DIABETES SCREENING DATABASE
A Comprehensive Electronic Patient Record for Global Risk Assessment in a Rural Community

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Abstract: Interprofessional health care is becoming more prevalent with an increase in chronic diseases such as diabetes and cardiovascular disease. In addition preventative models often require large numbers of risk factors for identification of preclinical cases. CSU has established a diabetes screening clinic augmented by an ACCESS database. The novelty of our work is that the ACCESS database integrates into the public health sector and provides a more comprehensive review of health/disease indicators. Information on traditional health indicators in addition to autonomic nervous system function tests, fundus examination and foot assessment results as well as pro-inflammatory, pro-coagulation and antioxidant biochemistry can be added by the university-based screening clinic as well as by diverse primary health care practitioners and specialists that would otherwise not have access to this detailed information for patient assessment and treatment. Our results are in favour of this interdisciplinary database indicating that over one year we have identified 16.2% of people with no previous medical condition to have pre-diabetes, 2% had retinal disease and 21.5% had foot problems. Moderate to severe ECG anomalies were identified in 19.3% of the participants. Of these, 68.8% were either commenced on treatment, had their treatment changed or received surgery. Our results indicate that a comprehensive EPR manager as part of an interdisciplinary health screening initiative is able to track people that require intervention but were missed in the current public health system as implemented in our community.

1 INTRODUCTION

For optimal health care, providers need the necessary information when they give treatment. Health care provider and patient information and decision support needs can be satisfied if primary care providers use electronic patient records that are comprehensive and provide the necessary information to the general practitioner or specialist at the time of consultation (EPRs) (Bates et al., 2003). Often electronic records may indicate that a patient has attended a specialist for an assessment but the results may not be available to the general practitioner nor to other primary health care providers and specialists. In addition many rural areas experience a lack in specialists and allied health professionals as well as general practitioners. Electronic patient records (EPRs) provide a powerful opportunity for health assessments yob re integrated as part of an integrated interdisciplinary primary health network. Universities with additional resources in rural communities can also to support this initiative by establishing screening clinics as part of their health professional courses. University-based teaching and research can provide screening/assessment results especially for tests not routinely carried out in the community due to lack of available services. With additional risk assessment results during consultation, the GP's EPR is valuable in identifying patients at risk for undiagnosed type 2 diabetes, cardiovascular disease or other illness. Previous research on use of electronic patient records (EPR) indicated that general practitioners are able to utilise information on additional risk factor assessment from the EPR during regular consultation (Klein Woolthuis et al., 2007). EPR recall systems based on HbA1c levels showed that the median practice-specific proportions of patients

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with HbA1c recorded annually increased from a median 65% to 77% when using an EPR (Mohiddin et al., 2006). An Australian study conducted by Burns et al. using the CARDIAB®^{TM} register recall system evaluated the process of care of patients for nine parameters critical to quality of care in diabetes: glycaemic control (HbA1c), blood pressure, body mass index, total cholesterol levels, triglyceride levels, high density lipoprotein levels (HDL), microalbumin level, foot checks and eye checks. They demonstrated the potential of CARDIAB®^{TM} to provide support to general practice in the management of diabetes (Burns et al., 2004).

Divisions of General Practice, universities and other primary health care providers have a key role to play in supporting general practitioners (GPs) to provide proactive, preventive care for their patients with cardiovascular disease (CVD) and diabetes (Penn et al., 2004). They can achieve this by providing them with global risk marker information and health assessment results. Risk stratification is currently based on the Framingham cardiovascular risk equation and therefore include factors such as blood pressure, diabetes, age, gender and HDL (Sheridan et al., 2003). However research has suggested that a more global approach to identification of diabetes and cardiovascular disease may be appropriate (Michos et al., 2006). In addition the risk status of persons without CHD varies greatly, and this variability mandates a range in the intensity of interventions. Effective primary prevention thus requires an assessment of risk to categorize patients for selection of appropriate interventions and a more comprehensive screening /health assessment that includes additional factors provided by combining the information obtained from an interdisciplinary health care system and available via an EPR (Jelinek et al., 2006, Woodward et al., 2006).

The major and independent risk factors for CHD are cigarette smoking, elevated blood pressure, elevated serum total cholesterol and low-density lipoprotein cholesterol (LDL-C), low serum high-density lipoprotein cholesterol (HDL-C), diabetes mellitus, and advancing age. Other factors are associated with increased risk for CHD. These include obesity, physical inactivity, elevated homocysteine, pro-coagulation and pro-inflammatory factors. An assessment of global risk based on the summation of all major risk factors can be clinically useful for in identification of high-risk patients who require immediate attention and intervention and changes in intervention based on the global risk estimate (Grundy et al., 1999).

Health assessment and determination of risk factors included in a global risk equation is often not possible in rural communities where there is a lack of general practitioners, allied health practitioners and specialists. University-based teaching and research has the opportunity to integrate with the public health system (Jelinek et al., 2006). An electronic patient record system that spans from university-based teaching and research to public health care and that incorporates data obtained from an interprofessional health care system is required.

The EPR must integrate medical, nursing, and allied health worker data as well as the results from pathology laboratories that may be shared by the health care team. The EPM needs to be secure, provide relevant template forms, incorporate a recall system and specific reports, and a means of tracking interventions by diverse health care professionals. The majority of databases meet this criterion but are mainly specific for certain medical specialities such as general practice. The DiScRi database discussed here extends these fundamental principles to address the needs of an interdisciplinary health care team with emphasis on identification and follow-up of people with and without diabetes or cardiovascular disease as well as identification of those at risk of diabetes and cardiovascular disease based on a global risk assessment. Information of outcomes following referral to general practitioners, allied health and medical specialists provides information to of global health care and the status of the patient. The database allows access to all biochemistry and pathology results as well as the retinal photography, 12-lead ECG and Doppler peripheral vessel blood flow velocity traces that is collected by diverse health care professionals that would otherwise not be available in a coherent form.

2 METHODS

2.1 Database

The Diabetes Screening Research Initiative (DiScRi) application was designed using Microsoft ACCESS (under Microsoft Windows), SQL (Select Query Language) and VBA (Microsoft Visual Basic) languages. The CDM (Conceptual Data Model) and LDM (Logical Data Model) were designed using MERISE theories. The database contained 22 entities and 153 attributes (Table 1).

Accurate information is available for demographics, medical history, biochemistry, urine analysis as well as lifestyle, medication, foot, eye

and heart health including antioxidant levels, pro-inflammatory and pro-coagulation factors for a patient. There is also a direct access to files such as retinal and ECG pictures, and a resume of most important health information (BP, age, cholesterol, diabetes status, medication).

The body-mass index (BMI), the ankle-brachial pressure index (ABPI) for assessment of peripheral vascular disease, the Ewing score, which indicates presence and severity of cardiac autonomic neuropathy as well as absolute 5 year CVD risk are automatically calculated. Cover letters for the general practitioner or specialist, if required, are automatically generated with a link between Microsoft Access and Microsoft Word (an update in the database will update the Word document) and can be sent by e-mail (using Word mail function), or printed for mailing and/or storage as hard copy.

2.2 Screening Participants

To assess the utility of the DiScRi database, patients were recruited through the media and the research had Charles Sturt University Human Ethics approval. All participants had their height, weight and waist circumference measured. A urine sample was analysed and a blood sample used to determine levels of glucose, electrolyte, cholesterol, HbA1c, antioxidants, pro inflammatory and pro-coagulation markers. Retinal photographs of the posterior pole are used to determine presence of diabetic retinopathy and risk of CVD. Heart function was determined by 12-lead ECG including calculation of corrected QT interval (QTc), QT dispersion (QTd), frequency and time domain analysis results. The latter are indicators of preclinical cardiac autonomic neuropathy (CAN). CAN is also assessed using the Ewing battery. Foot health assessment includes ABPI, monofilament for peripheral neuropathy (PN), ankle and knee reflexes, and muscle tone. Thus the university screening simulated an interdisciplinary health provision system.

3 RESULTS

3.1 Database Characteristics

From the introductory screen, the database allows access the demographic data, clinical history, follow-up, biochemistry, eye, heart and foot assessment results.

Figure 1 shows an example of a test recording screen. For the ECG analysis, the 12-lead ECG trace can also be accessed. The 3-lead recording indicates the results for the assessment of cardiac autonomic neuropathy based on the Ewing score.

All data is divided into tables that can be

Table 1: Entities contained in the DiScRi database.

Entities	# values	Examples
GP	4	Name, address, telephone, email
Patient	5	Name, address, telephone, DOB
Analysis	2	
Medications	2	Current medications, change medications
Clinical history	5	Diabetes, HT, CVD, medical information
Foot history	3	Presence of ulcers, general pain, numbness
Heart history	10	Angina, fainting, heart attack, stroke, chest pain
Eye history	2	Glaucoma, cataract, diabetic retinopathy
Other history	6	Kidney, bladder, GIT
Lifestyle	7	Smoking, alcohol, family history for diabetes/CVD, diet, exercise
Consultation history	6	Attendance to health care professionals; details of consultations
3lead ECG Ewing	7	Lying to standing HRV change
3lead ECG HRV	17	Frequency and time domain results for HRV
12lead ECG	8	HR , QTc, QTd, interpretation,
Neuropathy	7	Monofilament, ABPI,
BMI	4	Height, weight, waist circumference
ABPI	5	Systolic blood pressure at arm and ankle
Glucose	5	time since last meal, glucose level at screening
BP	5	Lying and standing BP
Urine	12	Glucose, protein, albumin
Biochemistry	26	Cholesterol, antioxidants, pro-inflammatory, pro-coagulation markers
Eye analysis	5	Eye pathology, AVR diagnosis, photograph

separately accessed, However for a quick overview during a consultation, the global information page indicates the date of last visit and includes the possibility of accessing the eye photographs of the retinal posterior pole, the 12-lead ECG trace and information on glucose and cholesterol levels as well as blood pressure and BMI (Figure 2). From this page the user can also move to any of the analysis for specific and more comprehensive results.

An important addition to this database is the opportunity for detail follow-up provided by diverse health care practitioners as shown in Figure 3.

3.2 Screening Outcomes

A review of the outcomes for the university-based simulation study that measured health/disease indicators indicated that in this rural area the prevalence is worse compared to the national average for all tests in the diabetes cohort and elevated for the ABPI and ECG in the non diabetes group (Table 2).

Table 2: Prevalence of pathology in a rural cohort determined through a university-based screening initiative.

Measure*	% Non diabetes	% National Average
PN	8.13	19.4 (foot ulcer)
ABPI	11.6	unknown
BMI	25	20 (>30kg/m2)
HT	28	30 (140/90)
ECG	13	12(diab) / 3(control)

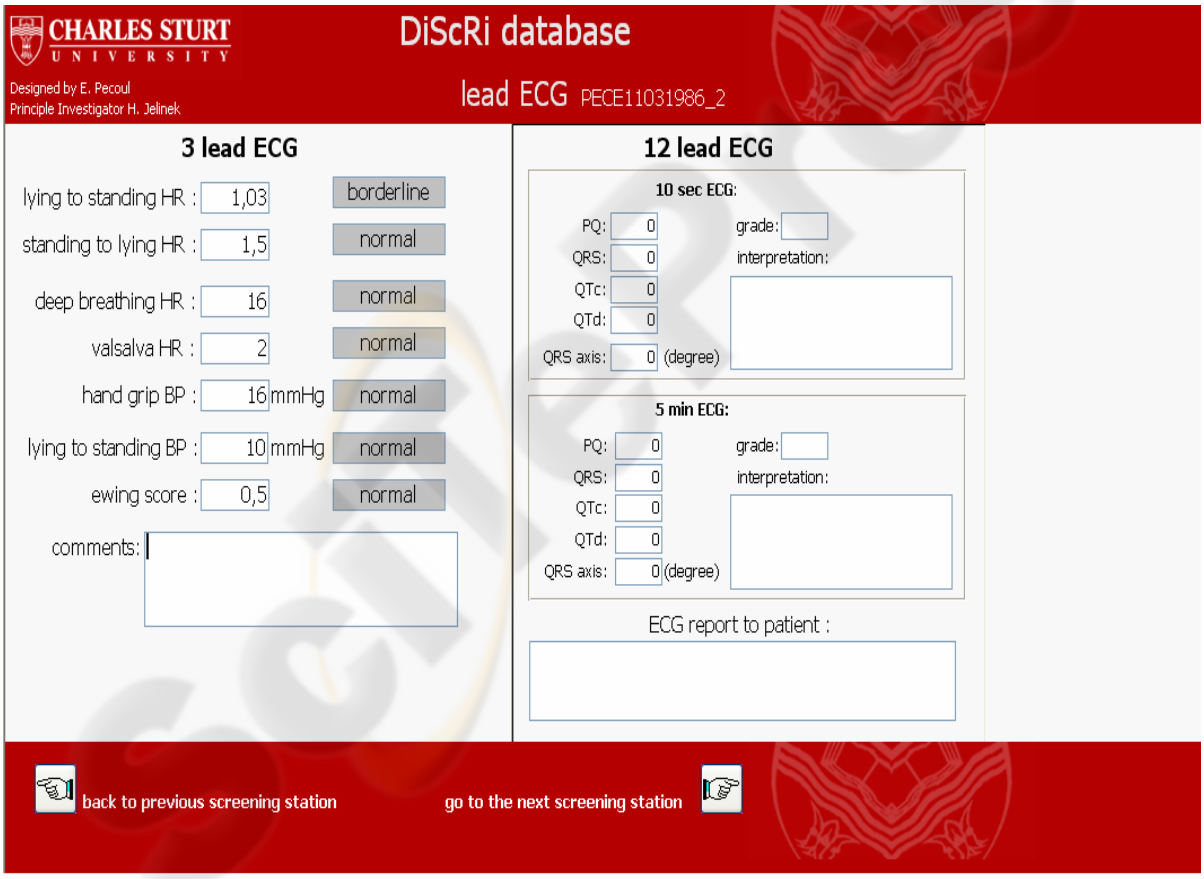

Figure 1: ECG assessment form.

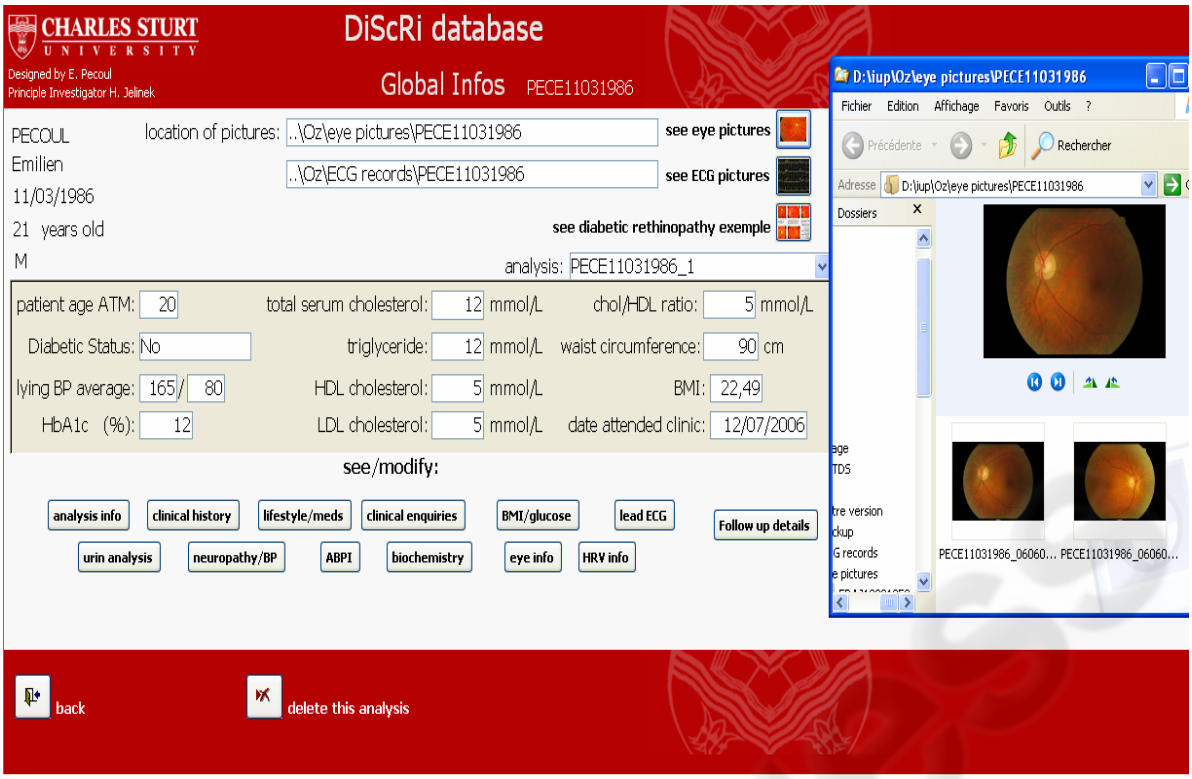

Figure 2: Global information screen with eye photograph.

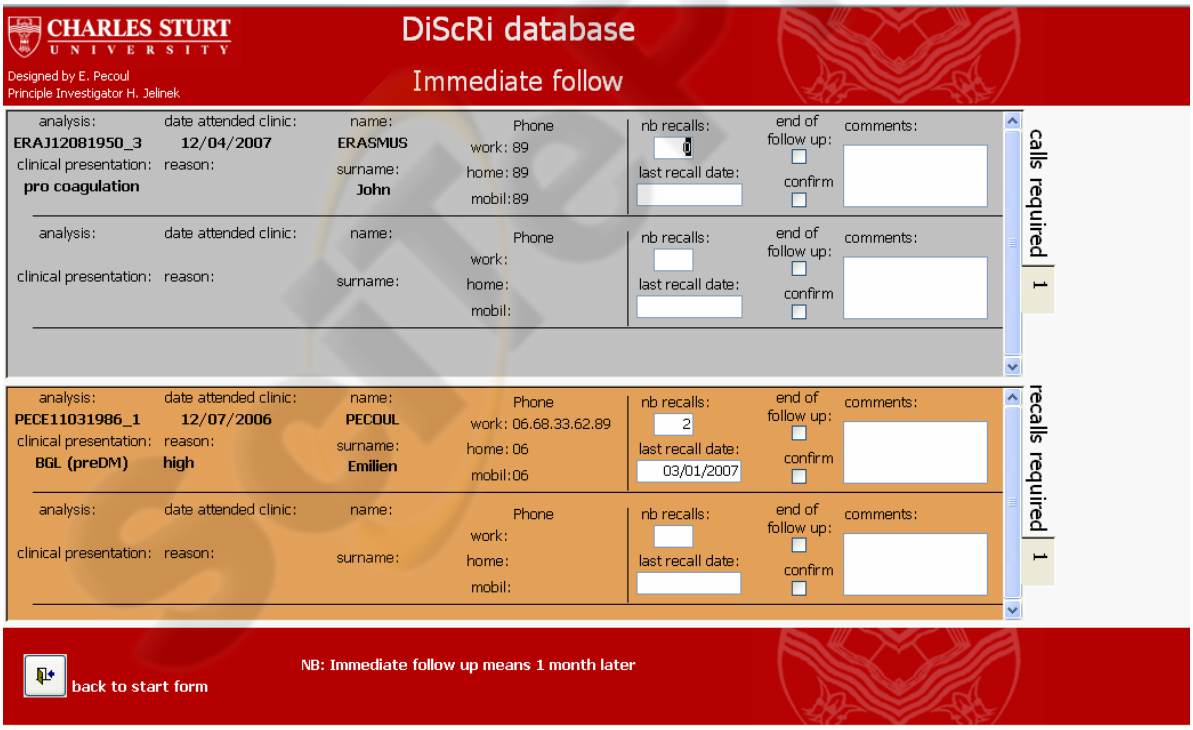

Figure 3: Recall screen.

4 DISCUSSION

In Australia, general practitioners play an important role in the management of diabetes. This involves careful monitoring of behavioural risk factors, blood pressure, glycaemic control and lipids; early detection of complications; and management according to evidence-based guidelines (NHMRC, 2004, Newnham et al., 2004). However, a comprehensive health review can only be provided by an interdisciplinary health care team. With the rapid advances in information technology in the last decade, various diabetes information systems have evolved in different parts of the world. Availability of new technologies and information systems for monitoring and treating diabetes is critical to achieving recommended metabolic control. A comprehensive EPR that includes data for global risk assessment and patient review and provides mechanisms for practitioners to gain information on performance and results from a diverse primary health care team that would otherwise not be integrated is essential for evidence-based practice and improvement in health care provision.(Joshy and Simmons, 2006) The DiScRi study indicates that an EPR that incorporates information across the health care sector arising from annual consultations in the university setting such as test results and outcome of referrals, as well as lifestyle data such as smoking status, exercise and body mass index is of benefit to both the health care providers and the patients.

Effective EPR implementation and networking could eventually save more than $81 billion annually—by improving health care efficiency and safety—and that HIT-enabled prevention and management of chronic disease could eventually double those savings while increasing health and other social benefits.(Hillestad et al., 2005) DiScRi data provides important baseline information for health care quality improvement at local, state and national levels. Including pro-coagulation and pro-inflammatory factors improves overall health care planning as the physician has additional information.(Navab et al., 2006) Similarly, options for viewing retinal images that indicate early signs of diabetes or presence of CVD seen on 12-lead ECG or peripheral pulse wave analysis can be of use to general practitioners. The database allows access to all biochemistry and pathology results as well as the retinal photography, 12-lead ECG and Doppler peripheral vessel blood flow velocity traces. Making the DiScRi EPR the most comprehensive primary health care database available in Australia.

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