alcohol use and medical history are entered into this module.

Physical examination

The physical examination is carried out by senior doctors (consultants) and all the information pertaining to this, such as blood pressure, foot examination and general examination, are entered into this module.

Test advice

This module caters for handling of test requests. The test advice given to the patient is entered by

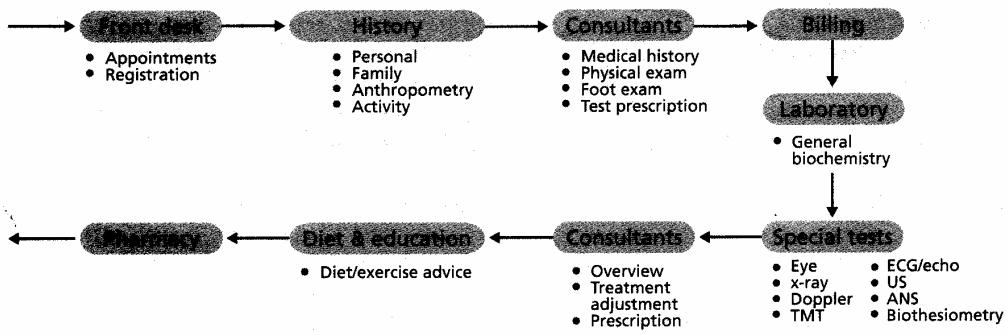

Fig. 2: Interconnection of the modules.

the doctor. The speciality of this module is that the test advice can be given in the form of packages, for example, the GTT package includes an oral glucose tolerance test, lipid profile, microalbuminuria, renal function test, eye examination, ECG, chest x-ray, doppler imaging and biothesiometry.

Billing
This module deals with money receipt generation and instant bill calculation for paying cases. Laboratory tests and special test charges are available on-line for billing.

Eye department
Ophthalmologists directly enter eye exam findings including visual acuity, fundus examination, laser treatment, etc., into the computer.

Overview
This module gives an overview of all the information on the patient and is used by consultants. The module also covers treatment advice given by consultants.

Implementation
Most of our DEMR end-users initially had no experience with computers. All the staff underwent basic training in Windows software and DEMR handling. The systems manager at our centre conducted a training programme highlighting the details of each module in the DEMR. Training sessions were carried out in groups involving members of similar disciplines (e.g. dietitians or clinical assistants). A trial run was conducted in May 1998 and the pros and cons of the DEMR system were assessed. The necessary steps were taken to make DEMR more user-friendly. DEMR become fully functional at MVDSC in August 1998.

Further modifications
Single requisition entry for all tests has increased the time doctors spend with their patients. Reports are now directly entered into the DEMR. Graphical display of clinical and laboratory tests for patients has enabled doctors to view a patient's complete clinical information at a glance. A summary sheet containing complete information about the clinical and medical status of the patient and laboratory results facilitates understanding of the patient's health status.

Centralized server

Twenty-five computers at different sites (front desk, dietitians, ophthalmologists, diabetologists, laboratory, special departments, etc.) are interlinked to the DEMR system. A centralized server is needed to support all these dispersed sites. A centralized server with 128 MB RAM and 4.5 x 3 GB hard disk with RAID5 configuration supports the whole system at our centre. Problems at local sites are rectified by the IT professionals and computer personnel at our centre.

Preliminary analysis of data

A total of 20,000 patient records have been entered into the DEMR (August 1998–December 2000). A preliminary analysis was carried out on 9554 patients. SPSSC served as the analysis tool for the database. The results show that 1.1% of patients have Type 1 diabetes, 85.1% have Type 2 diabetes, 0.4% have fibrocalculous pancreatic diabetes (FCPD), 0.9% have gestational diabetes (GDM), 3.8% have impaired glucose tolerance (IGT) and 8.6% have other diagnoses (*Fig. 3*).

A clinical profile of the study patients is given in *Table I*. The mean age of Type 1 diabetic patients is 32 ± 15 years, similar to that reported in a recent study from the same city [14]; however, onset of Type 2 diabetes occurs at a younger age [15]. Type 2 diabetic patients are obese in comparison to Type 1 diabetic patients. FCPD patients are lean, with a mean BMI of 19.2, which is comparable to findings in our earlier reports [16]. The mean HbA_{1c} at the time of first registration at our centre in patients with Type 1 diabetes is 11.3 ± 2.7%, in Type 2 diabetes it is 9.2 ± 2.1%

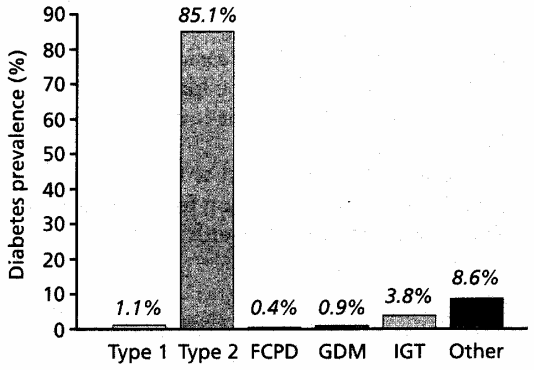

Fig. 3: Prevalence of the various types of diabetes among patients registered at our centre (n = 9554).

Table I: Clinical profile of the patients in DEMR.

Parameters	Type 1 diabetes (n = 106)	Type 2 diabetes (n = 8130)	FCPD (n = 41)
Age (years)	32 ± 15	51 ± 11	32 ± 12
Male (%)	68	64	66
Duration (years)	6 ± 7	6 ± 6	6 ± 6
BMI (kg/m^2)	20.8 ± 3.4	25.1 ± 3.9	19.2 ± 2.7
Systolic blood pressure (mmHg)	135 ± 25	144 ± 22	142 ± 27
Diastolic blood pressure (mmHg)	80 ± 6	84 ± 7	78 ± 9
HbA_{1c}(%)	11.3 ± 2.7	9.2 ± 2.1	10.8 ± 2.7
Serum cholesterol (mg/dl)	187 ± 46	199 ± 43	170 ± 35
Serum triglycerides (mg/dl)	140 ± 121	184 ± 166	134 ± 58
HDL cholesterol (mg/dl)	48 ± 12	42 ± 9	45 ± 10

and in FCPD it is 10.8 ± 2.7%. Mean cholesterol and triglyceride levels are higher among Type 2 patients than among Type 1 and FCPD patients. The prevalence of hypertension is higher among Type 2 patients (26.4%) than among Type 1 (12.3%) and FCPD patients (4.5%) (*Fig. 4*).

Benefits of DEMR

Computer systems have been reported to facilitate disease management [17, 18]. Studies have suggested that a computer-generated clinical dataset is a support tool as valuable as the stethoscope, provided data entry is properly carried out [5, 6, 16–19]. The benefits of DEMR at our centre are summarized below:

- DEMR has helped standardize various procedures such as medical and clinical examinations, and automation has enabled continuous improvement;
- clinical decisions can be made rapidly, leading to better and faster medical intervention, thus increasing doctors' productivity;
- complete follow-up data are available, providing a wealth of information at a glance; moreover, all the information is available all of the time on the desk top;
- retrieval of past results is easier;
- an administrative database for appointments, registration and billing has improved customer service;
- the patient summary sheet with complete clinical and medical information facilitates patients' understanding of their health status.

Conclusion

In summary, the DEMR supports clinical processes and provides quality diabetes health care. The availability of clinical information on the patient all of the time enables faster consultations. Moreover, it permits individual health care targets to be set, not only by individual doctors but also by the health care team. DEMR is a valuable research tool. It has helped our centre in its quality assurance programme, leading to ISO 9002 certification. The MVDSC is one of the first diabetes centres in the world to achieve this certification.

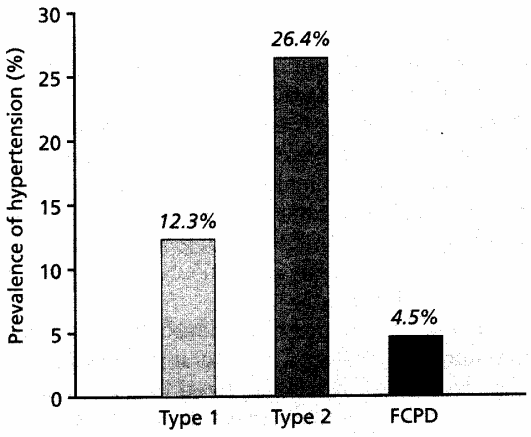

Fig. 4: Prevalence of hypertension among diabetic patients registered at our centre (n = 9554).

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