Building the Environment for Successful Computer-Based Decision Support: A Feasibility Study with Family Physicians

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ABSTRACT

RATIONALE: The promise of electronic technologies, such as Electronic Medical Records (EMR), is to provide physicians with assistance in managing their practices and to drive improved clinical outcomes for patients. Many commercial products claim to provide computer-based decision-support systems (CDSS) without any clear analysis of the risks, benefits and outcomes.

BACKGROUND: The Centre for Evaluation of Medicines, an academic research institute affiliated with McMaster University, is conducting a study on EMRs and prescribing practices amongst community family physicians in the Hamilton area. The research project is called the COMPETE study (Computerization of Medical Practices for the Enhancement of Therapeutic Effectiveness). COMPETE is a three year project to compare quality of information gathered by paper chart reviews vs. EMR and to assess the effectiveness of computer generated educational interventions.

METHOD: We hypothesize that computerized decision-support systems require the following 'enabling' preconditions: 1) physicians should enter patient data during the patient encounter (i.e., in real-time), 2) a pre-existing base of patient data will be required to provide most clinically relevant decision-support, 3) data should be entered in a manner which is structured, standardized, consistent and relatively complete, 4) key fields of data required include details of medications past and present, diagnoses including adverse events and diagnostic test results, 5) practice-wide decision support requires that most if not all, patients' data be charted in the EMR decision-support software should work reliably and be useful in practice.

Using in-office interviews, analysis of office workflows, analysis of practice management software data and analysis of clinical records, we predict the feasibility of implementing successful computer-based decision-support in family practice clinics.

RESULTS: We will present a collation of these results with interpretation of their impact on feasibility of providing successful CDSS to family physicians, obstacles that still remain to making CDSS a reality and suggestions for how to overcome the obstacles.

INTRODUCTION

As health care becomes ever more complex, integrated, fast paced, community based and quality demanding, electronic medical records (EMRs) are becoming standard office equipment. Potential advantages over current paper-based offices include faster, portable and more reliable access to charts, instantaneous access to decision support from the simple (drug interaction flags) to the complex (patient specific messages re: prescribing recommendations), ability to rapidly formulate patient summaries for referrals and letters, integration of laboratory and pharmacy data directly into the patient record, ability to query the practice population to support preventive health maneuvers or research, and tighter security.

The promise of Electronic Medical Records however, will not be fully realized until decision-support systems that automate some of the knowledge integration tasks of medicine become more available. Very little has been written about the factors that lead to successful implementation of decision-support systems in medical practice.

BACKGROUND

The Centre for Evaluation of Medicines, an academic research institute affiliated with McMaster University, is conducting a study on the impact of computerizing community physicians in the Hamilton area. The research project is called the COMPETE study (Computerization of Medical Practices for the Enhancement of Therapeutic Effectiveness). COMPETE is a three year project to evaluate the impact of EMR on practice efficiency, quality of care and privacy concerns and to assess the effectiveness of computer generated educational interventions.

As EMR use is rare in mainstream family practice in Canada, considerable time and effort were applied to selection of EMR software and recruitment of family physicians.

Description of EMR System: We have recruited 32 family physicians in 18 practices in the Hamilton-Wentworth area of Ontario. Twelve physicians work in a Health Systems Organization model, meaning reimbursement through a capitation system, the rest are typical fee for service primary care physicians. Both reimbursement systems are managed by the province. Most physicians are community-based physicians practicing in urban settings; one clinic of six practitioners practice in a more rural setting. Computer skills vary widely amongst the physician participants. Each physician pays a nominal monthly fee to participate in the COMPETE project in exchange for a complete EMR system. The system includes a local area network (LAN) using Windows NT on the server and Windows 95 on the workstations. Each physician has a mean of 4 workstations – one for the receptionist and three for the exam rooms. The software used is Purkinje's Dossier of Clinical Information (DCI) version 1.4 which is commercially available internationally. Initial participants started with version 1.3, then were converted to version 1.4 when it became available in the summer of 1999. The system includes practice management software for billing and scheduling. This software is interfaced with Purkinje's DCI to allow access to a patient's EMR chart from the scheduler program. The DCI is a structured template-based EMR with integrated prescription module including real time drug interaction checks, diagnostics module for ordering and reporting, a cumulative patient profile and knowledge look-up resources. The server has mirrored hard-drives using a Raid 1 configuration. System back-ups are done nightly and the tape is taken home by a designated staff member at each site. Each site has a service contract with a systems integrator to ensure a 2-hour response time/4-hour fix for server problems and a 4-hour response/8-hour fix time for all other equipment. System downtime has been less than 2%.

All physicians and staff were trained in several sessions just prior to their system implementation. Study staff also provided onsite technical and software use support as needed. Data quality management was actively pursued by project data quality staff. Early management reports have noted that most, but not all, physicians enter patient data electronically. On average 65% of patients seen in participating clinics have encounter information beyond scheduling and billing entered in the EMR. A few physicians do not enter any notes on paper and chart all patient information into the computer. However, others use a mix of paper and electronic chart. Patients with multiple complaints and those who require counselling are more likely to have their records entered on paper as a structured EMR does not lend itself to rapid charting of psychosocial and counselling problems.

Due to ongoing restructuring amongst private laboratory companies in Ontario, only 11 of the 18 sites are able to receive lab results electronically. Other patient information from outside the office, including consult notes, x-ray reports, come into the office on paper since virtually none of the specialist groups are computerized. A few offices scan these reports into the EMR.

METHODS

We hypothesized that an enabling environment for decision-support for encounter based situations and for population care should include the following factors: 1) physicians should enter patient data during the patient encounter (i.e., in real-time). Clinical decision support is thought to be most effective when applied in real time when the targetted decisions are being made. <1> 2) The majority of patients who see the physician should have their data entered when they come to see the physician, especially those with high morbidity diseases. This ensures that pro-active population-based care initiatives such as immunization blitzes have the required data to manage population health. 3) Data should be entered in a structured, standardized and relatively complete manner. Structured, standardized data entry ensures that any decision-support software can link entered data with knowledge databases. 4) Information entered should be accurate and consistent with other data in the EMR. Accuracy and precision of data is directly related

to the efficiency of decision-support software. If there are inconsistent data, decision-support software will provide conflicting advice. 5) There should be a pre-existing base of patient data to provide clinically relevant decision-support. Historical data is usually required for intelligent decision support. The longer the preceding history, potentially the more refined the decision support can be.6) Decision-support software should work reliably and be useful in practice. Speed and integration with work flow are prime requirements.

Databases used for this study included a patient scheduling database, a database of invoices, the EMR notes database, the EMR medications database and the EMR diagnoses database. The scheduling database has information about the patient ID, the date and the time of the encounter. The invoices database has information about the patient ID, the date of the service, a diagnosis and a procedure code (e.g., CPT). The notes database has information about the patient ID, the note ID, the date of service and whether the note was signed or not. We used only signed notes for this study.

Table 1	Scheduling	Invoices	EMR
# Encounters	245,333	285,159	179,693
# of Patients	47,317	57,444	31,634
# of Diagnoses	N/A	285,159	282,119
% Male/Female	42/58	N/D	39/61
% > 65 yrs	15	N/D	17
% 18-64 yrs	60	N/D	61
% <18 yrs	25	N/D	22

N/A – Not Applicable N/D – Not Done

Table 1 shows some of the characteristics of the COMPETE research database. All data were collected in a period from Mar 26, 1998 to Oct 7, 2000. The invoices database has more entries than the scheduling database because it includes patients that the physician may see in other settings, including emergency room visits, nursing home visits and hospital visits. The EMR medications database has 188,607 medications and the EMR diagnosis database has 234,740 diagnoses.

Since it was possible that some patients would not attend in spite of having a scheduled appointment, we considered a patient to have been 'seen' if they had both a scheduled appointment *and* an invoice on the same day.

RESULTS

The number of patients who attended the clinic (patients 'seen') and had their information entered into the EMR is shown in Table 2. About 64% of all patient encounters were charted electronically. We considered any EMR note that was signed on the same day as the patient was 'seen' as having been completed in 'real-time'. Table 2 shows the results of this study. About 56% of patients seen in the COMPETE study have their information charted in real-time.

Table 2	Patients 'Seen'	EMR Notes	% Patients Charted in EMR
# Encounters – all	259,401	165,966	64%
# Encounters – 'real-time'	217,526	122,849	56%

Patients "Seen" = Patients Scheduled *and* Invoiced

It is possible that physicians are entering all patients with chronic morbidity disease and leaving out those patients with self-limiting, acute illnesses. We therefore analyzed by diagnosis supplied with the billing invoice to see which types of patients have their notes entered in the EMR. Table 3 shows the ten most frequent diagnoses for patients who had their information entered in the EMR and the ten most frequent diagnoses for those patients who did not have their information entered in the EMR.

Table 3

Diagnoses in Invoice File for Patients with an EMR Note			Diagnoses in Invoice File for Patients without an EMR note		
Disease	*Dx Code*	*Total*	*Disease*	*Dx Code*	*Total*
Hypertension	401	8762	Anxiety Neurosis	300	4944
Anxiety Neurosis	300	7581	Non-specific Abn	796	3717
Bronchitis --Acute	466	4428	Pharyngitis	460	2929
Adult Annual Health	917	4317	Hypertension	401	2858
Osteoarthritis	715	3781	Diabetes Mellitus	250	2418
Diabetes Mellitus	250	3528	Well Baby Care	916	2391
Pharyngitis	460	3286	Bronchitis --Acute	466	2334
Leg Cramps	781	2734	Senile Dementia	290	2163
Lumbar Strain	724	2557	Dyspepsia	787	2115
Dyspepsia	787	2405	Lumbar Strain	724	2006

Table 3 clearly shows that there is no clear separation by diagnosis. For example, of 11620 encounters where hypertension was a diagnosis, 8762 or 75% were charted in the EMR while 2858 or 25% of the encounters were not entered in the EMR. Similarly, of the 5946 patient encounters where diabetes mellitus was the diagnosis, 2418 or 41% of encounters were not entered in the EMR. Many patients with significant morbid diseases do not have their information entered electronically.

Table 4 shows the quality of the data in the EMR. For demographic data, the *% Available for Analysis* column reports the percent of fields in the database that contained data. For clinical data, *% Available for Analysis* reports the percentage of fields that have data in a coded format, suitable for analysis and research purposes.

Demographic data, which are required for reimbursement were well represented in the database. Other data, which are less critical for clinical care such as Drug Information Number (DIN) were only available 75% of the time. However, some information that would be useful for clinical care, such as reasons for stopping a medication were poorly represented in the database. Of the 16,416 medication entries that were explicitly stated to have been stopped, only 980 of them had a recorded reason for stopping the medication. Literature estimates indicate that the number of medications that are discontinued in clinical practice are, in fact, much higher than the 6% represented in our database. Premature medication discontinuation rates can be as high as 20-25% over a few months.

Table 4	Number	% Available for Analysis
Age	180835	100
Gender – Female	110042	100
Gender – Male	70793	100
Marital Status	7310	23.1
Postal Code	174776	97
Diagnosis codes (ICD 9-CM)*	234,740	92
Medication codes (MediSpan GPI)	218,980	96
Drug Information Number (DIN)	163,214	75
Number of Medications Stopped	16,416	6
Reasons for Stopping Meds	980	6

* Discrepancy in number of diagnosis codes between Table 1 and Table 4 reflects the filtering out of diagnoses that belong in the family history, social history and past medical history contexts.

Table 5 compares diagnostic data in the invoices file vs. diagnostic data in the EMR. The *% Matching* column indicates the percent of EMR diagnoses that were also in the invoices database. We used the number of EMR diagnoses as the denominator for this comparison.

Table 5

Diagnosis	Invoice	EMR	Both	% Matching (95% CI)
Diabetes	5194	3580	1860	52 (10.4)
Musculoskeletal	21001	6330	2194	35 (8.2)
Cardiovascular	16054	16033	5654	35 (7.3)
All Diagnoses	285,159	234,740	46976	20 (3.1)

DISCUSSION

Only 64% of patients who were seen within the study had their information entered into the electronic medical record. Many of those who don't have their information entered have important diseases that require pro-active management. To allow for more complete management of patients with high morbidity disease, physicians will have to chart more of their patients electronically.

Furthermore, only 56% of patients had their data entered in real-time. This means that 44% of patients potentially may not be able to benefit from the medication advice (drug-drug interactions check, drug-disease interactions check) or other decision-support tools that may be available to the clinician through their EMR.

One major barrier to more complete charting and more real-time charting is the EMR interface. The need for keyboarding skills and suboptimal interface design make for slower charting and decreased efficiency in charting for physicians. As well, the lack of integrated data on all diagnostic testing, specialists' reports and hospital discharge summaries meant that these information "perks" could not be used as incentives to use the EMR more completely.

There are significant deficiencies in family physicians' charting habits for decision-support to be successfully implemented. Physicians need to be more complete in their charting and they need to record more information about their clinical decision-making, such as reasons for stopping medications and prior therapies that may have been tried. Physicians also need to have more consistent charting practices and their databases need to be more consistent.

Limitations of this study include our definition of 'real-time' charting. Ideally, this should be calculated in a much smaller time-frame than one day. However, there is great variability in the time at which a note is opened and closed. In some practices, a nurse may initiate a clinical encounter with a patient and the time stamp is put into the chart at that time. The physician may see the patient later and add more information into the chart.

Another limitation is that the practice management software we used in the study does not link the scheduled appointments and the invoices for a patient encounter. Since in most practices, the billing is done as a batch process once a week, many patients will have their invoice made out on a different day than the day the service was provided. In most cases, the date of service on the invoice is the day the service was provided, but in some cases the two dates do not match.

Most importantly, although we believe that there is wide consensus with our views on the determinants of successful CDSS, these determinants have not been established in any rigorous study.

We conclude that there are still many physician and practice-specific barriers to overcome before decision-support can be widely applied. We also submit that EMR technology will need to make significant strides in user interface design and data integration before the full promise of pro-active patient management and real-time clinical decision-support will be realized.

REFERENCES

1. Holbrook AM, Sullivan S, Keshavjee K, Hunt DL, for COMPETE Project. Predictors of Success in Electronic Decision Support for Prescribing. Can J Clin Pharmacol 2000;7:61.

SPEAKER INFORMATION

Karim Keshavjee is a Family Physician with a part-time practice in Mississauga, Ontario, Canada. He is also an Associate Member of the Centre for Evaluation of Medicines, an independent academic research institute affiliated with McMaster University in Hamilton, Ontario.

Currently, he is contracted to the Centre for Evaluation of Medicines to help manage the COMPETE (Computerization of Medical Practices for the Enhancement of Therapeutic Effectiveness) study. COMPETE (http://www.compete-study.com/) is a research project which is studying how medicines are used in a community setting by computerizing the medical records of Family Physicians in Hamilton, Ontario.

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