Installation of the Chronic Disease Electronic Management System (CDEMS) for a Portland-based Community Clinic

By

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CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

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Installation of the Chronic Disease Electronic Management System (CDEMS) for a Portland-based Community Clinic

has been approved

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Abstract

Chronic disease management is an effective way to improve healthcare outcomes while also reducing healthcare expenditures. The Wallace Medical Concern, a Portland-based community clinic, was in need of an electronic chronic disease registry for diabetes management to satisfy a grant stipulation. The purpose of this project was to determine the best chronic disease management system for the Wallace Medical Concern and configure the system to best suit their needs. The Chronic Disease Electronic Management System (CDEMS) developed by the Washington State Diabetes Prevention and Control Program was ultimately chosen. This capstone will examine the CDEMS architecture and how it can be customized to effectively manage diabetic and pre-diabetic patients. It will also describe lessons learned from implementation as well as propose what the chronic disease management system of the future must encompass in order to meet the new emerging needs of community clinics.

Introduction

Diabetes currently ranks as the 7th leading cause of death in the United States[1]. Not only is its high prevalence a danger to the well-being of the American population, it also triggers a significant financial strain to our healthcare system. Studies estimate that diabetes creates over $176 billion in healthcare costs for diagnosed diabetic cases, and as high as $218 billion for undiagnosed, pre-diabetes, and gestational diabetes costs combined[1]. With 8.3% of the U.S. population affected by diabetes, 7 million people are estimated to be undiagnosed[2]. With these staggering statistics it is obvious that better diabetes prevention, screening, and management is needed in the American healthcare system.

Disease registries, the purpose of which are to ensure health data is collected at every point of care during a patient's visit to illustrate disease trend and improve the clinician's decision-making process for care, have become an effective tool in addressing this national epidemic. Early disease registries started off as simple card catalogs and paper patient records detailing patient ailment, current condition, and treatment. But with the digitalization of healthcare records, electronic disease registries have become the new standard for patient disease management. From a macro-level public health perspective, the purpose of a clinical electronic disease registry is to provide clinicians with population-based analyses that create a clearer picture of the state of health of their target population, while allowing them to better coordinate patient care[2]. These registry applications provide a system that standardizes patient care with customizable forms for information intake and on-the-

fly data analysis for outcome measuring and reporting. Disease registries are often a stepping-stone to the adoption of a full Electronic Health Record (EHR) system and are valuable tools to validate the quality of EHR data when used in tandem[2].

Given the serious nature of diabetes and the ready availability of computerized disease management systems, this project focuses on adopting such a solution to aid in the amelioration of diabetes incidence and prevalence within the Portland, Oregon metropolitan area. It is the intent of this project both to provide a community clinic with better tools to combat the disease of diabetes within its service community and to develop a template for other community clinics to follow.

Background

Wallace Medical Concern

The Wallace Medical Concern is a non-profit Federally Qualified Health Center with several locations throughout the Portland and Gresham, Oregon communities. What once started as a single physician venturing into the Portland city center to provide care to the homeless has blossomed into a 300-volunteer-strong organization providing a myriad of health services through three dedicated clinics. At the time of this project, the Wallace Medical Concern had recently won a grant that stipulated as a condition of funding that an electronic disease registry must be used to support their chronic disease management program. The purpose of the grant was to reduce the incidence and prevalence of diabetes within Wallace Medical Concern's service communities through quality-driven metrics and standardized delivery of care. To complement a diabetes management program already offered, plans to install a chronic disease electronic management system were developed for the organization's Gresham location. At the beginning of this project, all Wallace Medical Concern locations exclusively utilized paper-based health records but were transitioning to the EpicCare Electronic Medical Record (EMR) system manufactured by Epic Systems Corporation of Verona, Wisconsin.

Wallace Medical Concern Rockwood Clinic Patient Demographics

Wallace Medical Concern's Gresham, Oregon clinic primarily serves an economically disadvantaged and largely Hispanic patient demographic. Their target demographic for the diabetes management program were Hispanics aged 18 and

over. According to the Oregon Health Authority, economically disadvantaged Oregonians are 1.5 times more likely to develop diabetes[3]. Between 13.6% and 29.5% of the Rockwood neighborhood surrounding the Wallace Medical Concern clinic lives below the poverty line[4]. The community's racial demographics are generally White (68.7%) with only 18.9% Hispanic, but due to the location of the clinic and the availability of Spanish-language friendly services, the patient base of the clinic is predominately Hispanic[4].

Given the large Hispanic service population, diabetes is of a particular problem for the Wallace Medical Concern. Oregon statewide prevalence rates indicate 10% of the Hispanic population has some form of diabetes[3]. Furthermore, diabetes accounts for 11-14% of Hispanic mortalities, reducing life expectancy by as much as 24.87 years due to premature death[3]. Compounded by the fact that 46% of Hispanics in Oregon did not possess health insurance before the Affordable Care Act, the work of the Wallace Medical Concern to provide safety net coverage of diabetes screening and management was vital to the overall health of this community[3].

The Journey to an Electronic Disease Registry

This capstone was initially conceptualized as a project to prepare the Wallace Medical Concern for their installation of the EpicCare EMR system. The purpose was to help customize the EpicCare installation to reflect their preference for clinical workflow and modify the data forms to complement their diabetes management program. However, during the Wallace Medical Concern's due diligence in preparation for "going live" with the EpicCare system, it was brought to light that their installation of the EMR might not provide the chronic disease management tools

needed to support their diabetes program in time to satisfy their grant stipulations. It was at this point that an affordable ancillary system was sought to ensure that the Wallace Medical Concern had an effective means to electronically manage their diabetes disease cases.

After considering a number of off-the-shelf electronic registry systems, Wallace Medical Concern concluded the Chronic Disease Electronic Management System (CDEMS) best fit their needs. Installation of CDEMS was to take place at the principal site of the diabetes management program in the Wallace Medical Concern Rockwood Clinic in Gresham, Oregon. At the time, no formal electronic disease registry had previously been installed at Wallace Medical Concern. Instead, the Wallace Medical Concern clinics had stored patient information for the purpose of a diabetes disease registry in a self-configured Microsoft Access database. Data from traditional paper-based records pertinent to diabetes management were transferred by hand to this generic Microsoft Access database so it could act as a point of reference upon patient follow-up.

The Chronic Disease Electronic Management System (CDEMS)

The Chronic Disease Electronic Management System (CDEMS) was developed by the Washington State Diabetes Prevention and Control Program[5]. First released in 2002 and periodically updated until 2012, CDEMS is a Microsoft Access database application available exclusively for the Microsoft Windows operating system. CDEMS was funded by the Centers for Disease Control and Prevention and is pre-coded to track and monitor diabetes, asthma, and adult preventative health services, but is customizable to monitor other chronic conditions. As of 2007, as

many as 130 clinics in Washington State had installed CDEMS, with additional users in at least 35 states[6].

Methods

The focus of this project changed as it progressed from conception to completion, yet the goal always remained the same: to outfit the Wallace Medical Concern with an electronic solution to store and manage patient health information so they may better serve their target population. Several iterations of plans on how to best equip the Wallace Medical Concern with a chronic disease management system were made before a final solution was agreed upon. Through its core objectives, this project illustrates how CDEMS was selected, installed and configured to best serve the Wallace Medical Concern's needs and how it can provide an example for similar clinics to follow suit.

The objectives of this project were four-fold:

1. To describe the Wallace Medical Concern's requirements and specifications for a chronic disease management system.
2. To document the selection process of CDEMS and its installation within the Wallace Medical Concern.
3. To describe lessons learned from implementation.
4. To propose what the chronic disease management system of the future must encompass in order to meet the emerging needs of community clinics.

System Selection

The Wallace Medical Concern had a number of limitations and preferences to consider when deciding how to establish their electronic disease registry. The

following standard gamble was solicited from Wallace Medical Concern staff as we attempted to elucidate their preferences for an electronic disease registry in terms of priority:

1. Affordable installation/low barrier to entry
2. Ease of use
3. Low maintenance
4. Available and affordable technical support
5. Robust functionality
6. Connectivity to complementary systems (EMR, laboratory reporting, etc.)

Due to the stressors of financial limitations and their impending implementation of EpicCare, the Wallace Medical Concern was chiefly interested in the most economic solution to fulfill their chronic disease management needs. Expenditures in terms of licensing price and cost for implementation were chiefly considered in the decision making process. Upon evaluation of the current solutions on the market, Wallace Medical Concern gravitated toward free-to-use products with low barrier-to-entry installation requirements. Aside from licensing fees for chronic disease management software, the need for purchasing additional hardware and software to install the platform was another major concern they wished to avoid if at all possible.

In addition to the financial constraints, technical limitations were also a major a factor for the Wallace Medical Concern. Without having a dedicated in-house information technology (IT) staff, there was a great need for a low maintenance/easy-to-use solution, preferably with detailed installation documentation and a helpful online community for troubleshooting and system support. The Wallace Medical

Concern possesses a modicum of IT support for general computer, network, and printer maintenance, but does not have the human resources necessary to service complicated clinical software. Given their scarcity of resources for training and maintenance, familiarity and ease of use were important factors for selection. System ease of use was important because the staff wanted something similar to how easy it was to operate the Microsoft Access database program they were already using. To reduce the time of additional training, the Wallace Medical Concern staff wished for a system familiar enough that they could quickly adapt to it.

Given the modicum of technical support resources on hand, the Wallace Medical Concern prioritized low maintenance and affordable technical support secondary to the cost of the system. It was a wish of the staff that once the system was installed, updating the chronic disease management software would not be too technically laborious nor would it necessitate any substantial upgrades to their available hardware or operating systems. Given that there were only a few computer portals within the clinic for input of patient data, it was also a preference that the system be lightweight in terms of computer resource requirements. Preferably, the clinic wanted a solution that could operate from their current network and array of workstations instead of a more complex package requiring more "modern" hardware.

When interviewed about the breadth of functionality needed, the majority opinion was “nothing fancy, just enough to fulfill our clinical disease surveillance requirements for our grant.” Due to this mindset, the “robust functionality” and “compatibility with other systems” categories trailed the end of the standard gamble. They were interpreted more as luxuries by the Wallace Medical Concern and were

welcomed only as a bonus to the chronic disease management system fulfilling their base needs.

The fact that CDEMS is licensed as a free-to-use product created on the Microsoft Access program, which they had licenses for already, made it a very convenient candidate. CDEMS easily satisfied the Wallace Medical Concerns' top priorities of finding a freeware solution that utilized the same physical and technical resources they already and successfully use. The robust user forum on the CDEMS website along with their highly detailed installation instructions were also essential for CDEMS to meet the Wallace Medical Concern's needs. To confirm that CDEMS was an appropriate choice for the project, a one-on-one consultation walkthrough of the system was commissioned from the developers of CDEMS prior to installation to verify that the system's functionality matched Wallace Medical Concern's needs and intent of use.

Factors Shaping the CDEMS Implementation Strategy

It was the intention of the Wallace Medical Concern to mold the new CDEMS clinical workflow as closely as possible to their preexisting processes for intake and tracking of patient diabetes data. Figure 1 illustrates the Access database and paper clinical workflow that the clinic utilized prior to this project. Under this protocol, patients would come to the clinic and their consent would be requested for diabetes screening regardless of their chief complaint. Upon consent, the patient would then be tested according to the American Diabetes Association Risk Assessment and have their HgbA1C and/or capillary blood glucose (CBG) levels measured. These

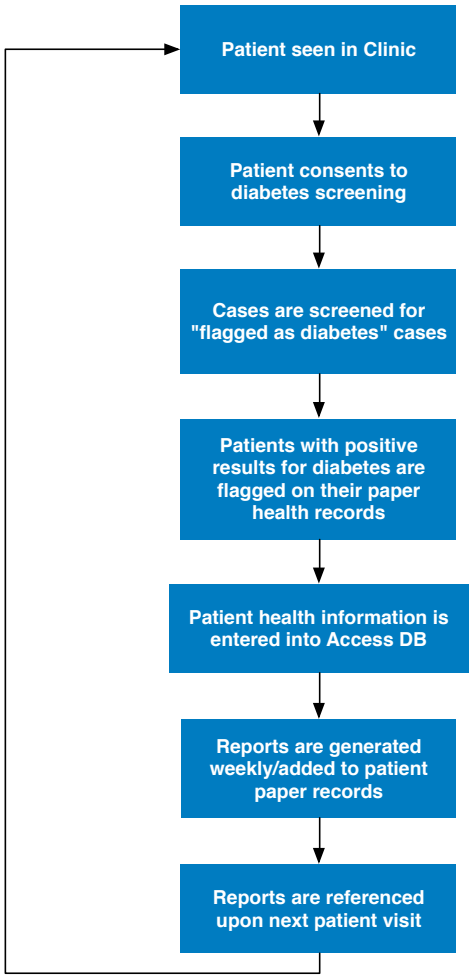

Figure 1. Pre-CDEMS Access Database/Paper Clinical Workflow

tests take only a matter of 15 minutes for results to identify whether the patient is diabetic or pre-diabetic, and are performed while the patient is still in the clinic. If results indicate that the patient is either diabetic or pre-diabetic, the patient's paper health record is marked to reflect diabetic status. If diabetic, the patient is given a modicum of education related to their diabetes status, prescribed medication if necessary, and is set up with a follow-up appointment within the next 2 weeks. For patients who have consented to chronic disease monitoring, their paper health records would be updated for diabetes status and flagged for later review.

At the end of the work week, newly flagged cases would then be entered into the Microsoft Access database and labeled as either “pre-diabetic” or “diabetic.” Previously identified cases would have their records updated. The diabetes database tracks a modicum of metrics for each patient, namely: CBG levels, HgbA1C levels, body mass index (BMI), HDL levels, and blood pressure. Reports are generated for each patient in the database listing their metric data and are printed and attached to their paper record to be referred to upon the patient’s next visit, when the cycle would start over again.

As CDEMS was confirmed to be the chronic disease management system of choice, there was an initial interest in attempting to connect CDEMS with the impending EpicCare implementation so that data could automatically be shared between the systems. Figure 2 illustrates options for a hypothetical clinical workflow between CDEMS and EpicCare used to help the Wallace Medical Concern staff understand how the two systems would operate in their new clinical environment.

In this scenario the patient would be seen in clinic and data would be entered into EpicCare. Patients who consent to diabetes screening and are identified as diabetic would be flagged within the EpicCare system so their health data may be transferred in some modality to CDEMS. Three possible modalities were considered for this project. The first option was to develop a means to interface EpicCare directly with CDEMS. The possibility was discussed with Wallace Medical Concern’s vendor for EpicCare, the Oregon Community Health Information Network (OCHIN). Upon receiving preliminary consultations about the cost for such a feature, the Wallace Medical Concern’s staff deemed it too costly to implement at the moment. A

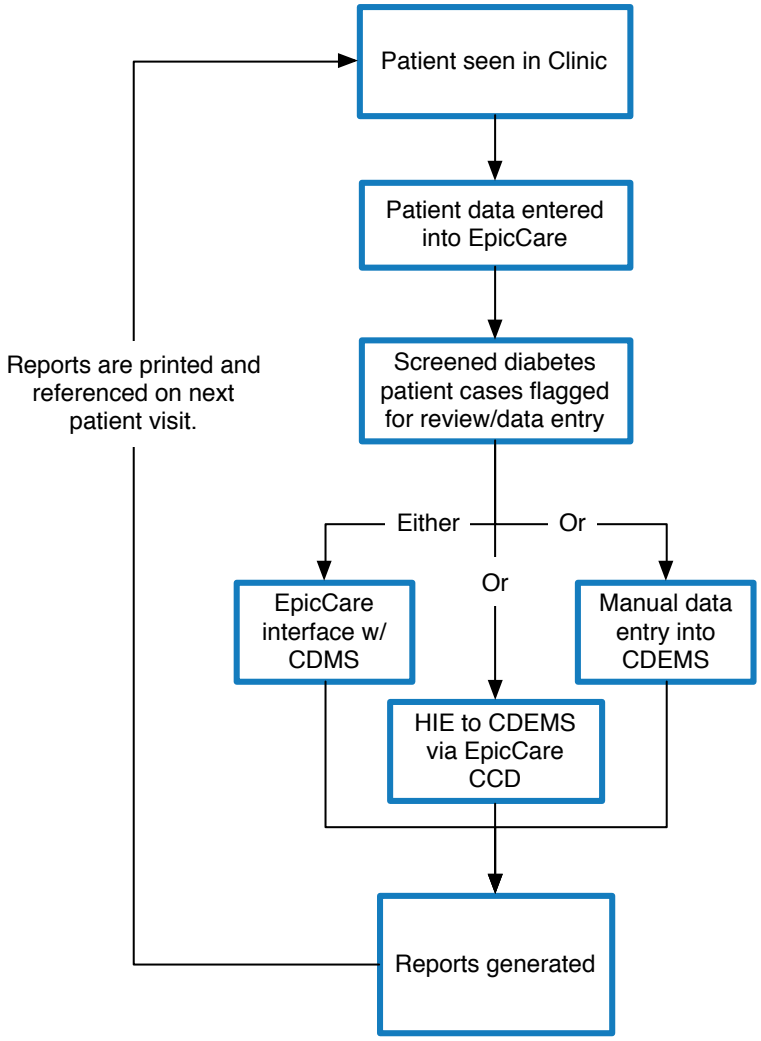

Figure 2. Proposed CDEMS and EpicCare Clinical Workflow

second option, to subscribe to Health Information Exchange (HIE) services to automatically transport data between EpicCare and CDEMS, was also solicited from OCHIN. An HIE service would automate the process of making EpicCare data portable into CDEMS. Once again, the feature was enticing to incorporate into the project, but the estimated costs were too large for the Wallace Medical Concern to support at the time of a CDEMS and EpicCare implementation. The last option was to manually transfer patient data from EpicCare to CDEMS.

Considering the prohibitive expensive to either develop an interface or subscribe to HIE services, the third option of importing diabetes patient data by hand from EpicCare to CDEMS was selected. In order to go forward with this decision, a new clinical workflow to incorporate CDEMS into their current clinical service was developed. As illustrated in Figure 3, via this pathway consent for participation in the diabetes management program is requested for all patients seen at the clinic. If the

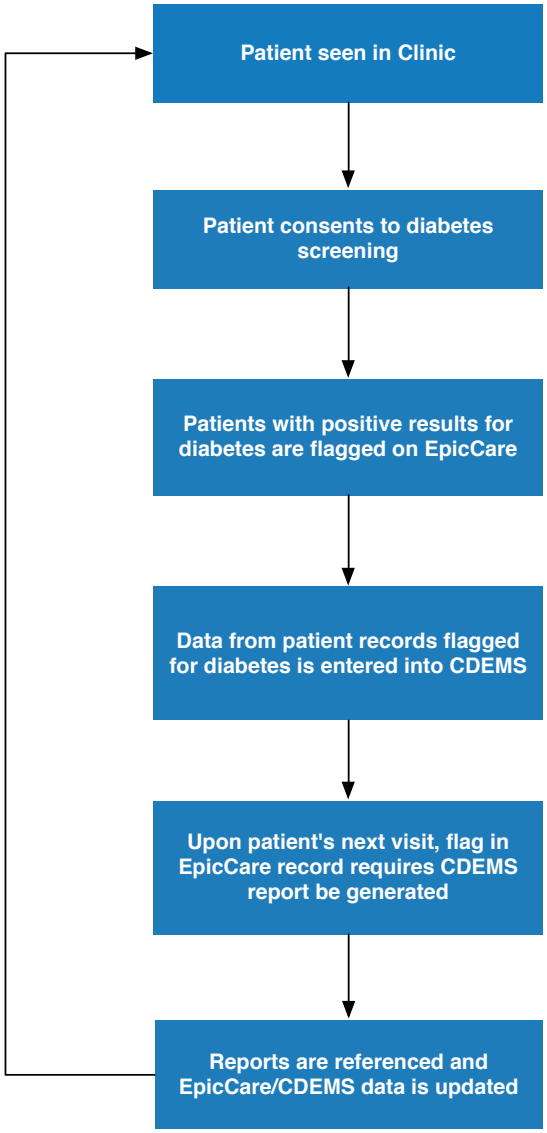

Figure 3. Final CDEMS Clinical Workflow

patient is known to be diabetic or if diabetes is discovered on the visit, the patient file would be tagged in EpicCare to indicate to the clinic manager to review a change of status. At the end of the week, all patient records flagged for diabetes management would have their updated diabetes information added to CDEMS. Upon the patient's next visit, a flag in the patient's record would alert staff to generate a CDEMS report on paper, to be referenced during the patient's course of care. Any updates to diabetes status would be marked in the patient record and flagged so that any new data may be included in CDEMS during the next weekly CDEMS update period.

Considering the Wallace Medical Concern's resource limitations and urgent need to implement an electronic chronic disease management system as swiftly as possible, the pathway depicted in Figure 3 was chosen as the best of all available options. Given the higher priority for the clinic to have a stand-alone chronic disease management system to satisfy grant stipulations, the manual data migration option was more convenient in the short term as compared to a more tailored system that would take more time to implement.

CDEMS Architecture. The Chronic Disease Electronic Management System (CDEMS) operates exclusively on the Microsoft Windows operating system. At the logic layer of the registry, CDEMS also requires the installation of the database management system, Microsoft Access, to utilize Access forms for the data entry and presentation of health information. Patient data can be housed in one of two ways: 1) within the Microsoft Access database program itself or, 2) by tethering to a Microsoft SQL Server instance for more robust security and scalability when CDEMS is concurrently being used by multiple users.

The core of the CDEMS registry is divided into 3 main components: A data entry program, a reports program, and a data storage file all in the form of Access database files[5]. The data entry program supports data entry, editing, and viewing as well as printing of the patient CDEMS Progress Note[6, 7]. The reports program produces intervention, summary, and user-defined reports and allows users to create custom queries. Lastly, for clinics that opt to use the Microsoft Access data layer, the data storage file stores patient health data and clinic setup tables. Figure 4 illustrates the full stack of software used by the CDEMS registry. An ancillary generic HL7 electronic laboratory interface is also available to automatically migrate lab data to

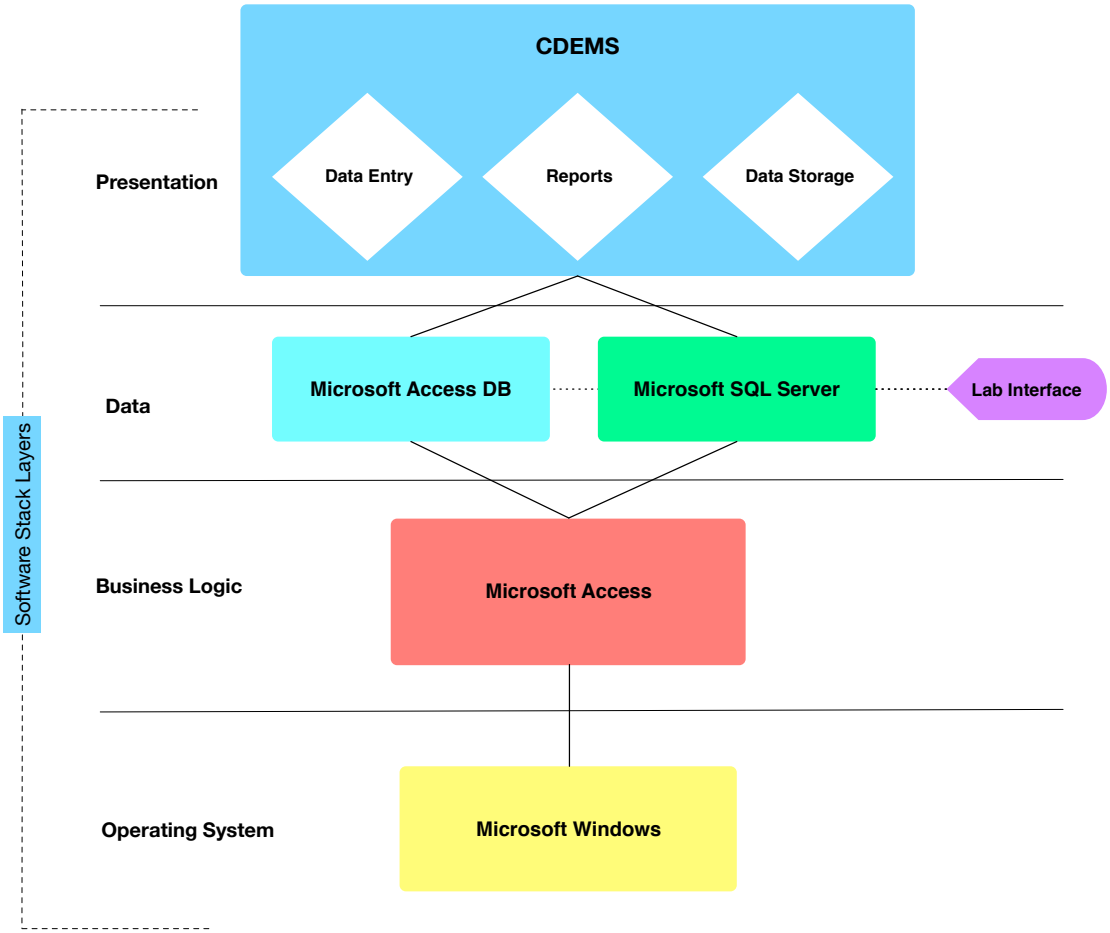

Figure 4. CDEMS Architecture

patient records inside CDEMS[8]. Other data interfaces can be developed for CDEMS, but only a generic HL7 lab interface is supplied by the Washington State Diabetes Prevention and Control Program.

Network Configuration. There are several options for using the CDEMS registry with multiple users. The simplest way to utilize the program is on a single workstation, but this limits use to only one user at a time. To enable concurrent use of the registry by multiple users, CDEMS can either be fully or partly installed on a network server or configured with a Microsoft SQL Server. Figure 5 portrays these three options for standard networking configurations. To enable multiple use of a single registry within an organization, CDEMS can be fully installed in a network (e.g. Windows NT) and a path or shortcut icon can be added to every workstation to access the server-based CDEMS installation. If it is too resource-heavy to run a full CDEMS installation off the network, it is also possible to install the CDEMS program on every workstation and install the "cdem_dta.mdb" data file on the shared network server[6]. Under these

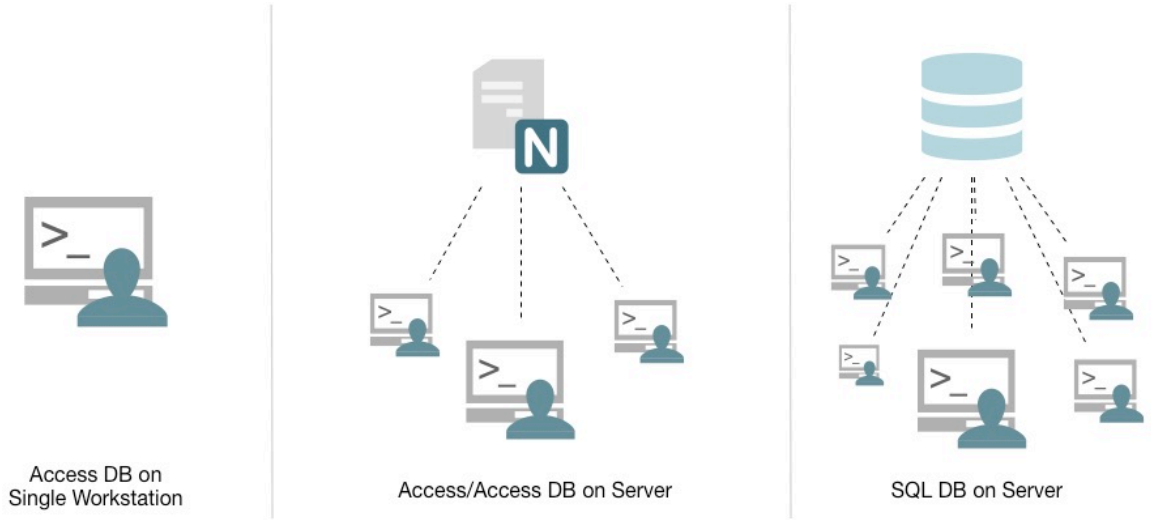

Figure 5. Networking Options for CDEMS Database Storage

conditions, hardware resources are more distributed between the workstations, as only the Access database file is requiring server resources.

The last option for network configuration is to run CDEMS connected to a Microsoft SQL Server database from every workstation. A full installation of CDEMS minus the "cdem_dta.mdb" data file would be made to every workstation and then configured to connect to the Microsoft SQL Server database[9]. The database would be prepared by adding the appropriate CDEMS table structures into the database. Once the CDEMS data entry and reports programs are linked from every workstation, the clinic would be able to handle up to 10 concurrent users accessing the database at once with a database limit of up to 2 Gigabytes of data. Although this process is more laborious than the other network configurations, it is an attractive solution for any medium- to large-sized clinic that needs more speed, scalability, and security than a Microsoft Access database has to offer.

It is also important to note how CDEMS connects to non-affiliated servers and systems through data interfaces. The CDEMS registry provides a generic HL7 data interface to allow lab data to be electronically synchronized to the database. As Figure 6 illustrates, this action can be accomplished by connecting directly to either

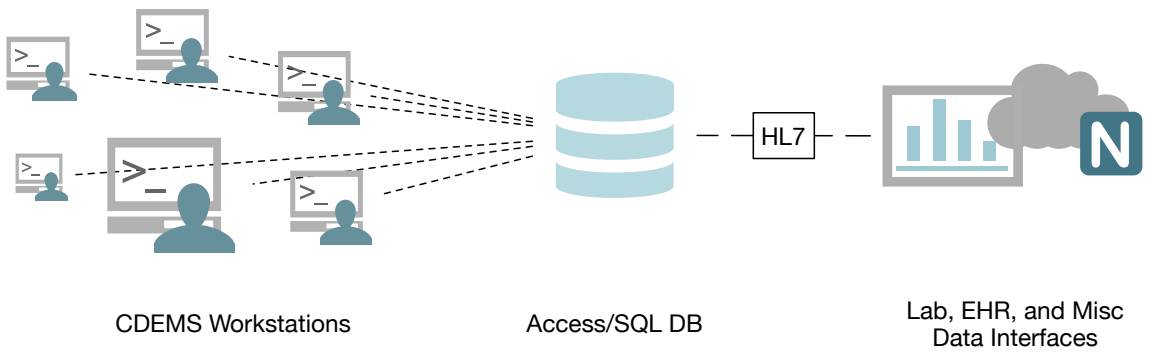

Figure 6. Networking Outside Data to CDEMS via Data Interfaces

the Microsoft SQL Server or the Access database before the data is passed on to the CDEMS presentation layer. Other interfaces can be developed to synchronize to the Access or SQL Server database in the same way as the lab interface, expanding the possibility for electronic health record or financial systems to also connect to CDEMS. Although not an automatic process, data can also be imported into CDEMS directly using a Microsoft Excel spreadsheet or comma delimited file.

Installing CDEMS

With the Wallace Medical Concern's Gresham clinic already in possession of four workstations operating Windows 7 and Microsoft Access, and connected by a shared network, the first step in the installation process was to install CDEMS on all workstations and the data file on the network server. Not detailed in the official CDEMS installation literature, but a hurdle we experienced while attempting to install the program on a 64-bit version of Windows 7, is that CDEMS works best on a 32-bit version of Windows. Any attempt to install and run CDEMS on a 64-bit Windows operating system requires the user to work around driver incompatibilities that are commonly ameliorated with the installation of new 32-bit drivers.

There are three different options for installing CDEMS: 1) by zip file (.zip), 2) by executable file (.exe), and 3) by unzipped format (.accdb and .mdb)[7]. It is recommended that installation be attempted using the zip file first, but then attempt the executable file if that is unsuccessful, and then, if both of those fail, using the unzipped format. We were able to successfully install the CDEMS data entry and reports zip files on all 32-bit versions of Windows 7 with relative ease. Workarounds were needed to install the data entry component on a 64-bit version of Windows 7

after solutions were found within the CDEMS User Forum. The data file "cdem_DM_dta.mdb" was uploaded to the clinic's Microsoft Windows NT server so all workstations could access the same database while relying on their own hardware to process the data entry and reporting programs separately. Lastly, CDEMS on each of the four workstations were linked to the server-based data file and verified to be synching data correctly to the server from multiple workstations at once.

Importing Data

As the intent of utilizing CDEMS within the Wallace Medical Concern's Gresham clinic was to support their diabetes management program, importing patient data into the CDEMS registry only had to pertain to diabetic and pre-diabetic patients. At this point in time, the clinic was exclusively using paper records along with their own formatted Access database to track patient diabetes data. When examining the volume of data they had on hand and considering they are a small clinic, the decision was made to only add patient data by hand to the new system as patients visited the clinic, rather than importing all old data. As illustrated before in Figure 1, when patients enter the clinic and are identified as diabetic on record or by HgbA1C rapid test, their paper health record is flagged. At the end of the workweek all patient files flagged for diabetes are entered into CDEMS. The purpose of this method is to not overload the staff with new clerical tasks while incorporating CDEMS into the clinical workflow as seamlessly as possible by mirroring the same process they used with their previous diabetes Access database.

From the more technical aspect of CDEMS, the tlkpClinic table within the database had to be configured before any data could be imported. Considering the

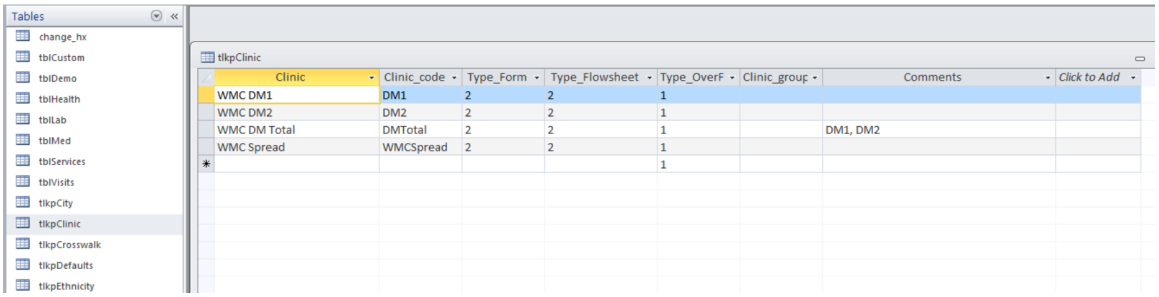

Figure 7. Customizing the "tlkpClinic" Table in the Data File

primary use of CDEMS was for diabetes management, it was decided to group patients within the clinic by health condition. As seen in Figure 7, four different "clinics" were created within CDEMS: 1) "DM1" for diabetes mellitus type 1 patients, 2) "DM2" for diabetes mellitus type 2 patients, 3) "WMCSpread" for all Wallace Medical Concern patients, and 4) "DMTotal" for a combination of diabetes types 1 and 2. The point to this clinic approach was to separate patients by type of diabetes while leaving the "WMCSpread" group as a "catch-all" clinic in the event the Wallace Medical Concern wants to track all patients (including non-diabetics) in the future. The "DMTotal" group was created as an aggregate of both "DM1" and "DM2" clinics so progress reports automatically combining both types of diabetes data may also be generated.

Selecting Progress Note Style and Measures

CDEMS features a variety of Progress Note styles in the Data Entry program and offers a considerable amount of flexibility in customizing them. The Wallace Medical Concern made their choice based on the default style for the 2008 WA State Collaborative DM Data file, which is a CDEMS data file tailored specifically for diabetes tracking measures. Figure 8 shows a sample of Progress Note style 2 as it

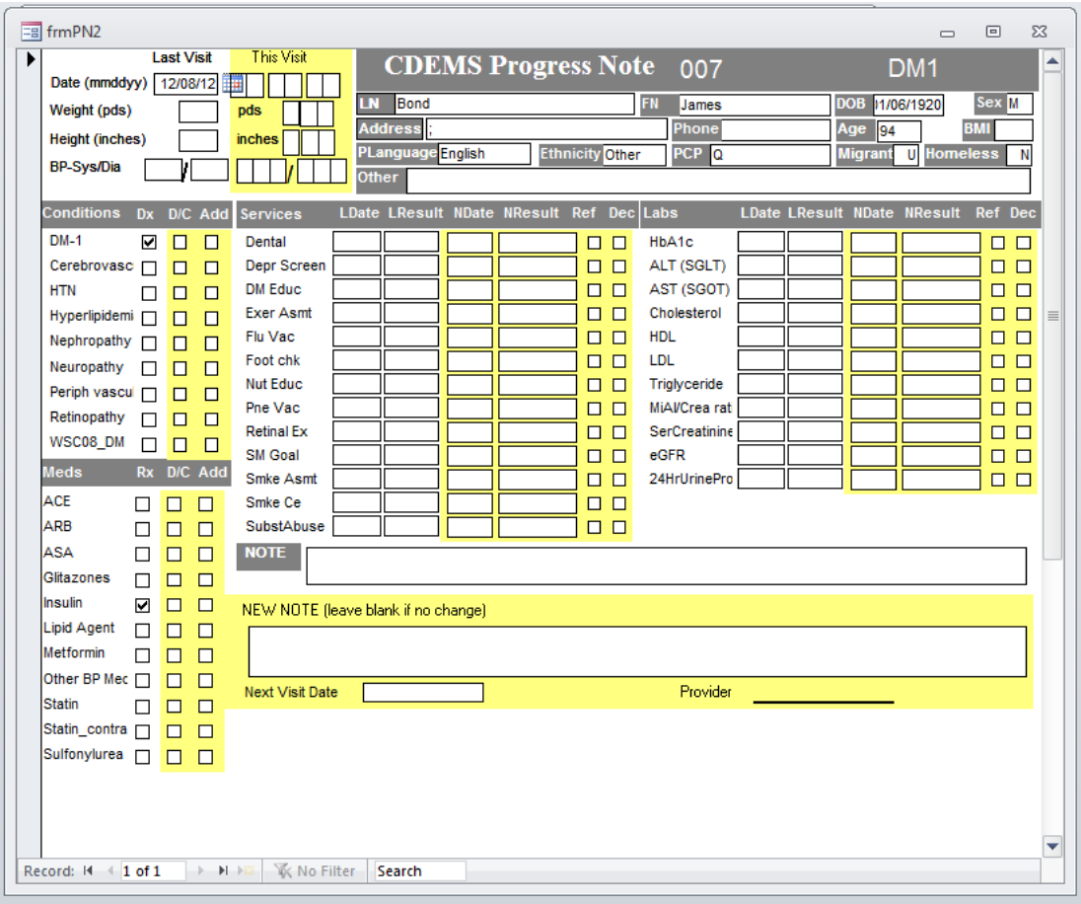

Figure 8. CDEMS Progress Note Style 2

relates to information intake for a diabetes type 1 patient. Tracking measures can be configured in the “tlkpSetup” table of the CDEMS data file. Since the WA State Collaborative did such an effective job at establishing measures in their diabetes-oriented data file, the Wallace Medical Concern chose to use their diabetes-oriented version over the stock CDEMS data file. Figure 9 shows a sample of diabetes mellitus type 1 measures being tracked by CDEMS.

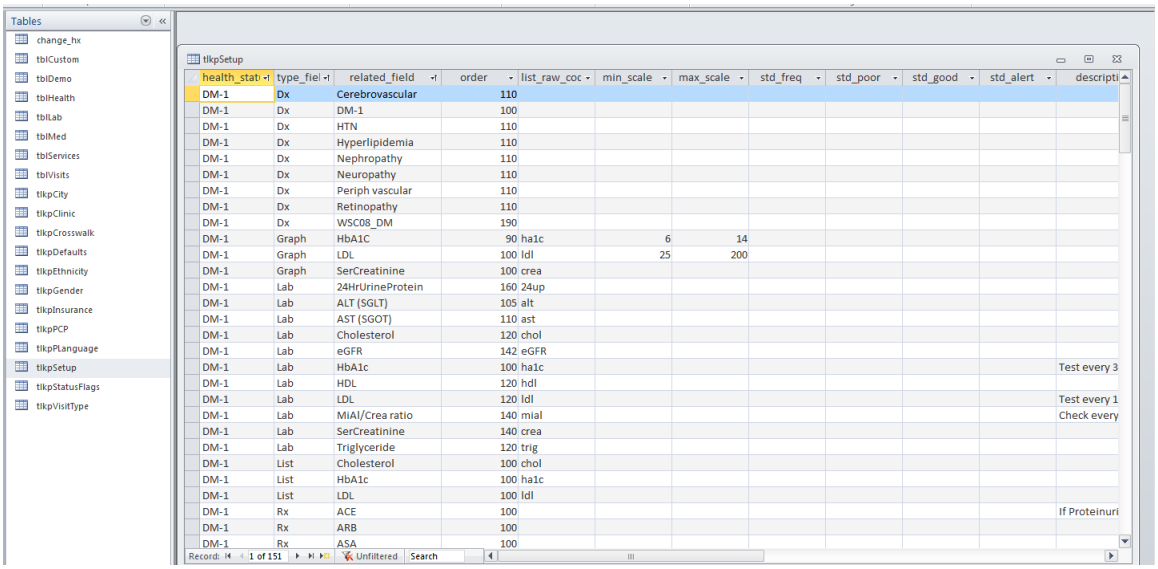

Figure 9. Sample of Diabetes Mellitus1 Measures

Setting Up the Tickler

CDEMS features a tickler alert function that serves as a reminder and early warning system to draw clinician attention to labs and services that are due

health_status	related_field	std_freq	std_poor	std_good
DM-1	Chol	366	>200	0
DM-2	Chol	366	>200	0
DM-1	HbA1c	90	>7	Between 6.5 and 7
DM-2	HbA1c	90	>7	Between 6.5 and 7
DM-1	HDL	366	<45	Between 50 and 45
DM-2	HDL	366	<45	Between 50 and 45
DM-1	LDL	366	>100	Between 95 and 100
DM-2	LDL	366	>100	Between 95 and 100
DM-1	Trig	366	>150	0
DM-2	Trig	366	>150	0
DM-1	Flu Vac	366		
DM-2	Flu Vac	366		

Table 1. American Diabetes Association Target Goals[6]

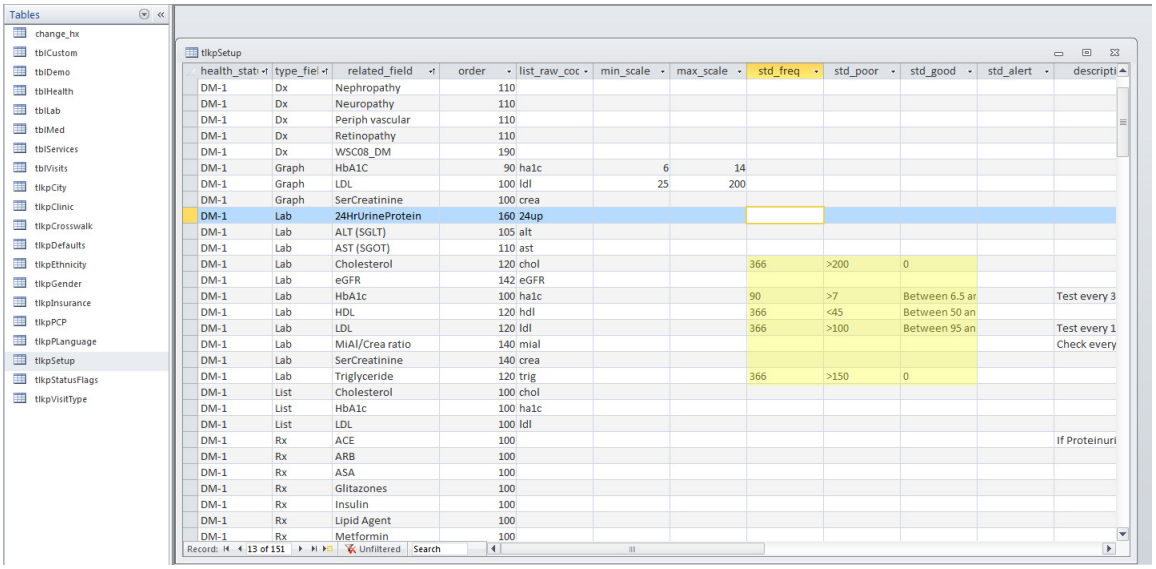

Figure 10. Sample of Tickler fields set according to ADA Recommendations

or outside of the acceptable result range[6]. Tickler parameters were established using the American Diabetes Association (ADA) recommendations for target goals as presented in Table 1[6,10]. These target goals were then configured into the "tlkpSetUp" table along within the tracking measures for DM1 and DM2 labs and services. Figure 10 shows a sample of DM1 tickler fields set within the tracking measures for various other DM1 conditions.

Setting Up Reports

The CDEMS Reporting program features five types of CDEMS Reports: 1) pre-defined Diabetes Summary Reports, 2) user-defined Summary Reports, 3) pre-defined Intervention Lists, 4) user-defined Intervention Lists, and 5) custom queries. For the purposes of the Wallace Medical Concern's diabetes management program,

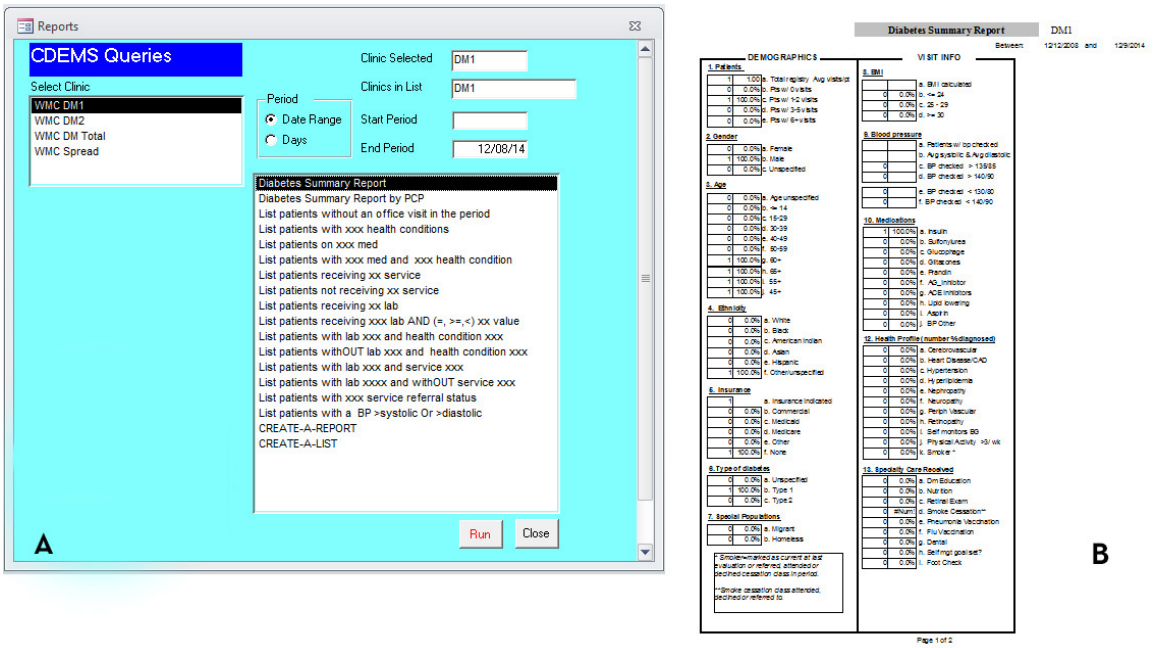

Figure 11. (A) CDEMS Report Main Menu and (B) Diabetes Summary Report

the pre-defined Diabetes Summary Reports, as shown in Figure 11, were found to be more than adequate for the project. Having a system like CDEMS that was created with diabetes management in mind has made a lot of the configuration, though very flexible, unneeded for the purpose of this project.

Aside from the Diabetes Summary Reports, the CDEMS pre-defined Intervention Lists may also be useful to the Wallace Medical Concern. As illustrated in Figure 13, all patients within a clinic can be referenced based on criteria such as health condition, service received, and with or without an office visit within a designated range of time. In turn, the results are listed in a spreadsheet table annotated by columns. With the Diabetes Summary Report and pre-defined Intervention Lists being so robust, there was no attempt to create custom queries or

reports for the Wallace Medical Concern, but those options may be used in the future if the clinic starts to track other chronic diseases with CDEMS.

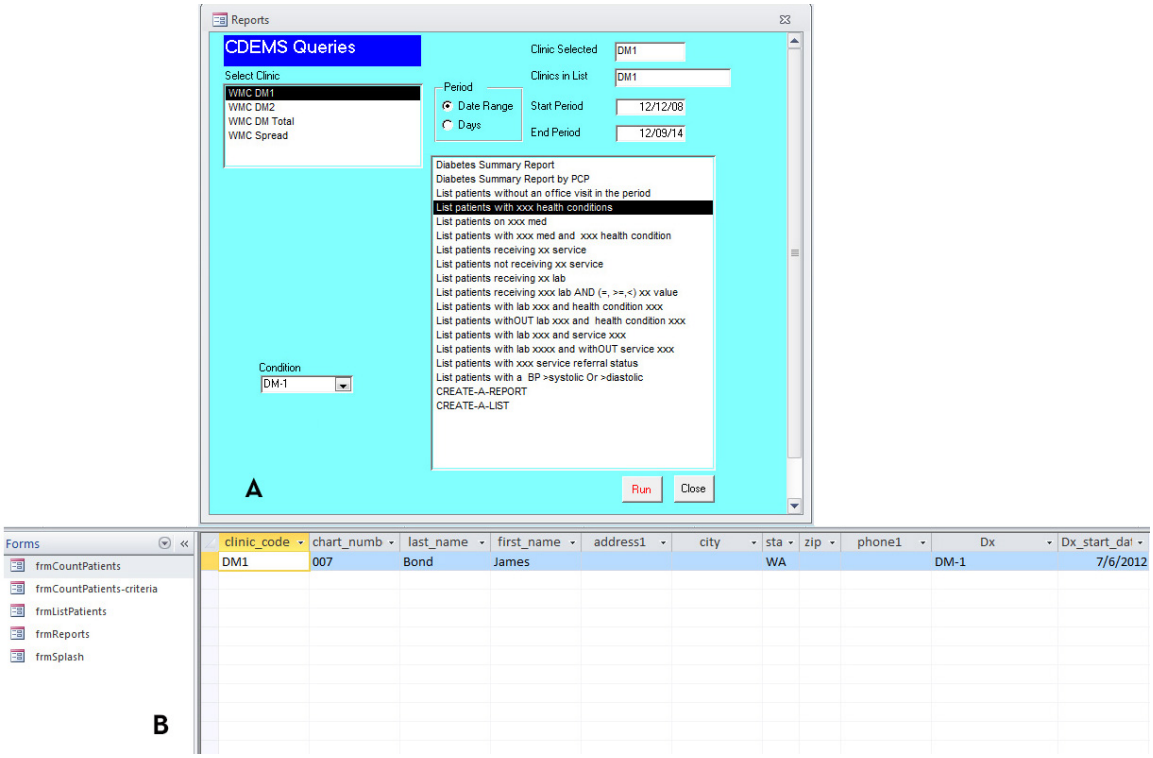

Figure 12. (A) CDEMS Main Menu Selection of Intervention List and (B) Resulting Sample List View

Discussion

Overall, the CDEMS registry is a very flexible chronic disease management program. The fact it is freeware and relies on software common to most business environments makes the system a very attractive option for clinics looking to adopt a disease registry. With a level of customization that allows it to track and report a myriad of health conditions, CDEMS is a powerful management tool with the capacity to help improve clinical service for organizations that do not necessarily have the funds or resources to deploy a more commercial solution. However, it is a software package created when paper patient records were all too prevalent. As CDEMS is written to fit in a paper record based clinical workflow, and does not feature the technology to make integration with more modern health data solutions an easy or economical task, the CDEMS platform will need to evolve with healthcare in this new digital age in order to remain relevant.

For instance, the evident workarounds needed to utilize CDEMS on a 64-bit Windows operating system are a telltale sign that without active maintenance, the CDEMS project is in danger of becoming obsolete due to incompatibility with evolving technologies. Unfortunately, the Washington State Diabetes Prevention and Control Program discontinued maintenance of the CDEMS project in 2012. In an age where 32-bit operating systems are increasingly rare, a clinical system looking to utilize the CDEMS registry will have to arrange for dedicated older computer hardware to run the program. And in turn, this may be a factor that forces clinics to turn away from such a competent system in favor of more modern yet costlier solutions.

The primary driver for this project was the Wallace Medical Concern's need to satisfy a grant by adopting a chronic disease management system to improve diabetes within their target population. Although the aspiration was to employ as sophisticated a system as possible, the barriers of cost and a projected lack of EpicCare's interoperability forced the Wallace Medical Concern to make considerable concessions. Ultimately what was outfitted for the Gresham clinic was a simple installation of a freeware program that is not very "future proof" for the organization. Although it does satisfy the grant requirements and it is an effective chronic disease management system, CDEMS will most likely only serve as a stepping stone for the Wallace Medical Concern as they transition from paper records into the EpicCare EHR system.

Once the Gresham clinic progresses more in terms of the digitalization of their health records, they will most likely come to a point where they need to transition to a newer chronic disease management system, probably within the next 5 years. Currently the plan is that once EpicCare is launched at the Wallace Medical Concern, the data entry forms within EpicCare will be customized to flag whether CDEMS needs to be referred to for the patient's next visit. The lack of integration between EpicCare and CDEMS is needlessly laborious. A preferred solution would have the ability for health data to synchronize automatically between the two systems. Yet for that functionality to exist, due to EpicCare's lack of interoperability, a special interface would have to be developed to bridge the gap between the EHR and CDEMS. This means either the Wallace Medical Concern will have to commission the development of such an interface or subscribe to a HIE service to make one form of the data more

portable to the other. These are costly solutions that the clinic may entertain in the future when their budget allows, but when considering all the costs, it may be more financially sound to simply adopt a commercial system that works more inline with EpicCare.

Despite the uncertainty of how long CDEMS will be a mainstay within the Wallace Medical Concern, there are some plans to test how long the registry will be viable to their clinical service. Considering there is an available lab interface to synchronize to CDEMS, there is a loose plan to connect the component after the EpicCare transition has completed. If the Gresham clinic's use of CDEMS for their diabetes management program proves useful enough, they may also adopt the software at other Wallace Medical Concern clinics if another chronic disease management system has not already been procured. Interfacing with EpicCare may also be an option but it will be contingent on budget, how much staff grows to value the CDEMS registry, and their projections for how long they anticipant on keeping their current workstation technologies as upgrading to 64-bit systems may present compatibility issues to the longevity of CDEMS use. But considering all the factors and given the relatively small size of the Wallace Medical Concern's Gresham clinic, there is a good chance CDEMS may be the right fit for their small-scale diabetes management program for a good amount of time.

What Community Clinics Need in a Chronic Disease Management System

With the current pitfalls of the CDEMS registry in mind, there are a number of recommendations that can be made on what community clinics, like the Wallace Medical Concern, need from the future of chronic disease management systems.

With a new landscape of emerging medical technologies on the horizon, community clinics may not need the most state-of-the-art tools but they need digital solutions that allow them to work with their neighboring healthcare systems.

Support funding. A strong case can be made that there is both an economical and public health benefit to outfitting community clinics with better technologies. Studies have proven that effective chronic disease management can save millions of dollars in national public healthcare spending[11]. Studies on the effect of chronic disease strategies on conditions like congestive health failure (CHF) and chronic obstructive pulmonary disease (COPD) have shown a 36-45% drop in readmissions, with hospital savings of $535 per-member-per-month and $424 million per year in Medicare savings[11, 12]. Chronic disease management for diabetic patients has been shown to reduce emergency department/hospital utilization by 71%, with a $685 to $950 drop in per patient per year costs[11, 13]. This monetary savings is a strong incentive for investment from the state and federal level in technologies that facilitate effective disease management.

The CDEMS registry itself was a project funded by the Washington State Department of Health from 2002 until 2012. With over 200 clinics nationwide at one point using the CDEMS registry, it is a demonstration that good technologies are a good investment of public funds. And we see that trend continue today with support offerings from both public and philanthropic funding. The Parkland Center for Clinical Innovation (PCCI) received a $2M scientific grant in 2013 to develop their Pieces™ health monitoring and analytics platform from the Gordon and Betty Moore Foundation[14]. The Center for Disease Control (CDC) awarded 5 organizations $9.4M

in 2014 for national implementation and dissemination of chronic disease prevention systems[15]. With such large endowments being issued to fight chronic disease, it is hopeful these investments will translate into affordable solutions that non-profit community clinics like the Wallace Medical Concern can adopt to improve their clinical outreach.

With stronger financial support to develop better chronic disease management systems, the proliferation of such systems would have a net benefit to the public health realm. As more community clinics are equipped with effective tools to better recruit, track, and manage chronic diabetes cases, the more population-based data can be accrued. As this bevy of data gets reported to local public health departments, we could from a macro-level start seeing a clearer epidemiological picture of the true prevalence and incidence of disease. This improved bio-surveillance would then in turn benefit the reporting community clinics by supplying a better reference point to the true morbidity and mortality needs of their own target population. Chronic disease cases, which would otherwise be "lost in the cracks," could be more effectively linked to community clinics, aggrandizing patient referral and recruitment. If community clinics and larger healthcare systems can talk the same digital language, data sharing of local patient information transforms the possibilities of improved continuity of care and chronic disease interventions.

Interoperability. Funding is not enough, however, for there to be effective data sharing. There also has to be better collaboration between technology industries and healthcare stakeholders. One of the greatest impediments to CDEMS being a "future-proof" registry was its inability to easily interface into an EHR system. There needs to

be an easier and more economical way to transform health information into portable data. One effort to solve this exact problem is being addressed through the Direct Project, created to establish standard protocols, message formats, and assorted other processing requirements for safe and trusted communication between Health Information Service Providers (HISPs)[16,17]. Such a communication technology would allow community clinics to effortlessly share health data between EHRs or chronic disease registries. If adopted by all health information technology developers and vendors, it would also allow there to be a standard for any data system to talk to another. This standardization in the health technology industry would ensure systems like EpicCare and CDEMS naturally have a language to communicate through, alleviating a lot of the barriers to interoperability in the current marketplace.

Telemedicine and Care Guidance Integration. As important as funding sources, neighboring health systems, and health technology vendors are to chronic disease management, the most important stakeholder has yet to be addressed, the patient. The future of healthcare and patient engagement lies in expanding the clinic doors to the patient's home[18, 19]. Telemedicine services, which allow the patient to seek clinical advice and knowledge from outside the clinic, can increase healthcare access and prevent health conditions from escalating into acute events[18]. Considering chronic disease management systems function as data analytic and visualization software already, the next step to improve these systems is to integrate them with complimentary services such as: 1) online patient empowerment portals to promote active patient education, 2) telehealth services which assist in intervention when

health measures are out of bound with recommended guidelines, and 3) the importing of healthcare data from telemetric and telediagnostic devices.

Wearables and the 24/7 Data Stream. With companies such as Fitbit, Withings, and Jawbone marketing wearable health and fitness monitoring devices, we are witnessing the verge of a 24/7 patient data stream revolution[18, 19]. These devices track user parameters such as movement and heart rate to trend a person's exercise habits, but more specialized "wearables" could monitor richer clinically relevant data through blood cells and breath acoustics[18]. By integrating 24/7 data streams into a chronic disease management system we can trend health habits and develop more personal and effective health chronic disease programming. With the use of telemetric and telediagnostic wearable devices, we could also forecast and mitigate potential acute events before they happen.

Gamification and Behavior Nudge. With this impending influx of health data, chronic disease management systems can transform into patient health behavior programs. With smarter health information we have a more accurate pulse on the current clinical status of a patient. But how do we use this data to help a patient enhance their health behaviors? A growing trend in medical technology is the gamification of healthcare to persuade patients to engage more into their self-care and promote healthier life choices[18, 19]. Such programs as MySugr, a mobile app that transforms childhood diabetes management and education to feel like a game, can impact health behaviors by changing the narrative patients immerse in[20]. By engaging the patient through competition, storytelling, and tokenized challenges, we

can change the way chronic disease is approached for better health outcomes[20]. And by integrating more data to analyze health trends, telehealth services to expand intervention, and game therapy programs to influence healthier behaviors, we can build chronic disease management systems that match our emerging technologies and clinical needs in the future.

Conclusion

The Wallace Medical Concern was in need of an electronic chronic disease management system to satisfy a grant stipulation for diabetes management. After some careful inspection of the clinic's needs and requirements, the Chronic Disease Electronic Management System (CDEMS) was selected for it's low adoption cost and high level of flexibility. At the end of implementation, the Wallace Medical Concern had an effective disease registry tailored for diabetes management that fit the immediate needs they had to satisfy.

Although it is uncertain how long the CDEMS registry will remain at the Wallace Medical Concern, CDEMS is recommended for it's ease of use, flexibility, and as a low cost solution for clinical environments in need of an economical chronic disease management system. Hopefully this first step in adopting health information technology will usher in a new period of better health access for Portland patients and improved health outcomes for the Wallace Medical Concern.

References

1) American Diabetes Association. Statistics about Diabetes. 2013 [cited 2012 June 6]. Available from URL: http://www.diabetes.org/diabetes-basics/statistics/

2) California Healthcare Foundation. Chronic Disease Registries: A Product Review. 2004 [cited 2012 Sept 20]. Available from URL: http://www.chcf.org/publications/2004/05/chronic-disease-registries-a-product-review

3) Oregon Health Authority. Diabetes, Heart Disease, and Stroke in Oregon. 2013 [cited 2014 Sept 2] Available from URL: http://public.health.oregon.gov/DiseasesConditions/ChronicDisease/Documents/OHA8582_AllVolumes.pdf

4) Portland State University. 2010 Census Profiles Oregon Cities D-G. 2011 [cited 2012 July 8] Available from URL: http://www.pdx.edu/prc/sites/www.pdx.edu.prc/files/2010%20SF1%20Cities%20D-G.pdf

5) Chronic Disease Electronic Management System. Basic Info. [cited 2012 June 8] Available from URL: http://www.cdems.com/basics.html

6) CDEMS. Data Entry Guide. 2011 [cited 2012 December 2] Available from URL: http://www.cdems.com/dload/CDEMS_DataEntry_Guide_0712.pdf

7) CDEMS. Reports Guide. 2011 [cited 2012 December 3] Available from URL: http://www.cdems.com/dload/CDEMS_Reports_Guide_0712.pdf

8) CDEMS. Electronic Lab Interface User Guide. 2011 [cited 2012 December 3] Available from URL: http://www.cdems.com/dload/LabInterface_Guide_0712.pdf

9) CDEMS. CDEMS+SQL Server. 2012 [cited 2012 December 2] Available from URL: http://www.cdems.com/dload/CDEMS%2BSQL/CDEMS%2BSQL_Guide.doc

10) CDEMS. Diabetes Cheatsheet. 2012 [cited 2012 December 2] Available from URL: http://www.cdems.com/dload/WSC/DMCheatsheet_031208.doc

11) Health Management Associates. “Chronic Disease Management: Evidence of Predictable Savings.” 2008. [cited 2014 December 5] Available from URL: http://www.healthmanagement.com/files/Chronic Disease Savings Report final.pdf

12) Center for Health Care Strategies, Inc. (CHCS). “The ROI Evidence Base: Identifying Quality Improvement Strategies with Cost-Saving Potential.” Technical Assistance Tool. November 2007

13) Siderov J, Tomcavage J, et al. “Does Diabetes Disease Mangement Save Money and Improve Outcomes?,” *Diabetes Care* Vol 25: 684-689, 2002

14) PCCI. PCCI Announces the Official Launch of Pieces System At Texas Health Resources. 2013 [cited 2014 December 6]. Available URL: http://www.prnewswire.com/news-releases/pcci-announces-the-official-launch-of-the-pieces-system-at-texas-health-resources-218821861.html

15) Centers for Disease Control. CDC Announces FY 2014 Funding Awards for Chronic Disease Prevention and Health Promotion. 2014 [cited 2014 December 6]. Available URL: http://www.cdc.gov/chronicdisease/about/2014-foa-awards.htm

16) HealthIT. DIRECT Project. 2014 [cited 2014 November 15] Available from URL: http://www.healthit.gov/policy-researchers-implementers/direct-project

17) HealthIT. Implementation Guide for Direct Edge Protocols. Version 1.1, 25 June 2014. [cited 2014 November 15] Available from URL: http://www.healthit.gov/sites/default/files/implementationguidefordirectedgeprotocolsv1_1.pdf

18) Mesko, B. The Guide to the Future of Medicine Technology and the Human Touch. Webicina Kft. 2014. [cited 2014 November 20]

19) PSFK. PSFK Presents: The Future of Health. 11 April 2014. [cited 2014 November 20] Available from URL: http://www.slideshare.net/PSFK/psfk-future-of-health-report-33393202

20) mySugr. mySugr Diabetes Management App. 2014 [cited 2014 December 6]. Available from URL: http://mysugr.com/