

INTRODUCTION

An electronic health record platform with telemedicine and data analytics capabilities is a powerful platform that can help make a difference in chronic disease management by various care providers.

Chronic Disease Management System or CDMS is one such product. **CDMS** is a **comprehensive medical and health record web application** that provides the **platform for the multi-disciplinary group of care providers** to share their input and communication as well as **using telemedicine as enabler of communication** that is important to ensure timeliness and effectiveness of information presentation for patient care and intervention of chronic diseases.

Diabetes, hypertension, hyperlipidaemia and other chronic diseases are common in Malaysia. Results from the National Health Morbidity Survey in 2015 for adults aged 18 years or older, 3.5 million adults were found to have diabetes, 6.1 million had hypertension and 9.6 million had hypercholesterolemia. There was also an alarming rate of undiagnosed diseases; 9.2% for diabetes, 17.2% for hypertension and 38.6% for hypercholesterolemia. [1] Patients with chronic diseases requires lifelong care. They may develop complications such as diabetic retinopathy, diabetic nephropathy, diabetic foot problems, cardiovascular disease, etc if their conditions are not controlled or treated early.

Data from the 1997 Diabetes Info Series I published by the Ministry of Health Malaysia and Academy of Medicine indicate that diabetic retinopathy is one of the leading causes of blindness amongst Malaysian adults. More than half of diabetic patients will have pathological changes in both eyes in a matter of years which will eventually lead to blindness. [2] From the MOH Diabetic Retinopathy registry 2008, among 19,632 new diabetics seen for the first time at MOH Ophthalmology clinics, 9% of eyes were blind (VA worse than 3/60), 27% has low vision and 34.6% has some form of DR. [3] In addition, **diabetes mellitus also accounted for more than half of the primary renal disease among new dialysis patients in the last 10 years, with 61% in 2014.** [4]

Comprehensive care by multi-disciplinary team of care providers shows marked improvement in chronic disease control [6] [7] [8]. Locally, Community-based cardiovascular Risk Factors Intervention Strategies (CORFIS) study had shown that the proportion of patients achieving target Blood Pressure in patients with hypertension is significantly higher than those receiving normal care. [9]

METHOD

Chronic Disease Management System or CDMS is a **comprehensive medical and health record web application** that includes many modules as below to cater for the **multi-disciplinary group of care providers at local clinic as well as specialists who are at hospital** to share their input and communication.

The clinic module is used by the team at the clinic



Clinic Module

The Clinic module enables multi-disciplinary team at clinic that provides direct care to patients to collect, communicate and share their data via the various forms and real time reports presented in the system. Some decision support flow is built into the system to guide better, consistent care to patients. Data collection includes demographics, social history, medical history, complications, allergy, physical examination, drug prescription, adverse event reporting, lab examination, clinical events, case notes of various groups of care providers, alert on Tele-Consulting review feedback, patient self-monitoring result, etc

The tele medicine module enables remote consultation by various specialists as follows to ensure timeliness and effectiveness of information presentation for patient care and intervention of chronic diseases.



Tele DR By Ophthalmologist

The TeleDR (Tele Diabetic Retinopathy) module used telemedicine with non mydriatic cameras to capture fundus image. Through the images that are auto transferred to CDMS, fundus camera operator reviews and identifies urgent / non urgent cases as well as identify eye diseases of patients, in particular stages of diabetic retinopathy, maculopathy, glaucoma, age related macular degeneration and others. Patients with non urgent problem will continue regular follow up at local clinic while urgent cases are referred to ophthalmologist at hospital. Ophthalmologist at hospital also has access to the system to review patient's information and update the outcome of the patient.



Tele DF By Orthopedist

The TeleDF (Tele Diabetic Foot) module used telemedicine to synchronise photo of patient's foot to the CDMS system. Through clinical decision support feature, foot problems detected during physical examination will go through a series of flow of care and review and if necessary, referral to Orthopedist at hospital. Orthopedist at hospital also has access to the system to review patient's information, foot photo and update the outcome of the patient in the system.



Tele NEP By Nephrologist

With built in analytics algorithm that analyses various lab data, vital signs data and physical examination data, the TeleNEP (Tele Nephrology) module auto generates list of patients at risks to nephrologist



Tele Diet By Dietitian/Nutritionist

TeleDiet (Tele Dietary Advice and Counseling) module auto generates list of patients at risks to either the local dietitian or diabetes nurse educator, or nutritionist at state hospital.



Tele ECG By Cardiologist

The TeleECG (Tele Electrocardiogram) module used telemedicine with ECG machine to enable remote screening by cardiologist to determine whether it is an urgent case that require immediate referral to cardiologist at hospital.



Cardiovascular Risk Assessment

Various cardiovascular risk scores are presented to the specialists and health personnels who need this information for planning suitable treatment for patient.

Identifying patients at risk early is important to enable patients to receive appropriate treatment and education early, i.e. prevention is better than cure.

The system is located at a highly secured and state-of-the-art data centre. The application has built in security features that ensures preservation of security, integrity, confidentiality and privacy of patient information. Security features implemented are in line with Health Information Portability and Accountability Act (HIPAA) guidelines. Please contact us for more details.

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KEYWORDS

- Chronic disease management
- Telemedicine
- Multi-disciplinary care
- Remote review and consultation

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RESULTS

CDMS has been used for CORFIS project by private General Practitioners and by a number of government primary care clinics in state of Terengganu.

To date, there are only publications on tele diabetic retinopathy module. Results from other modules are unavailable due to no analysis has been done or published. Thus comparison is only made against TeleDR module.

Case Study 1: 'TeleDR Outcome Study from October 2009 to September 2010 from a 2010 presentation' Vs 'TeleDR Outcome Study from Jan 2016 to June 2016'

#	Description	Case Study 1: TeleDR Outcome from Oct 2009 to Sept 2010	1/1/16 to 30/6/2016 result
a	Total diabetic registered	2127	9463
b	Total fundus photo taken	1997	9665
c	Total sites with fundus machine	7	15
d	% with at least 1 fundus exam within the year	93.40%	100%
e	Average turn around time those marked URGENT	56% seen within 7 days	69.3% within 7 days 85% within 6 weeks

From October 2009 to September 2010, only 1997 fundus photos were taken from 7 sites. In comparison, in just 6 months in 2016, the number of fundus photos taken from 15 sites is significantly higher at 9665 photos. More sites were recruited in the hope to achieve more detection coverage.

Every patient enrolled in the system are patients under diabetic program in Klinik Kesihatan in Terengganu state. Hence, there was a 100% achievement of at least 1 fundus exam taken within a year. Some patients had more than 1 fundus exam taken in a year.

The average turn-around time for URGENT cases have improved from 56% to 69.3% seen within 7 days. Based on procedure, Ophthalmologist would review Urgent cases while 1st and 2nd grader would review non urgent cases. It was noted that there were some camera operators who mistakenly marked non urgent cases as urgent. To overcome the problem, initiative has been taken to plan for 2 times course yearly of once a year.

Case Study 2: Findings of fundus image from Jan 2016 to June 2016

Category	Types Of Photos	1/1/16 to 30/6/2016 result from Gradeable photos (combined both eyes)	%
Diabetic Retinopathy	No Diabetic Retinopathy	4926	69.00
	Mild NPDR	472	6.6
	Moderate NPDR	367	5.1
	Severe NPDR	106	1.5
	PDR	68	1.0
	Adv Diab Eye Disease	20	0.3
	Maculopathy	520	7.3
Non Diabetic Retinopathy	Glaucoma Suspect	285	4.0
	ARMD	83	1.2
	Other Diagnosis	292	4.1
		7139	100.00

Through the fundus image screening, majority (69%) of the diabetic patients did not have diabetic retinopathy. Thus, they **do not need to be seen by ophthalmologist** at hospital, which reduces workload of ophthalmologists at state hospital.

Sight threatening cases comprising of patients with severe non proliferative diabetic retinopathy (NPDR), proliferative diabetic retinopathy (PDR), advanced diabetic eye disease and maculopathy were picked up by the system for ophthalmologist to take action. It is hoped that through screening and treatment at an early stage, less patients would progress to blindness.

As additional benefit of the TeleDR, it was not only used for screening for DR but also detected other sight threatening diseases like glaucoma and age related macular disease.

CONCLUSION

Many data are captured routinely in Electronic Health Records. **With some data mining and data analytics applied, these data are useful for early prevention or control of patient's condition with the right intervention. Combined with telemedicine capability, chronic disease management which encompasses many discipline of care may come under one platform to better manage patient's condition.** The benefits of telemedicine in chronic disease management have been outlined in Telemedicine Cuts Costs and Improves Outcomes in Chronic Disease Management [10] and The Empirical Foundations of Telemedicine Interventions for Chronic Disease Management [11] which provided a comprehensive and systematic review of the scientific evidence regarding the benefits and impact of telemedicine.

The CDMS system shows many **benefits** for chronic disease management :

- as electronic health record (EHR)
- enable ease of care coordination
- improved continuity of care and communication of care among multidisciplinary teams
- provides faster and real time remote assessment of health-related information / images
- facilitate communication and prompt referral from primary care clinics to specialists in tertiary healthcare institutions
- provide tool for patients for self-management
- cuts the costs and time of travelling etc many other benefits.

The system can be used as a whole or just the specific telemedicine component to cater for the specific needs. Eg. User can select to use only CDMS's TeleDR module for eye screening and referral purpose.

It is hoped that the system can be used to benefit the care of more patients with chronic diseases.



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