The Evolution of a Health Information Brokering Service in the Province of British Columbia

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The Provincial Health Services Authority (PHSA) is implementing a health information brokering service in the province of British Columbia. This brokering service (called the Clinical Broker) is based upon the experienced gained by the B.C. Cancer Agency (BCCA) in the creation of its Electronic Health Record (EHR) for cancer care. The brokering service will initially focus on an operational need for information exchange between healthcare providers. Over time, it will be extended to include more complex healthcare services, such as results query, appointment booking and clinical decision support.

Given the results achieved at the BCCA, the brokering service is expected to more than pay for itself in operational savings. It will also result in improved care and reduced clinical risk by accelerating the delivery of clinical information. As a byproduct, a unique data resource for the development of a provincial EHR is being created at no additional cost. Extensive experience is also being gained on the development of interfaces to clinical information systems, clinical information workflow, and on the value of data standards for clinical information exchange.

This paper will examine the circumstances leading to the development of the Clinical Broker, and the opportunities that it will create in British Columbia. The story begins at the BCCA.

THE B.C. CANCER AGENCY AND THE CANCER AGENCY INFORMATION SYSTEM

The BCCA operates a cancer care program for the population of British Columbia. The management of information on cancer patients begins with the B.C. Cancer Registry, where, by law, all patients with a positive pathology of cancer must be registered. Approximately 60% of these patients will eventually be referred to the BCCA for treatment. Within the BCCA, care is primarily delivered through four comprehensive cancer centres, where the patients are primarily seen as outpatients.

Information on all cancer patients in the province is maintained in the Cancer Agency chart. As with other types of chronic disease, the chart is longitudinal rather than encounter-based. More than 60% of the pages in a cancer chart originate from outside the BCCA. Information is gathered and retained from diagnosis to death, and sometimes beyond, for research. The BCCA currently has more than 450,000 charts, of which more than 100,000 are active. These paper-based charts represent a very significant information management challenge.

In the fall of 1992, the BCCA began planning to build a new cancer treatment facility in the Fraser Valley. The existing information systems were dated and not capable of expanding to include the new centre. The market was examined for vendor solutions, but none were found

that met the needs of a comprehensive cancer program. Typical missing features included wait-list management, comprehensive resource scheduling, and the ability to support a population disease registry in a common database with a referred patient registration system. A decision was made to build, and the Cancer Agency Information System (CAIS) project was initiated. CAIS was intended to be a stopgap until an appropriate vendor solution was available.

From the beginning, the functionality in CAIS was aligned with caregiver need. A culture of physician and other caregiver involvement in system design decisions was established and persists to date. Health Records staff were also involved in every aspect of the project. The first version of CAIS was put into production corporate-wide in 1994 and included chart management, enterprise resource scheduling, patient and disease registration, patient-physician relationships, and a cancer treatment summary. For the first time, physicians were able to view information about their patients on computers located throughout the cancer centres, including their own offices.

The primary interface to CAIS is the resource schedule. Information on specific patients is obtained by drilling down through the patient's name in a resource time slot.

LABORATORY RESULT REPORTING

Laboratory services are essential for cancer care. Understandably, the next item care providers wished to have included on the CAIS chart was laboratory result reporting. With the exception of some of the specialized services in the Vancouver Cancer Centre, laboratory services for the BCCA are provided through other hospitals and private labs. In an ideal world, results could be reported back to CAIS with an HL7 interface, and matched to the CAIS electronic record. Unfortunately, none of the key labs had an HL7 interface in production. In addition, even though there was a provincial Personal Health Number (PHN) in British Columbia, most of the lab reports identified patients by their hospital chart number, not their PHN. So, in 1996, the journey to integrate externally generated data into the CAIS electronic chart began.

All of the lab systems were capable of reporting results as an ASCII character stream with the contents equivalent to a printed report. Several approaches were utilized for sending these data streams to the BCCA. Where available, the reports were encapsulated into files and transferred using the file transfer protocol (ftp). In the most primitive cases, a printer connected to the lab system was replaced by a computer capable of capturing a print stream.

Software was used to extract the individual laboratory results from the data stream. Metadata about the report were also derived from the data stream and the circumstances regarding its capture. The report was automatically attached to the patient record in CAIS when the patient identifier, patient surname and date of birth all matched between CAIS and the contents of the report. A "Lab Manager" application was written to handle exceptions, such as data streams that could not be parsed or reports that could not be matched.

For each report, this crude process captures three key data sets that persist into the design of the Clinical Broker today. The parsed lab results contribute to a clinical data repository for the patient. The ASCII presentation of the laboratory report contributes to a report or document repository for the patient. The report metadata contribute to a report or document index for the patient. For performance and/or security reasons these data sets can be stored on different computers, possibly at different locations.

The metadata on a report include a report ID, a patient identifier, the report type, the report date, the facility that generated the report, the name of the application needed to view the report, the date the report was captured, the owner of the report, the entry point of the report into the system, and a pointer to a copy of the report.

Challenges remain with the above lab report capture process. Exceptional effort is frequently required to get appropriate patient identifiers on the report when a new lab is initially connected. Since the individual data elements are not tagged (as would be the case with HL7 or

XML), any modifications to the report will result in parsing exceptions. Clearly, a standard for the transfer of laboratory results is desirable. Such a standard, the B.C. Laboratory Test Standard, has been developed in B.C. To date, only one private lab is using this standard to transfer results to CAIS. None of the other linked labs are capable.

Currently, more than 300,000 external lab reports a year are electronically transferred to CAIS. More than 99% are electronically matched to the patient record. The physicians and other care providers are delighted to have lab results included on the electronic chart. Specialized viewing interfaces have been developed to allowed them to view cumulative results, or results on a selected number of test items.

DOCUMENT MANAGEMENT

In 1995, the BCCA initiated an extensive review of its internal processes. It readily became apparent that the patient information management (PIM) processes were in need of major redesign. Little or no value was being added to the end product (the clinical chart) in far too many of the process steps. Twelve redesign projects were identified, most of which involved some aspect of automating the capture or distribution of parts of the clinical chart – primarily by adding document management and workflow features to CAIS.

All paper-based clinical information entering a cancer centre was immediately scanned. Fax servers were installed to electronically capture all faxed clinical documents. A "Document Manager" application was created to facilitate the extraction of metadata on the document and to manage the document workflow. The documents were linked to the electronic patient record and forwarded electronically to the physician responsible for the patient's care.

The Lab Manager application was integrated into the Document Manager application to consolidate "document" management operations. Additional features in the Document Manager allowed lab reports to be forwarded electronically to the physician responsible for the patient's care.

A transcription application was created. Patient information is inserted automatically into specialized document templates upon entry of a patient identifier. Patient-physician relationships stored in CAIS are used to derive distribution lists for the document. Upon completing the transcription, metadata on the document are extracted automatically, and the document is attached to the clinical record and routed electronically to the author.

Workflow components were added to the CAIS applications. An "Action List," which lists documents needing review or signature, was created for all caregivers. An electronic signature capability was added to the Action List. Caregivers were given the ability to key in or edit clinical documentation from their Action List. All physicians do their post-transcription document edits as they review the original document for signature. Rules were created to automate the document workflow. The Document Manager application is used to manage exceptions to the automated workflow.

The external document distribution process was also automated. The BCCA distributes about two million reports annually to physicians throughout the province. These reports are captured throughout the day from all cancer centres into an electronic post office. The post office sorts the reports by destination and prints the sorted reports on a series of printers. The printed report contains a bar code that is read by a folder-inserter machine to determine the number of reports for an envelope. The folder-inserter machine folds the reports, stuffs them into an envelope, and places postage on the envelope. A pilot project has been initiated for report delivery via a secure e-mail service. The BCCA has saved more than $1 million annually by implementing the external document distribution process. One-quarter of this is in the reduced cost of postage alone.

With the addition of laboratory reports, clinical documentation and document imaging to CAIS, the use of the historical paper chart was reduced dramatically. The number of staff in health records has been reduced by 5 to 10 percent annually in spite of an annual five percent increase in patient load.

IMAGE MANAGEMENT

The next step in the evolution of CAIS was image management. Starting around the year 2000, more and more of the diagnostic images required for cancer care were no longer available on film. Initially, the source of the image would agree to produce film as an exception, but over time these requests were being denied. Images were arriving on CDs and their management and storage was becoming an issue. A decision was made to extend the functionality of CAIS to include the management of clinical images. The process turned out to be very straightforward as, unlike most other types of clinical information, there was a well-established and implemented standard for the transfer of diagnostic images – DICOM.

A process was developed for abstracting the image metadata from the DICOM header and inserting it into the "document" metadata structure. A DICOM viewer was integrated into CAIS. Image management functionality was added to the Document Manager. Initially the images were transferred from CDs, but over time connectivity was established to PACS systems at other locations in the province.

At first, the images were stored on servers in a standard file structure. The process worked well, but it was not scalable. The large size of many of the image studies made it desirable to cache the study on a local server to reduce network traffic. This now required the management of multiple copies of an image. The image servers were multi-terabyte in size, and as a consequence were expensive and difficult to back up and restore. Fortunately, a new approach to image storage was about to go into production.

The BCCA had entered into an agreement with Bycast Media Systems (www.bycast.com) for the development and implementation of the company's Endeavour MultiSite™ medical image archive. This solution uses a grid storage architecture built from a distributed network of low-cost servers. Copies of each study are stored at three geographically distributed locations for performance and fault tolerance. To date, six nodes are in production located in Vancouver and Victoria with a total storage capacity of nine terabytes. Images are transferred directly into the storage grid from PACS systems in Vancouver and Victoria and directly from diagnostic imaging equipment in the Vancouver Cancer Centre. DICOM header metadata are inserted electronically into CAIS from the Bycast nodes. Exceptions are handled through the Document Manager application in Health Records.

CAIS TODAY

The CAIS application has proven to be strategic for the BCCA. With a provincial scope, the same applications and information are available in all cancer centres throughout the province. The range of information available has continuously expanded to meet clinical priorities. Additional modules are being added to support clinical trials, nursing notes, and on-line requisitioning. It is anticipated that the BCCA will be paperless within 12 months.

In the CAIS applications, access to the clinical record for non-structured data and for workflow is through views of "document" metadata. The Document Manager view is used primarily by health records staff to manage the capture and electronic workflow of the documents. The view available through the resource scheduling application is used primarily by caregivers to drill down into detailed information on patients who have been scheduled to a resource. This view provides a comprehensive history of "documents" (including lab results and diagnostic images) for a patient, and is in essence an EHR for cancer care for the patient. The "Action List" view provides a list of "documents" that require review or signature.

In each of the above, a table of document metadata is displayed to the user, one row of metadata per document. The user can sort the metadata table by any data type such as event date or source of report. The user can also drill down through the metadata to view the document itself. The collection and management of this metadata is at the heart of the Clinical Broker.

With the creation of the PHSA, the technologies piloted in CAIS are about to increase their scope.

THE PHSA

As of December 2001, the regional health structure in B.C. consists of five Regional Health Authorities and the Provincial Health Services Authority (PHSA). The PHSA is responsible for provincial health delivery programs and highly specialized services, which account for about one-third of the province's spending on hospital care. The PHSA directly governs and administers the BCCA, the B.C. Centre for Disease Control and Prevention, the B.C. Drug and Poison Information Centre, the B.C. Mental Health Society, the B.C. Provincial Renal Agency, the B.C. Transplant Society, the Children's and Women's Health Centre of B.C., and the Forensic Psychiatric Services Commission. The PHSA is also responsible for coordinating Telehealth for the province.

As with the BCCA before the implementation of CAIS, the agencies of the PHSA have a very significant information management problem with paper-based charts and the lack of an archive for clinical images. It is the intent of the PHSA to leverage the technologies used in CAIS wherever feasible in each of these agencies.

THE CLINICAL BROKER

Rather than developing integration between each of the PHSA agencies and the sources of external data independently, it is proposed that a Clinical Broker be used as a common point of document exchange. The Clinical Broker will be developed using message broker technology, with the message payload initially being clinical "documents." Standards are being used wherever possible for the messaging technology and for the clinical information contained within the messages. Over time, the Clinical Broker will also support clinical services as web services.

Interfaces are being developed between the Clinical Broker and each agency, as well as between the Clinical Broker and each external data source. The external interfaces developed as part of CAIS are being redeveloped through the Clinical Broker, thus leveraging the experience and connectivity gained through the development of CAIS. By developing connectivity to the Clinical Broker, an organization will be interfaced to all other organizations that are also connected to the Clinical Broker. It is the intent of the PHSA to leverage the scope of information exchange required by the sum of its agencies to draw significant participation from other health authorities and healthcare providers. Projects have already been initiated with other health authorities and with the vendors of physician practice systems. Use of the Clinical Broker will be available to all at cost.

In Phase 1 of the project, the Clinical Broker is providing an information distribution service. Information such as a laboratory report or an imaging study that is received from a source will be subsequently distributed to one or more recipients based on a distribution list contained within the message. Potential report delivery locations for healthcare providers will be obtained from the Provincial Provider Registry. The PHSA is the first health authority in B.C. to sign a data access agreement for use of the physician data stored in the Provider Registry. As part of the Provider Registry Project, the PHSA is also responsible for creating and maintaining the "report delivery location" information for physicians within the B.C. Provider Registry. This information is critical for the success of the Clinical Broker.

An additional eight Bycast nodes, capable of storing an additional 20 terabytes of images, are being added to the Bycast grid to facilitate clinical image distribution through the Clinical Broker. These nodes are being located in strategic locations throughout the province. This 14-node, 30-terabyte grid will form a matrix capable of distributing clinical images throughout B.C. This grid-computing technology could also be used as a distribution and archive storage framework for a provincial EHR.

As with CAIS, the Clinical Broker retains metadata on the information content that it distributes. This metadata includes a patient identifier, the source and destination of the information, the location of the service that created the information, the entity responsible for access and security for the information, and the type of information being distributed. The metadata may also contain a pointer to a storage location where a copy of the information is being stored.

It is anticipated that the existence of this metadata data structure will be controversial. Various approaches to the maintenance of governance, security, privacy and consent are being examined as the Clinical Broker expands in scope. Leadership in the resolution of these issues will be provided through the newly created office of the Corporate Director of Security and Privacy role in the PHSA.

In Phase 2 of the project, the Clinical Broker will provide a service for locating information. Queries requesting information on the existence and location of clinical data will be satisfied, provided that the requestor has the right to such information. Rights will be established based on law, facility or authority policy, named relationships between the patient and requestor, and patient consent.

With the completion of Phase 2, it is anticipated that the Clinical Broker will have a very significant and positive effect on the cost and quality of healthcare delivery. Many duplicate tests will be eliminated. Wait times for clinical services will be reduced due to the rapid availability of the required clinical information. Emergency clinical decisions will be based on more complete clinical information. Participants in Telehealth conferences will have simultaneous access to detailed clinical information.

Within the PHSA, we are very excited to observe how this emerging technology evolves. The Clinical Broker could ultimately provide the core data and security infrastructure for patients to manage their own electronic health records.

ABOUT THE AUTHOR

As Chief Information Officer, **Don Henkelman** is responsible for providing vision and leadership in the development of integrated information systems to support the business, human resources and clinical needs of all PHSA agencies. Mr. Henkelman has over 25 years of experience in healthcare information technology, most recently as the Chief Information Technology Officer of the B.C. Cancer Agency. He holds Bachelor's and Master's degrees from Simon Fraser University.