



Canadian Association of Radiologists
L'Association canadienne des radiologistes

**Manitoba Demonstration Project
In Physician Demand-Side Control
For Diagnostic Imaging**

FINAL REPORT

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Why Health Care Needs Demand-Side Control in DI

All parties involved in health care, particularly front-line clinicians, intend the best outcomes for patients. Two significant factors interfere with these positive intentions:

1. First, the knowledge base in medicine and technology has been advancing exponentially over the past 20 years. This rate of change has made it almost impossible for busy practitioners to successfully keep their practice patterns aligned with changes in 'best practice'.
2. The second interference is the increase in the sheer pace of health care practice necessitated by the growing divergence between demand for health care and the supply of practitioner time. This press of time forces clinicians to order diagnostic imaging (DI) by checking boxes on order forms without supplying accompanying details of history, signs and symptoms and differential diagnosis.

A range of studies from around the world report between 10% and 20% of DI tests that referring clinicians order are not the most appropriate given the patient's clinical symptoms^{1,2}. Lack of clinically relevant information makes it extremely difficult for consulting radiologists to participate optimally in suggesting more useful DI, efficiently developing accurate diagnoses and guiding the care plan.

The Manitoba Demonstration Project in Physician Demand-Side Control for Diagnostic Imaging presented a method for radiologists to assist referring clinicians to make the best use of radiological resources. One goal of the project was to support the clinical decision process involved in ordering DI to measurably improve the percentage of appropriate DI tests ordered and performed.

Connection to Wait Time Reduction

DI wait times are one of the five "areas of focus" for Health Canada. Although there are no scientifically based benchmarks for DI wait times, it is widely acknowledged

¹ Sigal,T. "ACR Criteria Cut Imaging Costs in Israel". Presented at the Radiological Society of North America Meetings in Chicago, 2004

² Litt,A. "Limiting MR and CT to Specialists Curbs Imaging Demand". Presented at the Radiological Society of North America Meetings in Chicago, 2004

that the currently common wait times³ for DI contribute significantly to the wait times for definitive diagnosis and treatment in a range of conditions with unacceptably high waiting times including cancer, joint replacement and cardiac services. Reducing wait times for diagnostic imaging services will provide patients with greater access to services and allow patients to advance more quickly to the next component of service treatment.

If appropriate DI demand-side control could be put in place, that would reduce patient backlogs and improve the efficiency of patient throughput in three ways.

1. By utilizing where appropriate, DI modalities with lower wait times, which will reduce the demand for modalities with longer wait times. For example, a modality such as ultrasound with a shorter wait time can, in certain circumstances, replace orders for MRI, a procedure with a long wait time in most Canadian health regions.
2. Going directly to the most appropriate DI test will move patients to definitive diagnoses more efficiently than building up DI tests from simpler to more complex (X-Ray to US to CT to MR).
3. Eliminating unnecessary DI will directly release DI resources to be deployed more effectively and reduce travel costs to service remote communities.

The Project

The Manitoba Demonstration Project in Physician Demand-Side Control for Diagnostic Imaging focussed on improving quality of care through improving the appropriateness of DI tests ordered. Clinical guidelines used in this project were adopted by the Canadian Association of Radiologists (CAR) after a review of the scientific evidence of best practice in the use of DI for clinical diagnosis and treatment management. For maximal effect clinical guidelines must be made seamlessly available as part of the clinician's regular workflow^{4,5}. The project imbedded the CAR guidelines in an electronic diagnostic imaging order entry system, Percipio™, developed by Medicalis Inc., a Canadian company based in Waterloo, Ontario. Real-time clinical decision support for DI also provides clinicians with another tool to involve patients and their families in patient-centred decision-making about DI testing.

³ For the purposes of this study 'wait time' is defined as the time between the clinician's ordering an elective procedure and the earliest scheduled time slot for that procedure.

⁴ Hunt,DL et al. Effects of computer based clinical decision support systems on physician behaviour and patient outcomes. JAMA 1998; 280: 1339-46.

⁵ Kawamoto,K., Houlihan,CA, Balas, EA, Lobach,DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ 2005; 330:765.

The project collected both qualitative and quantitative data to monitor physician acceptance of the guidelines, acceptance of the decision-support software and adherence to CAR guidelines for best practice. With funding from Health Canada and Manitoba Health, and with the support of the Winnipeg Regional Health Authority, Manitoba e-Health, and the Sections of Diagnostic Imaging and Pediatrics and Child Health, a study was carried out at the Children's Hospital in Winnipeg to test the effectiveness of providing real-time clinical decision support by incorporating the CAR guidelines into an electronic order entry system for diagnostic imaging. The study was approved by the Health Research Ethics Board of the University of Manitoba.

Methods

In 2005 the Canadian Association of Radiologists (CAR) published *Diagnostic Imaging Referral Guidelines: a Guide for Physicians*⁶. These were based, with permission, on the guidelines which had been developed and published by the Royal College of Radiologists⁷ in England. However, the CAR recognized that published guidelines in paper format are usually not very effective in changing physicians' behaviour. There is, however, some evidence that presenting guidelines in electronic format might be more effective⁸. Two recently published studies have suggested that providing guidelines as part of computerized order entry systems for diagnostic imaging can change physicians' behaviour and reduce imaging^{9, 10}.

The pediatric section of the CAR Guidelines was incorporated into a commercially available electronic order entry system for diagnostic imaging.¹¹ The software was initially deployed at the beginning of July 2006 in selected sites at the Children's Hospital, Winnipeg. The initial sites chosen were those where there was strong physician support for the project. Additional sites were added as the project progressed. The software was only implemented in a few sites to start with in order to help gain physician acceptance and to work out any implementation problems. Initially the computerized provider order entry (CPOE) software was implemented without activating the clinical decision support (CAR guidelines) in order to assess physicians' reaction to the electronic order entry system and to be able to separate their attitudes to CPOE from their attitudes to the clinical decision support and CAR Guidelines.

⁶ Diagnostic Imaging Reference Guide.

⁷ Royal College of Radiology, 38 Portland Place, London, England W1B 1JQ.

⁸ Garg A, Adhikari N, McDonald H, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. *JAMA* 2005; 293:1261-38.

⁹ Rosenthal DI, Weilburg JB, Schultz T, et al. Radiology order entry with decision support: initial clinical experience. *J Am Coll Radiol.* 2006; 3:799-806.

¹⁰ Sanders DL, Miller RA. The effects on clinician ordering patterns of a computerized decision support system for neuroradiology imaging studies. *Proc AMIA Symp.* 2001:583-7.

¹¹ Percipio, Medicalis Corporation, Waterloo, Ontario.

In October 2006 the clinical decision support (CAR Guidelines) were activated and over the next four months the software was deployed at a number of other sites at Children's Hospital. By the end of the project there were 14 sites in Children's Hospital participating in the project:

- Pediatric Emergency Department
- Children's Clinic, Respiriology Clinic, Cancer Clinic
- NICU, PICU, intermediate care nursery, neonatal resuscitation unit
- Individual clinicians' offices

Throughout the study and at all sites, physicians were still able to order imaging studies using the standard paper x-ray requisitions.

The project was slower in start up than hoped for. It took fully 9 months (three fiscal quarters) to get to initial data collection. Project start up (first quarter) required attention to the following issues: formation of the working teams (IT, Research & Evaluation, and Stakeholder-Participants); legal review of all contracts; initiation of physician recruitment. During the second quarter we began analyses to best fit the DI decision-support software into clinical workflow and with current IT systems ("process mapping"). We were still working to fit decision-support into existing IT systems during the third quarter, but we had baseline qualitative information collected by that time.

Data was collected on all the orders placed through the CPOE from the beginning of July 2006 to the end of August 2007. An independent analysis of this project was carried out by the Research and Evaluation Unit of the Winnipeg Regional Health Authority using both quantitative and qualitative methods.

Details on CPOE Software Interface with Support for Clinical Decision Making

Each participating physician logs into the order entry system (CPOE) and acquires the necessary demographic data about the patient automatically from the hospital's electronic admission/transfer/discharge (ATD) electronic record. The physician orders an imaging study from a series of drop down menus and then provides the relevant clinical information by clicking on appropriate items in lists of relevant history, signs and symptoms and differential diagnoses. There are also free text fields to enable the physician to provide more detailed information. If the imaging study ordered is appropriate for the clinical information provided according to the guidelines,

the request is automatically printed out in the Diagnostic Imaging Department. However, if the imaging study ordered is not appropriate, the relevant guideline appears on the screen, either recommending a more appropriate imaging study or suggesting that no imaging is required. The physician can then continue with the original order by over-riding the guideline, or follow the advice of the guideline. The software will also indicate to the physician if the patient has had the same imaging study ordered through the software within the previous month (duplicate order advice). In the present study, duplicate order prompts were not activated in the Intermediate Care Nursery, Neonatal Intensive Care Unit or the Pediatric Intensive Care Unit because it was recognized that examinations on patients in these units are required on a much more frequent basis than monthly. All the details of each order are saved within the software and are available for later analysis.

Quantitative Results

During the course of the study a total of 9925 orders were placed through the CPOE software. The majority of orders were for x-rays and fluoroscopy; the next most frequent imaging studies ordered were ultrasounds (Fig.1).

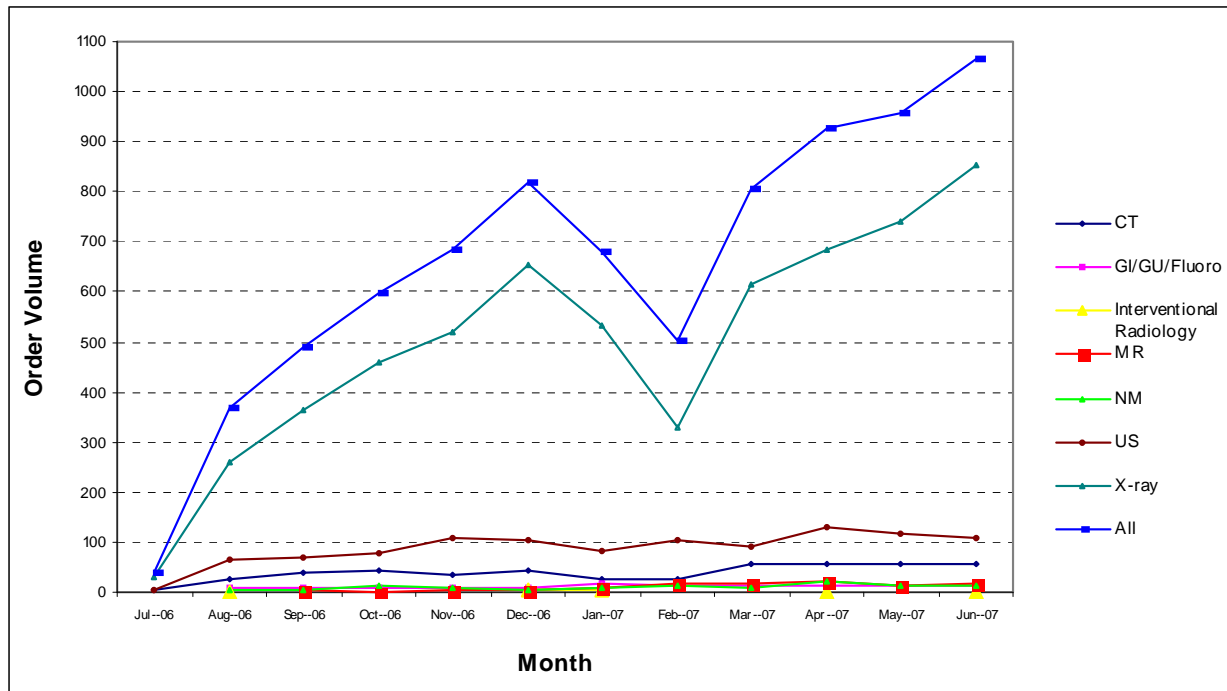


Figure 1

In general there was a steady increase in the number of studies ordered through the CPOE software month by month. The majority of the studies ordered came from the Emergency Department. The Emergency Department moved to a new building in

January 2007, and there was a period when they were unable to use the software, so that there was a reduction in orders in January and February (Fig. 1).

In order to assess what proportion of orders were actually being placed through the CPOE software; we determined the total number of orders for diagnostic imaging being ordered month by month from the Pediatric Emergency Department using the Radiology Information System (RIS) and compared that number to the number of orders being placed through the CPOE order-entry software Percipio. On average 60% of the orders from the Emergency Department were placed using the software (Fig. 2).

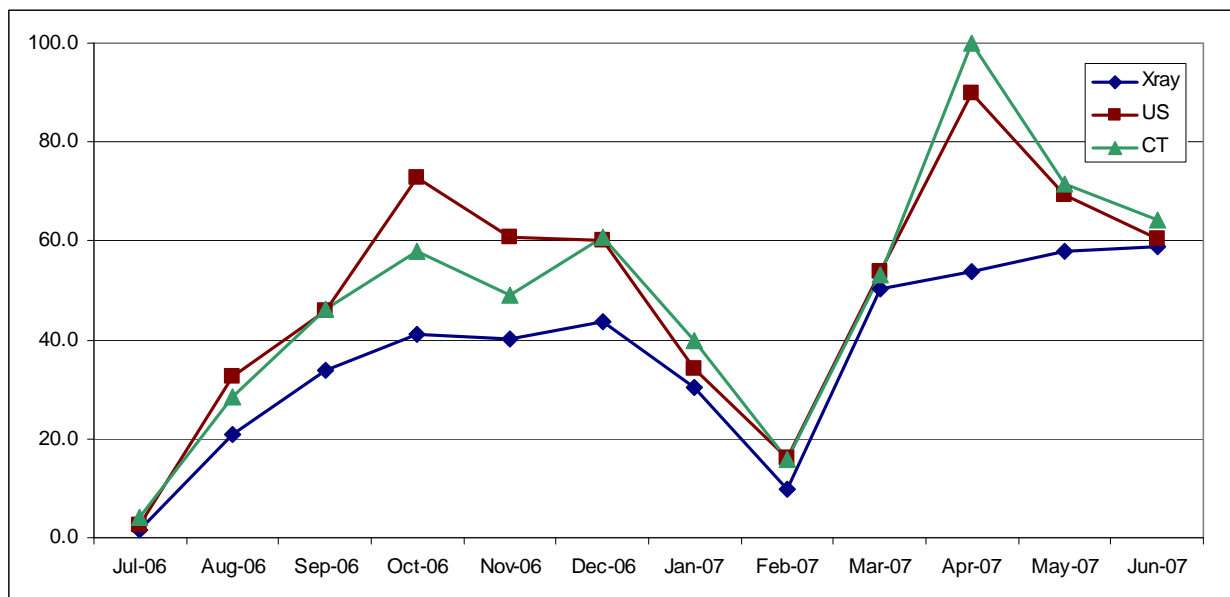


Figure 2

In addition to physicians, nurses and clerical staff on the wards were allowed to place orders using the CPOE software. However, we encouraged physicians to use the software in order to better test the effectiveness of the decision support. Initially a large number of orders were placed by nurses and clerical staff because that was the method used to place paper orders. After a process of encouraging physicians to enter their own orders the proportion of physician generated orders increased rapidly, and it remained steady at approximately 90% of orders throughout the rest of the study (Fig.3). Overall, during the course of the study, 77 physicians and 27 residents and fellows used the order-entry and clinical decision support software.

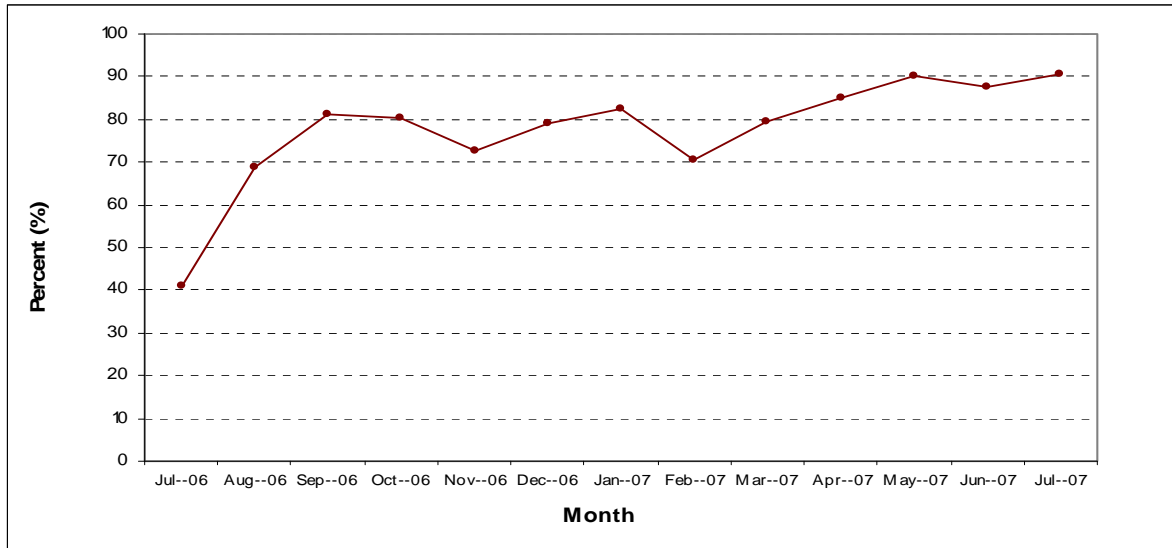


Figure 3

In total 8757 orders were placed through the CPOE software during the period that the guidelines were activated (Oct 2006-August 2007). Of these, only 1678 (19.2%) had relevant guidelines.

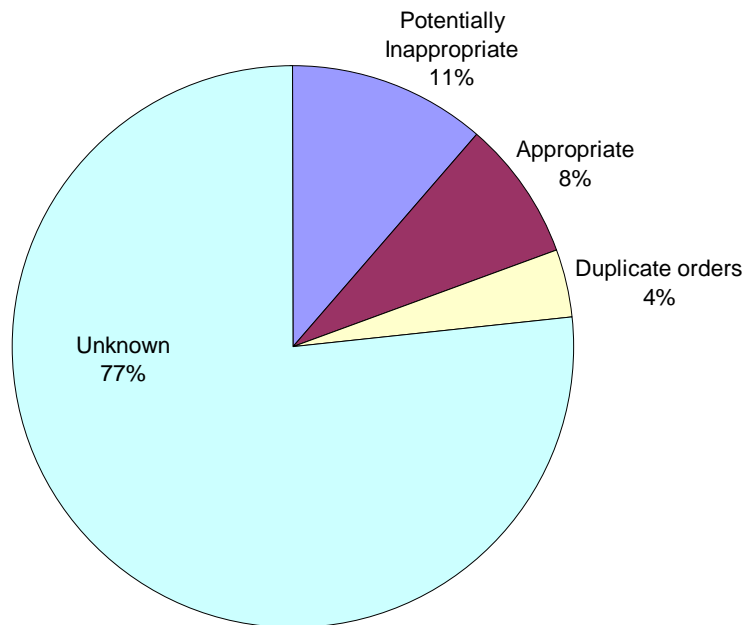


Figure 4

Of the DI orders that had relevant guidelines, 957 (57%) triggered those guidelines to provide advice to the ordering physician on a suggested alternative. Therefore, at least 11% (957/8757) of the orders placed during the study were potentially inappropriate according to the guidelines (Fig. 4).

Among the 'inappropriate' orders, the guidelines suggested that in 77% of cases no imaging was indicated, and for the remaining 23% the guidelines recommended a different type of imaging. The advice was accepted by the ordering physician in only 19 (2%) cases.

A further 367 (4%) of orders triggered a warning that the same procedure had been ordered on that patient within the previous month. A larger percentage, 40 (10.9%) of these were cancelled by the ordering physician. Another 52 orders triggered both an inappropriate guideline and received duplicate order advice, but only two of these were cancelled.

To confirm that orders were actually cancelled, the CPOE software was checked to make sure that the same imaging study was not ordered within the next 24 hours on that patient, and the Radiology Information System (RIS) was also checked to make sure that the same order had not been placed using a paper requisition during the following 24 hours.

The low percentage of orders that had relevant guidelines was unexpected. The data was analyzed to try to determine the reason for such low numbers. Analysis showed that up to 24% more of the orders would have had relevant guidelines if all the CAR guidelines had been activated, not just the pediatric guidelines. In other cases the orders were for multiple studies, for instance an x-ray of an elbow and a foot or of an ultrasound of the head and the abdomen placed at the same time. The software program cannot provide decision support for multiple orders. Analysis also showed that for 3057 (35%) orders the physician provided no differential diagnosis. Many of the guidelines are based on differential diagnoses; which made it difficult to provide guidance to physician when they did not indicate a differential diagnosis.

Qualitative Results

The WRHA Research & Evaluation Unit, which worked at arm's length from the project team, explored both the implementation and the impact of Computerized

Provider Order Entry (CPOE) with decision support. Evaluators analyzed data extracted from the ordering system; conducted interviews and focus groups with stakeholders (ordering physicians, radiologists, technologists, nurses, clerical staff.); collected additional feedback during meetings, clinical rounds, and site visits; and reviewed project documents.

Although CPOE and decision support were implemented as part of the same project, the two are actually highly distinct. Implementing CPOE involves a *process change*, which requires that staff learn and adopt a new way of doing the same things. Decision support, in contrast, seeks to promote a *practice change*, in which clinicians actually do different things. The two components will therefore be discussed separately.

Computerized Provider Order Entry (CPOE)

At the close of the project, CPOE had been successfully implemented in five pilot sites, and most areas of the hospital had at least begun implementation. Early on, steps were taken to remedy various technology-related and application-related problems that were making the system highly time-consuming and inconvenient for users. Nearly all of those interviewed described the implementation as “good” or “above average,” noting that the communication and training were helpful, the application was easy to use, and most glitches were fixed fairly quickly. On the other hand, some weaknesses were identified in the area of coordination; although the members of the project team were clear about their responsibilities, there was some confusion about [who should/ how to] address new issues, and some delays with follow-up. Several participants suggested that more active leadership support, and additional reminders to use the system, would have been helpful. Implementation was also hindered by several external obstacles (e.g., the move of the emergency department to a different location, unanticipated security issues involving laptops) that were hard to resolve in a short timeframe. Despite such difficulties, it appeared that, by the end of the project, a substantial majority of DI orders were being placed through CPOE.

Nearly all participants said that they liked the new system as well as or better than the old one, citing several strengths of CPOE (i.e. greater legibility, less room for errors). However, many indicated that their continued support was conditional on several improvements, including revision of the order lists and integration with other IT systems routinely used on site. As well, physicians noted that it took longer to enter orders on the computer than on paper. For physicians who saw outpatients, this cost was offset by the time saved on obtaining patient results, which were now available electronically. However, this benefit did not apply to ED doctors, who were used to rapid verbal reports from radiology; for them any extra time spent in order entry was a net loss. Another problem was identified by radiologists, who said that CPOE orders often lacked the contextual information they needed to understand the request (e.g., how the injury occurred).

Although participants raised several significant concerns about CPOE, there was overall a high level of support for continued use and expansion of the system.

However, the intent of the project was to implement CPOE, not primarily for its own sake, but as a medium for decision support. It is to this more crucial area that we now turn.

Decision Support

As outlined above under Qualitative Results, the decision support had very little impact on DI ordering overall: only 4.5% of the advice provided was accepted by physicians, which represents less than one percent of all orders. Physicians accepted 2% of the appropriateness guideline advice, adopting 15 of 737 suggestions to cancel a potentially inappropriate test, and 4 of 220 suggestions to choose a different modality. They cancelled 11% (40) of the 367 tests identified as duplicates. In all, only 53 tests were cancelled (0.6% of the total number of orders). NOTE: totals are affected by duplicate counting of orders with more than one advice trigger.

Physicians gave a variety of reasons for not attending to the decision support:

1. They believed that they and other doctors at the hospital (who were primarily specialists) already used DI appropriately, and sought advice from radiologists when necessary.
2. They felt that the computer program failed to process many important aspects of complex clinical situations, and thus produced advice too “generic” to be useful.
3. They explained that they had already made their ordering decisions by the time they got to the computer, and would not change their minds at this late stage.
4. Nearly all thought that decision support would be more useful for someone else (e.g., specialists thought it might be helpful in the emergency department; ED physicians thought it would benefit community pediatricians and generalists).
5. Several expressed a preference for alternative means of promoting guidelines (e.g., education, reporting, dialogue between physicians and radiologists).
6. A few noted that they sometimes ordered an inappropriate test on purpose, either to calm a worried parent or to avoid a longer wait for the more suitable test.

Discussion

It is widely recognized that the utilization of diagnostic imaging is increasing rapidly¹². It has also been estimated that up to a third of diagnostic imaging studies are partially or completely inappropriate^{13, 14}. The application of evidence-based guidelines can result in the reduction of the number of diagnostic imaging studies being ordered in given clinical situations without any risk to the patients^{15, 16}. These facts have motivated several organizations to develop and publish guidelines for diagnostic imaging.

Eleven percent of the orders placed in our study were considered inappropriate according to the guidelines, with only 20% of the orders having relevant guidelines. It is to be expected that a higher proportion of the orders would have been considered inappropriate if the software contained guidelines relevant to more of the orders. It is also important to note that in 77% of the cases the advice suggested that no imaging was necessary. Even if the advice recommends another type of imaging and the advice is followed, this can also result in an overall reduction in diagnostic imaging because if an inappropriate imaging study is carried out initially, the patient then often has to have a more appropriate imaging study later. The data from our project, therefore, indicates that there is the potential not only to make diagnostic imaging more appropriate but also to reduce the amount of diagnostic imaging being ordered if guidelines are implemented and if they are followed.

This project has demonstrated that incorporating guidelines and duplicate order advice into an electronic order entry system for diagnostic imaging has the potential to reduce and make more appropriate the diagnostic imaging being performed. Unfortunately, it appears that in at least in this tertiary care pediatric setting even providing guidelines during the ordering process does not change physicians' ordering patterns significantly. The Percipio software does however provide detailed information about individual physicians' ordering patterns. This individually detailed information could be used to support other interventions such as targeted education to improve compliance with the guidelines.

¹² Bhargavan M, Sunshine JH. Utilization of radiology services in the United States: levels and trends in modalities, regions, and populations. *Radiology*. 2005; 234:824-32.

¹³ Picano E. Sustainability of medical imaging. *BMJ*. 2004;328:578-80.

¹⁴ Institute for Clinical Evaluative Services. *Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review*. April, 2007

¹⁵ Stiell IG, Bennett C. Implementation of clinical decision rules in the emergency department. *Acad Emerg Med*. 2007;14:955-9.

¹⁶ Kerry S, Oakeshott P, Dundas D, et al. Influence of postal distribution of the Royal College of Radiologists' guidelines, together with feedback on radiological referral rates, on X-ray referrals from general practice: a randomized controlled trial. *Fam Pract*. 2000;17:46-52.

Why Such Limited Impact?

Low impact (5% accept rate) could be the result of several factors:

1. Insufficient guideline coverage of actual practice
 - Would additional guidelines increase impact?
2. Good existing DI appropriateness at demonstration site
 - Would guidelines be more useful for generalists (e.g. family practitioners) rather than specialists?
3. Need for stronger clinical engagement about DI appropriateness
 - Would more attention to demonstrating the “need” for guideline adherence, influencing physician knowledge and attitudes lead to more practice change?
4. Timing of advice
 - Was this intervention placed “too late” in decision-making process (after physician commitment to a course of action)?

Evaluation Conclusions

1. Limitations of computerized order entry systems must be addressed to achieve theorized benefits
 - Limitations include taking longer to order DI, increased information about the order which leads to less specific information about the purpose of the test, and lack of integration with other systems
2. Computerized order entry and decision support have the potential to reduce inappropriate DI use, but had a lower effect with the pediatric specialists than would be anticipated in the general physician population.
 - Lower impact observed during the demonstration project with pediatric specialists than originally hypothesized
 - Additional research required to appropriately define address the problem.
3. Implementing the clinical decision support was the first step in engaging physicians on the standard of care provided. In some cases, specialists identified differences between the CAR guidelines and their own specialty-specific standard of care and local guidelines. Efforts to change these behaviors must start with identifying this inconsistency of practice with the stated policy and then engaging physicians with various direct and indirect interventions to align the practiced standard of care with the evidence available.
4. Additional research is required in all of the following areas:
 - a) To understand clinicians’ decision-making process about ordering DI
 - b) To test different types of interventions to reduce inappropriate DI use
 - c) To determine how decision support (or other interventions) fits in with broader healthcare IT systems
 - d) To test interventions in other settings (specialist vs. generalist)

What We Have Learned

1. Complex processes are complex to implement
 - Slower than hoped for start up: 9 months to get to initial data collection
2. Introducing computerized order entry and decision support are two different changes. Computerized order entry is a *process change*. Decision support is a *practice change*. Each requires a different strategy
 - Computerized order entry was introduced as IT/process change, with effective and appreciated training and support.
 - The change management strategy for clinical decision support was focused on aligning the decision support correctly in the flow of clinical practice. Insufficient attention was paid to the introduction of clinical decision support as necessitating practice change.
3. There may be inappropriate use of diagnostic imaging: 4% of orders were duplications; and at least 11% of the orders were potentially inappropriate according to the CAR Guidelines with only ~20% of the orders covered by the guidelines.
4. Guidelines are always a work in progress. Accuracy, coverage and applicability are ongoing responsibilities for professional specialist societies.

Where Do We Go From Here? The CAR commitment continues.

- **Improve the delivery of guidelines in software.** CAR is working with clinical IT vendors to build in advice that has the highest clinical efficacy, includes information about the test outcomes and supports the adherence to guidelines by demonstrating to physicians which tests are most effective for particular disease states.
- **Increase awareness of guidelines.** CAR is actively seeking other regional, provincial and federal partners to assist and promote increased awareness of available radiology guidelines to physicians across the country.
- **Improve the coverage of radiology guidelines.** CAR is working with other sources of radiology guidelines to broaden and update guideline coverage.
- **Assess different physician specialties.** CAR has designed demonstration projects focused on family practitioners, secondary hospitals and rural settings in the belief that clinicians in these settings may be more prepared to accept advice about more appropriate DI use than specialists in quaternary level specialty hospitals.