Transmission and Connectivity

Report of Working Group 3
Medical Imaging Technology Roadmap

March 30, 2001

This publication is also offered electronically in HTML and PDF formats on the Internet at http://strategis.ic.gc.ca/medimage.

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Published and distributed by Industry Canada on behalf of the Medical Imaging Technology Roadmap Steering Committee. The views expressed are those of the authors and not necessarily those of the Government of Canada.

Aussi disponible en français sous le titre *Transmission et connectivité*. Une version électronique du document français est disponible à l'adresse suivante : http://strategis.ic.gc.ca/imagemed.

Catalogue No.: C21-30/3-2000E
ISBN: 0-662-29751-2

PREFACE

This report of the "Transmission and Connectivity" Working Group is one of five that comprise the Medical Imaging Technology Roadmap. This Roadmap is intended to provide a market-driven forecast of technologies needed to improve patient care and enhance the global competitiveness of the Canadian medical imaging sector. The Roadmap is expected to strengthen technology development, diffusion and adaptation, and help to guide public and private sector decision making with respect to product development, investment, human resources and other policy areas.

The 14-person Medical Imaging Technology Roadmap Steering Committee provided overall direction and guidance for this project (see Appendix A for the membership list). Steering Committee members represent companies, researchers, clinicians and government organizations involved with the Canadian medical imaging sector. Industry Canada is the catalyst and facilitator of the roadmapping process. A total of 75 people representing more than 50 organizations have participated in the project, creating opportunities for potential alliances and information sharing.

Visit the project Web site at http://strategis.ic.gc/medimage to view the following reports:

•WG1: Future Needs for Medical Imaging in Health Care (2000);
•WG2: Image Generation and Capture (2001);
•WG4: Image Analysis and Visualization (2000);
•WG5: Emerging Technologies with Emphasis on Photonics (2001);
•ORTECH: Medical Imaging: Discussion Paper (1999).

These reports are available in French at http://strategis.ic.gc/imagemed.

EXECUTIVE SUMMARY

PROFESSIONAL ISSUES

A generation after the *Canada Health Act* was enacted, the health care environment is undergoing rapid changes in everything from communication and medical technology to government fiscal policy. The federal, provincial and territorial governments realize that the clinical labour supply in all disciplines is insufficient to meet the coming health care demand, and that it is necessary to invest in information and diagnostic technologies in order to most efficiently stretch available resources. The traditional government bureaucratic health care model must continue to move towards an integrated delivery system, with tight integration of primary care across regions. Multidisciplinary specialty teams, working within a multiple region model, would deliver care across regions, making it possible for resources to be allocated according to the needs of the overall system instead of being under the control of any individual health care institution.

The emergence of regional integrated delivery systems is directing health care procurement decisions towards large-scale technologies capable of being integrated into health care information systems. Practitioners must be enabled to share information and make diagnoses across the frequently vast distances of their regions in order to efficiently allocate available health care resources and catch health problems at earlier stages. This is perhaps most acutely needed in rural areas, where practice volume, lack of certified vendors, and simple geography create considerable difficulties. The historical pattern of regulatory barriers unduly hindering the diffusion of new medical technologies must also be addressed.

Health care services in Canada are delivered within a multilayered policy structure that extends from the global to the patient/practitioner level. The Canadian health care market is very small when viewed from the global perspective, and the integration and interconnectivity technologies are usually developed by multinational corporations or high-tech start-ups. The Canadian medical imaging community needs to act in keeping with this reality, seeking out partnerships with practitioners, research institutions and existing medical imaging companies. Government investments must be coordinated across this spectrum and tap into the potential of corporate research by developing and utilizing partnerships.

TECHNICAL ISSUES

In this time of increasing health care demand and limited resources, picture archiving and communication systems (PACS) offer tremendous cost savings, as well as improved access to medical records. Nonetheless, the potential savings are frequently insufficient to offset the cost of PACS for small and medium-sized health care institutions. While PACS vendors have been adding a Web server to their systems, this solution offers a poor response time and diverts system resources from their primary role, that of providing images to the radiologist.

A more affordable solution is offered by Web-PACS, which employs common Web architecture and computer equipment, such as Web browsers and PCs, respectively, and permits the sharing of images beyond the immediate health care site. Application service providers (ASPs) operate the centrally managed facilities from which the applications can be rented, thus allowing institutions to archive and distribute pictures while not outsourcing applications infrastructure and maintenance.

In the clinical environment, transmission and accessing of medical images can greatly improve patient care and outcomes. Factors such as bandwidth and the reliability and security of the network are crucial. To optimize Internet-based access of medical images, Secure Web sites, e-mail transmission of commented images, and medical image directory services are technologies that must be developed and implemented.

ETHICAL ISSUES RELATED TO TELEHEALTH

Advances in telehealth raise several ethical and regulatory concerns. Judicial interpretation of the *Canadian Charter of Rights and Freedoms* protects an individual from unauthorized disclosure of his or her health information. It is therefore of paramount importance that health care professionals responsible for transmission and storage of medical information minimize the risk that such information can be intercepted or abused. Telehealth has not yet been specifically targeted by privacy legislation. Leaders in the field should consider devising a governance framework for telehealth, both to ensure compliance with existing legislation and to permit health care professionals involved in telehealth to understand and fulfil their responsibilities.

CONCLUSION

There is enormous potential for transmission and connectivity in medical imaging to parlay technology advances into a more efficient and more successful health care system. It is essential that Canadian health care decision makers abandon parochial mind sets and take every opportunity to share resources across regions, to integrate existing systems and institutions, and to ensure that this new mentality permeates all aspects of the development and procurement of future technology and the formation or reorganization of institutions.

While it is certainly also important that all unnecessary delays and requirements be removed in order to make the Canadian medical imaging community more competitive globally and to facilitate the diffusion of beneficial technology throughout the health care system, it is equally important that the regulatory framework stay abreast of the rapid changes and, insofar as it is possible, anticipate them. The current situation is unclear and untenable, and it exposes patients and practitioners alike to substantial, unnecessary risk. Only by acknowledging and meeting this challenge can the Canadian health care system reap the full benefits promised by the extraordinarily dynamic field of medical imaging.

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INTRODUCTION

SCOPE

The scope of the "Transmission and Connectivity" Working Group was to identify and describe key issues that need to be addressed and enabling technologies that need to be developed to fulfil future patient and market needs with respect to transmission and connectivity.

MEMBERSHIP

The "Transmission and Connectivity" Working Group consists of clinicians and representatives of the corporate sector and the research community. Appendix B contains a complete membership list.

OUTLINE

The body of this report is divided into three sections:

- Professional Issues;
- Technical Issues; and
- Ethical Issues Related to Telehealth.

Overview of the Canadian Clinical and Operational Health Care Environment

The Canadian health care system provides health care to more than 30 million citizens, with public funding in excess of $54 billion per year. It employs 740 000 workers in more than 1200 hospitals in 10 provinces and three territories. The system is governed by the *Canada Health Act*, which defines underlying high-level principles and policies. This Act embraces the principle of universality supported by 100 percent public funding, thereby guaranteeing care to all Canadian citizens. During the 1990s, the funding mechanisms and delivery infrastructure were subjected to tremendous fiscal and structural change. During the 1960s and 1970s, the government ran up debt to support social programs. It then spent the 1990s getting control of the associated deficits.

Since the 1960s, the *Canada Health Act* has been interpreted into ever-narrower bands of coverage and governmental responsibility. Furthermore, the Act has been interpreted differently in each province in regards to what ought to be covered. Today, numerous forms of disease management, pharmaceuticals and professional care are not covered. Medical technology and access to diagnostic tests are not mentioned in any formulas. In 1999, 70 percent of Canadian health care costs were funded by government, while the rest was paid through insurance or directly by Canadians. In reality, the publicly funded portion is lower than estimated, as proven by statistically rigorous studies completed by the Canadian Institute for Health Information and Angus Reid. Those studies have shown that when non-institutional care, family care or non-formulary-based medication are included, the government-funded portion of health care falls considerably.

A generation after the *Canada Health Act* was put in place, provincial and territorial governments are questioning its relevance to supporting health care needs in the 21st century. A paradigm shift is occurring in Canadian health care due to communication technology changes, new fiscal requirements, consumer pressures, medical technologies, pharmaceutical developments, and clinical delivery methodologies. Over the next several years, a new set of principles and criteria must put in place to be more representative of the new environment.

The lack of clinical process integration, coupled with new health care demands, has created a problem, which has been exacerbated, in part, by insufficient information management and diagnostic technologies to support decision making. Management and clinicians are making decisions and planning at the different levels without having a full understanding of how they are affecting care delivery in other areas. The federal, provincial and territorial governments are now starting to make the health care infrastructure investments necessary to drive out efficiencies and outcomes. Over the next 10 years, these governments are forecast to generate $100 billion in budgetary surplus, as a result of the revitalized, technology-driven Canadian economy. Governments will invest because not doing so will result in a future election defeat. Health care is the number one issue of Canadians. As a result of federal-provincial-territorial conferences and cooperative efforts, all levels of Canadian governments are finally coming to terms with the

necessary funding requirements and responsibilities delegation. New funded policy initiatives written during 1999 and 2000 aim to restore funding transfers.

Governments have publicly stated that the clinical labour supply across all disciplines will not sufficiently meet the coming health care demand. These governments are realizing that they must build a national technology and information management infrastructure. Information technologies, coupled with diagnostic technologies, are the primary means to make the existing resource pool more efficient and to enable care to be delivered more effectively.

The current system is financially stressed, largely because governments did not have the ability to monitor and adjust their expenditure allocations. Governments could not adequately trust how resources were being utilized or know where the specific clinical needs were within the system. Notably, provincial and territorial ministries of health could not adequately administer the delegation of funds, as they did not have quality, relevant reporting from the regions. Standards were not mature and the information systems were inadequately implemented.

Now, due to factors such as the aging population and the increased public expectations for higher quality care, every province and territory is facing increased demand for health care services. Many institutions have seen their diagnostic testing volumes double or triple in the last five years.

Canadian Health Care's Migration to Integrated Regional Health Care Delivery Models

The Canadian health care system is in the midst of evolving from a functionally driven, institutional bureaucracy towards an integrated delivery system, based on a public corporate model. Currently, primary care is not tightly integrated, though physicians must be economically and structurally integrated within the next decade to enable the system to survive. This major structural overhaul will cause profound changes within the Canadian system. Today, the care delivery system is integrated based on a governance structure and organizational model. New economics surrounding managed care have become the primary drivers of these organizational structures in Canada. A fundamental vision is to make the system consumer- or patient-focussed, while removing the internal parochial philosophies. The Canadian market is following European and Australian regional health models, while avoiding American health maintenance organization models, in part because of the need to serve geographically dispersed and marginal populations. It is likely the Canadian model will have its health care delivery corporations privatized in some form in the long run.

Regional organizations have been formulated within provincial jurisdictions based on two delivery forms. The first model supports larger market integrated delivery systems, which have the size to provide consumer choice and delivery competition, as represented by those in Ontario and Quebec. This model is typical of the larger provinces, where more than 50 percent of the Canadian population lives within urban settings. This model enables care delivery to be

streamlined across the care delivery system without excessive consensus building in multiple corporate entities. This advantage is an enabler to which vendors may favourably respond. Governance and management fall within one corporate structure, while services are often contracted out. Ontario's single governance model frequently covers only acute or long-term facilities.

The second Canadian model, which is built on regional health authorities, is geared towards smaller population markets. Often a single corporate entity is charged with delivery of all health care services to rural or multiple-small-city urban populations. Such a model delivers care across the continuum, including institutional care, public health and home care. This model is implemented in British Columbia, New Brunswick, Nova Scotia, Manitoba, Saskatchewan and Newfoundland. British Columbia and Saskatchewan are governed from a more preventative perspective and are therefore less reliant on technology.

Alberta has implemented a hybrid of both models with substantial elements of service competition, but different in that all regional health care delivery processes occur across a single governance model.

It is important to appreciate the differences between the two care delivery models. Most of the diagnostic imaging and medical treatment technology opportunities will be created in areas where care spans larger integrated delivery systems, possibly covering several hundred kilometres. Technologies that enable equipment to be operated remotely or by local technicians while the radiologist is in another location will solve some of the underavailability problems. Case management, and integrated care delivery management processes that span regions or institutions, ought to be the primary focus of governmental efforts to improve productivity and to optimize value for dollar. Profound outcomes will result from care coordination, collaboration and assessments that can electronically traverse facilities. Using this infrastructure, multidisciplinary specialty teams that work within a larger, multiple region model will deliver care across regional facilities. This flexible model will give practitioners the opportunity to work in numerous facilities according to system need, rather than individual institutional control.

Changing Communication Needs and Health Care Delivery Patterns

The development of regional integrated delivery systems is changing diagnostic and information technology procurement patterns. Projects are moving towards enterprise-level, large-scale technologies, which will be integrated into health care information systems.

Communication needs are evolving as a result of numerous underlying changes in the way processes are expedited, human resource allocation is coordinated and information is used to support decision making. Among the factors that are driving new communication approaches, some are particularly significant:

- health services are increasingly becoming an information-intensive business;
- the amount of knowledge about health is expanding beyond the human ability to absorb, retain and manage it;
- the breadth of clinical complexity and sophistication has outgrown what one human can provide in terms of clinical expertise;
- longitudinal episodic processes are being broken down across multidisciplinary caregivers, according to specific subprocess expertise;
- people are mobile and receive health services from many providers throughout their lifetime; and
- the demand for health services is rising faster than the capacity to provide these services;
- the move to evidence-based decision making.

Integrated enterprise information and diagnostic imaging process flows will become a critical system requirement, as program-based care is integrated across regional health models. Population health, disease management and program budgeting will fund on a more macro level, rather than with the historical operational block funding typical of 1960s government finance models. Within the next two years, projects will be completely procured based on regional business cases instead of on an individual department's technical criteria. These integrated solutions will be increasingly aimed at supporting assessment and care procedure processes of the specialist, primary care physician and clinician across departments. That is in contrast to the radiology-focussed criteria and buying power of the 1990s. Radiologists must be able to provide study and assessment services across multiple facilities and over greater distances, often without leaving a facility. Radiologists will then be able to assist in diagnostic imaging or nuclear medicine technologies at the point of care, or remotely via telemedicine, based on patient need. Technologies are becoming smaller and less costly per unit.

Diagnostic imaging communication requirements and clinical information needs are increasing because of increased volume and expectations. The report from Working Group 4, *Image Analysis and Visualization*, articulated the diagnostic imaging technology requirements and changes from a diagnosis modality perspective. New regional health care delivery organizational structures and new information and communication technologies cause a shift towards a new set of needs. There are a number of fundamental drivers that will require the development of advanced information and communication networks provincially, territorially and nationally. The following factors are driving investments beyond the modality interface:

- enterprise workflow across facilities requires multithreaded care delivery processes involving many providers in many interregional facilities;
- ambulatory patient treatments and higher acuity home care are resulting in demands for information support in a dynamic virtual care delivery system. Today, the majority of inpatient stays are less than five days, with 70 percent of procedures done on an outpatient basis;
- program specialization on a facility basis is requiring patients to move to where the specialty teams are located, within a larger regional or provincial delivery infrastructure;
- patient results, studies and health record details need to be communicated quickly, reliably and bidirectionally prior to the patient arriving for episodic treatment;
- the repatriation of care from tertiary to secondary and primary care institutions will transfer those complex procedures requiring tertiary support into primary care;
- diagnostic imaging is a way of enabling earlier diagnosis and treatment so as to avoid invasive surgery or escalated disease morbidity;
- diagnostic imaging technologies are increasingly being used as part of surgical procedures in order to avoid more invasive surgeries;
- diagnostic imaging technologies must be extended to those points of care on the boundaries of large regional health care delivery systems that otherwise would not have access;
- radiology studies need to be maximized at a larger number of facilities, while finding more efficiencies in a static pool of resources; and
- procedure and study volumes have increased, and operational periods are longer.

Related Current Problems Within Canadian Health Care

An environmental scan was completed, using executive papers, periodicals and interviews with key health care executives in 15 Canadian health care organizations. Canadian health care leaders identified the following fundamental problems, which were having a direct impact on patient, clinical staff and practitioners. These underlying problems create needs for practical solutions, some of which are linked to diagnostic imaging and medical technologies. Information technology and diagnostic imaging technologies should be targeted in the context of these Canadian problems:

- practitioner care is uncoordinated across the delivery system;
- non-medical practitioners are underused;
- provider payment systems and activity measurement standards are ineffective;
- attention paid to proactive disease treatment and management is minimal;
- there are unexplained variations in service utilization between large urban centres and the rest of the system;
- practitioners in larger centres are inefficiently distributed;
- the use of information and information technology in the delivery of care is insufficient;

- clinical decision making is based on insufficient or inaccurate information;
- patients need to know where to find care and how to access it;
- over the past decade, dissemination of proven technology has been retarded;
- there has been little exploitation of information technology;
- there has been little emphasis on customer or patient satisfaction;
- evaluations of quality of care and outcomes have been sparse;
- there are clinical and physician staff shortages;
- there are rigid role definitions that do not allow new models of care;
- minimal inherent abilities to maximize returns on investment in technologies are coupled with increases in and acceleration of costs; and
- there is an inability to redesign workflows and streamline care processes across regions.

Characteristics of the Canadian Diagnostic Imaging Health Care Environment and its Impact on the Adoption of Technologies

Policy Issues

Health care services in Canada operate within a multilayered policy structure that extends from the individual patient-practitioner layer to the global layer, with technical-professional, departmental, institutional, regional, provincial and federal layers in between. There is a significant degree of interplay between each layer of policy and decision making. However, each layer tends to have different priorities, key stakeholders, political agendas and overall purposes.

Bedside Health Care and the Delivery Processes

At the bedside, individual health professionals are guided in their clinical practice by professional associations, licensing bodies and local practice patterns. Referring physicians, radiologists, technologists, nurses and other health professionals are each guided by independent professional licensing arrangements that are interpreted by the individual practitioner at the local level. The individual patients seeking imaging services also influence the choices of imaging procedures. Their referral is based on their own preferences and personal circumstances. This is the clinical decision-making level, which directly provides health services.

Once a referral for an imaging study is received, there begins a process of matching the clinical requirements with the technical and professional capabilities available. It is becoming increasingly apparent that the collective failure to adopt common technical and professional practice standards at the higher levels is creating an overwhelming array of imaging options across Canada. With the recent development of the DICOM, HL7, CORBA, and HTML standards for the exchange of various forms of data, it is becoming technically expedient to interconnect widespread applications within individual institutions. However, there is still the need to establish data structures (rather like the generally accepted accounting principles used with accounting and

financial data) that will allow this information to be meaningfully and efficiently managed across multiple institutions and regions. Not surprisingly, recent mergers and regional efforts have all run into significant difficulties regarding the integration of data collection practices that were inherited from the various founding organizations.

Regional Health Authorities and Primary Care Reform

Changing Institutional and Group Practices

These arrangements create the next layer of policy structure by establishing specific operating policies and procedures to coordinate the work of the various professional groups and supporting staff as they provide health services. This level provides the day-to-day operating structures, the specific operating and capital budget allocations, the specific role definitions and the lines of authority to support the direct care delivery process at the local level.

Regional structures are emerging across Canada in various forms in order to coordinate the activities across institutions. Mergers of formerly independent hospitals and other health care organizations into multihospital systems and larger professional group practices result in another layer of corporate structures, roles, policies and procedures. Many of these structures are attempting to reduce administrative overhead costs, leverage economies of scale, increase overall productivity and reduce operating variability across sites, all the while struggling to apply emerging information technologies to health service delivery. The need for information standards within and across regional boundaries is acutely apparent at this level.

There are varying degrees of adoption of regional structures across Canada. Even though Ontario has the largest provincial population in Canada, it has moved towards developing regional structures at a slower rate than other provinces. Referral patterns for hospital services tend to organize around the urban centres with the critical population mass needed to support regional or tertiary academic medical centres. Community hospitals provide the majority of hospital-based services in small communities. Regional structures essentially establish an overriding corporate and governance structure to coordinate the planning of service delivery across a large number of communities and, in some cases, regional and academic medical centres.

In addition to hospital-based services, there is an extensive array of imaging clinics that are also attempting to consolidate ownership. Most clinics are owned and operated by groups of radiologists, and tend to function on a regional level. However, there has been a recent emergence of provincial and cross-provincial clinics owned by non-radiologists and operated as profitable business ventures, in contrast to the traditional model of a physician owning and operating a practice. This level is establishing a corporate policy and procedure framework for multiple institutions and, in some provinces, combines the entire health portfolio of hospital, public health,

professional practice and other health services, such as nursing homes and long-term care facilities.

Federal-provincial-territorial Cooperation and Coordination

Health care falls within provincial and territorial jurisdiction. Broadly speaking, each provincial and territorial government establishes the general health policy framework, funding levels and implementation strategy. All provinces and territories access federal funding by claiming they support the broad principles outlined in the *Canada Health Act*. The provinces and territories are testing the applicability of the Act, in particular the controls over fund allocation. In western Canada, the emergence of private hospitals and the rapid expansion of private imaging clinics by non-physician groups has received considerable attention as pressures for health services mount on the public health care system. The tension between the increasing needs for imaging and health services and the current policies governing their delivery is anticipated to increase as a concerned electorate strives to ensure access to needed services at an affordable level without bankrupting either an individual afflicted with numerous health problems or the government. The health policies that will be chosen through the electoral process will determine which side of this debate will prevail. Such a debate cuts across all the levels of the system, from the bedside to the national level, and is subject to unpredictable swings in public opinion and the influence of special interest groups.

The provincial and territorial level provides the broad policy framework and funding priorities for health services in each province. This level is also the active political arena for establishing how each province and territory will govern health service delivery. Although there are many similarities in how the provinces and territories have structured the delivery of hospital, professional and public health services, there are growing differences in the chosen models. In fact, there are 13 distinct "health care systems," loosely associated through the *Canada Health Act*, that receive a major portion of their funding from the federal government. This level has tended to reinforce the differences between political climates across Canada and tends to build systems that are only loosely connected, with minimal standardization of policies, funding practices and implicit incentives for health service providers. This leads to wide variability in decision-making practices and priorities, parallel with the current consolidation of influence at the provincial-territorial and regional levels.

Federal influence over the delivery of health services is primarily through the transfer of funds to the provinces. Federal responsibility for health care is only in the relatively small areas of native affairs, immigration and national defence. However, given the significance of health services to all Canadians, the federal government has also established a role in the areas of health research and broader public and population health issues, and has established the *Canada Health Act* as a broader health policy framework with which the provinces must comply in order to access federal transfer payments intended to fund a significant portion of their health service infrastructures. As federal transfer payments have decreased, in part to balance the federal budget, the provinces have

increased their portion of the funding for health services and have recently challenged the interpretation of the *Canada Health Act*.

With both federal and provincial budgets essentially balanced, and with growing surpluses looming, there are emerging debates about how to best use these resources. The balance between competing demands for federal and provincial surplus dollars is struck at the federal and provincial levels. Many special interest group agendas compete for their share of these funds and for influence on the evolution of public policies emerging in Ottawa and the provincial legislatures. Ultimately, governments must balance health funding against the demands for funding by the educational, defence, research, private sector transportation, economic, natural resources and other social and economic policies of both the federal and provincial governments.

The federal and provincial levels interact to form the overall national and provincial legislative and regulatory frameworks that apply to all aspects of Canadian life — including the delivery of imaging services.

Global Information Management and Technology Engineering Influences

The global level of influence on decision making is emerging as a very significant force in the imaging industry. Most manufacturers of imaging equipment, computers and telecommunications infrastructures are multinational corporations or emerging high-technology start-up companies. The technical solutions being developed by these groups are relatively specialized and focussed applications of technologies developed to support the consumer entertainment, communications and computing markets. As the economies of scale drive the prices of these technologies down, the development of new applications focussed on the medical imaging market increases. The Canadian medical imaging and health care markets are very small when funds allocated to salaries and administrative overhead are deducted from total funding. Thus, at a global level, Canada is viewed as a small population with some attractive larger regional centres — that is, a highly fragmented market to which it is expensive to supply and service imaging equipment.

Medical imaging is a global field, and the generation of new knowledge and operating practices occurs, for the most part, outside the boundaries of Canada. Many of the technical opportunities for integration and interconnectivity across various information systems within the imaging industry in Canada stem from the global-level developments of the Internet, LAN/WAN, telecommunications and computer technologies. Such engineering and technical developments are just starting to be applied to medical imaging processes.

Impact Assessment of Current Fragmentation and Multilayered Decision Making

Technical developments on a global scale have highlighted the underlying fragmentation of Canadian health care services. Much of this fragmentation may be seen as a layering of competing agendas, roles, jurisdictions and operating time scales. This structural fragmentation of policies and operational decision making has made it difficult to capture the benefits of new technologies and they have increased the costs of building an integrated information infrastructure. Large investments in this infrastructure are being made by individuals, departments, institutions, regions, provincial and federal governments, private and public sector organizations associated with health care, and global manufacturers. This trend is expected to increase in the near future.

However, the degree to which individual provinces remain isolationist or cooperative in the assessment of imaging technologies and the development of a framework of policies and technical standards will determine the degree of interconnectivity that will be achieved within Canada. Without the alignment of basic technical and professional operating standards, this fragmentation is being perpetuated at all levels. Moreover, each dollar invested in information infrastructure in such an environment moves all levels of the Canadian health services delivery system further down the road of fragmentation. How much this will affect the health status of individuals, or whether or not this is an effective use of available resources, will be debated by policy analysts, economists, politicians, journalists and technical writers.

Given the significant number of layers of fragmented decision making within Canada, how can we make the best use of our collective resources in order to harness the immense technical capabilities that are emerging to serve the growing demands for health services? What safeguards against abuse need to be established prior to broad-scale integration of very sensitive medical imaging information? What structural changes would let the provinces retain their constitutional jurisdiction over health services while allowing a national framework of technical and professional standards to emerge? How will the enormous costs of establishing this health infostructure be minimized to reduce the corporate and individual tax burden? What will be the role of the private and public sectors in establishing and maintaining these systems when leveraging of global technical developments occurs? Are there opportunities for joint ventures across all layers of decision making? What vertically integrating structures are required to cut across horizontal layers in order to efficiently and effectively create the necessary technical, clinical, professional, institutional, governmental and policy linkages required to capitalize on the technical capabilities of emerging information and communication technologies? How will individual rights and freedoms be protected with the establishment of an integrated health service infostructure?

These and numerous other policy questions need to be actively debated and addressed. The various government structures at the provincial and federal levels must provide the necessary forums for these and other debates to occur in a productive and democratic manner.

Current Challenges and Weaknesses Within the System and Their Impact on the Professional

Though there are challenges and weaknesses to be found across the health care system, rural health care delivery faces a set of special problems that have brought it to the point of crisis. Some of the challenges and weaknesses within the rural health care delivery system are fundamental barriers that need to be addressed. Communication technologies will affect many of these fundamental issues:

- difficulty with recruitment and retention of appropriately trained rural physicians, which in turn leads to:
  - < insufficient availability of rural physicians for shift staffing in emergency rooms and hospitals; and
  - < insufficient specialized medical personnel for appropriate consultation with respect to diagnosis and treatment.
- high practice volumes and time commitment associated with a rural practice;
- breadth of clinical skills required to intervene in the broad range of health problems faced by rural physicians on a regular basis;
- because there are few available links, emergency coverage and "on call" duties are insufficiently supported by consultative back-up teams at other linked facilities;
- lack of sophisticated medical or imaging diagnostic capabilities to fully evaluate conditions; and
- lack of a sophisticated medical image directory service (MIDS) communication system that would allow real-time communication with the secondary- and tertiary-level hospitals in the region in which the rural physician is working.

Provincial or regional MIDS are key to the communication of diagnostic images. However, the amount of resources allocated to MIDS are often insufficient to allow them to operate at their highest level of complexity and effectiveness. Systems design, informatics, technology and change management issues surround enterprise master-patient index systems and MIDS. Both systems are necessary for communication and collaboration of care delivery. The biggest challenges do not surround the technology, which is already developed. Rather, the challenges and need for focus reside in building sufficiently large and skilled multidisciplinary teams to implement and support the technology. In the majority of health care projects, outcomes are not achieved because management does not understand that they are investing in an enterprise system that is complex and multifaceted. Technology procurement too often follows the box procurement practices of the purchasing departments.

The issues of licences, credentials and liability for the users of this system are being or will be addressed by the governing bodies and liability carriers and thus will not be debated here. Governments will need to work on integrating testing measurement, nomenclature and billing

codes standardization across provincial jurisdictions if they are to solve underlying departmental silo problems. These structures are major barriers to realizing economies of scale and maximizing the productivity of radiologists.

Privacy and access to this system is an issue that will be addressed via government policy. The system must comply with privacy issues and access must be on a need-only basis. The computers and programs that will run the system should be able to monitor this easily. Access could be controlled by access codes, even fingerprint or retinal scanning, and the system itself could be protected by appropriate firewalls and transmission by encryption or other means that are being developed.

Regulatory encumbrances have been a problem throughout the development and implementation of many medical advancements. Ultrasound, computed tomography (CT) and now magnetic resonance imaging (MRI) have all been plagued by excessive governmental control and regulations that have stifled the development and the expansion of medical programs that have since proven to have major impacts on the delivery of health care throughout Canada. Currently, MRI and, to a lesser extent CT, are still bogged down in bureaucracy and we should expect similar unjustified and detrimental resistance to MIDS.

Local issues often indirectly affect the professional. Development of communication and collaborative solutions, coupled with investments in informatics and change management, would stimulate high-value, knowledge-based industries by enabling the development and expansion of services across the regions. Improved triage capabilities and regional collaboration would allow for the streamlining of patient care. Many inefficiencies would be eliminated within society. Currently, family members are often required to leave work early to accompany a patient for consultations done more than 150 km away in larger centres. When assessments and treatments can be done locally with remote virtual consultation, the cost to the provinces and the community can be greatly reduced. Duplication and redundancy would be profoundly reduced. Although often not measured, these are in part direct costs to the health care system, and have a measurable effect on government finances.

The lack of patient safety and the inability to quickly provide care to minimize morbidity and disease progression demonstrates the current inequality of health care found in the rural and remote regions of Canada compared to urban settings. Universal health care is not a reality in Canada, and therefore implementation programs for these technologies are one of the fundamental methods of eliminating the disparities in the Canadian system.

Impact of Communication Technologies on the Professional

It is important to look at clinical practitioner decision making, and accessibility to images or

information at the micro level, in the context of the larger system. Communication and information technologies must respond to critical systems requirements. These requirements will be examined next.

Accessibility

Judgment, knowledge, information and data are not interchangeable concepts, and therefore need to be clearly understood when constructing integrated health information systems. First, technology must be accessible and available, readily and immediately, to all clinicians and knowledge workers when they need to interface with the enterprise-level processes. New technologies must be deployed that are mobile, lightweight, and easily integrated into care delivery. These technologies, and the information they communicate, will be the fundamental elements of care delivery within the new Canadian system, and must be respected as such.

In order for health information to be usable by everyone from front-line clinicians and managers, through to the policy-level decision makers, there must be generally accepted use of language and standard data definitions to allow events to be routinely and reliably captured. Otherwise, the usefulness of integrated clinical information systems is severely constrained, and in fact may create greater confusion and reduce the overall effectiveness of decision making.

In the same manner that a librarian is a master at categorizing information and searching key words and phrases to obtain relevant research findings, it is imperative that the data inputs be carefully structured using known parameters and assumptions that are generally well understood. Otherwise, the outputs — trends, variances and results — lack the necessary context to allow sound judgment to be applied when making decisions and gleaning new insights and understandings. Ideally, such information is routinely generated and necessary information collection practices, in addition to the technical infrastructure, are integrated in a meaningful way.

The health care field has routinely collected massive amounts of data without paying sufficient attention to their overall integration, or to contextual elements that would allow for their systemic interpretation. This has created a system that currently has the ability to generate data and analyses without linking the bases of thinking, judgment and knowledge to ensure that sound decisions are being made. Where integration has occurred, it tends to be through integrating data structures and data definitions that support financial decision making, but not the growing need for standard data structures and processes to support clinicians. This results in artificial measures of care outputs that are not specifically related to the resources consumed.

Decision Making

Decision making in large academic centres attempts to balance clinical, technical, resource consumption, economic, philosophic, sociopolitical and academic perspectives. Not surprisingly,

this highlights the industry-wide need to refine the knowledge and tools so that informed judgment can be applied to large-scale decisions, and not just the narrow range of information to which the individual is exposed. This parallel development is essential if the technical transition currently underway is to have a meaningful impact on Canada's care delivery system.

Building the network of information highways (wireless, broadband, and PACS- and radiology information systems-enabled) will create the conduits for capturing, storing, transmitting and manipulating data collected at various points in the overall imaging system. However, these essential infrastructure developments will precipitate a fundamental need to reconceptualize the imaging information systems so they can capture the potential created by this infrastructure. A new language is emerging that captures the essence of the imaging activities, and includes a standard set of data definitions. More and more, these standards will be required in order to collect, collate and compare data across sites and jurisdictions. Furthermore, they will be useful in making reasoned decisions that will ensure the future abilities of the imaging systems are sufficient to provide contemporary services.

Interoperability

Interoperability between information systems and organizational processes in a multiregional context is a key issue in today's environment. The impact on care delivery optimization and the professional is profound, but is often underprioritized by government policy-makers. On a global basis, many working groups have been developing national and global standards for the exchange of information. The overcoming of this barrier will significantly impact the system. The HL7 group (health level 7; http://hl7.org), in its release of version 3 (messaging standards), will enable information systems to exchange information in a complete, accurate and meaningful format for the complex decision-making processes of a 21st century health care system. The working groups and their associated standards and their working groups are causing important breakthroughs. From these, governments will need to invest resources in the development of information workflow models. Interoperability standards and technologies are key, but not a complete solution. In most developed countries, the technology components are available, but work needs to be done to standardize measurements, terms and mnemonics. Practitioners will be able to profoundly impact clinical outcomes when information and processes can be integrated across larger regional environments.

Technologies are needed to support the practitioner and clinical teams so that processes can be integrated. These technologies need to focus not just on the electronic layers 1–3 of the IS0-OSI (International Organization for Standardization-Open Systems Interconnection) model. Technologies are needed to support the effective mapping and integration of information and the building of open information models. Integration and interoperability initiatives need to focus on policy, process redesign and information modelling. New tools need to be developed for information and communication modelling, as well as for the integration of information systems.

Software application information models need to become open so that multiple organizations can exchange information within a known set of multithreaded workflows. To date, this is not the case. Technology interoperability is mature from a communications perspective, but it is not mature from a processing software perspective.

Collaboration

Practitioners and health care organizations will be driven to collaborate on processes and information decision making. In doing so, the critical requirements of mobile data capture, integration and seamless availability of the right information at the right place and time will be foremost. Collaboration will occur within multidisciplinary teams that will, in the long run, operate across multiple referring facilities and tertiary specialty care centres. If care is to be provided using community-based models, then there must be more collaboration and communication in assessment, plan treatment and reporting than what is currently practised. There must be investments in new information systems, diagnostic medicine and communications systems, as the current infrastructure is 10 years out of date. Planning and change management will be necessary to replace obsolete processes, improve practices and personal habits.

Transmission and Connectivity Vision – Its Impact on the Professional

As indicated earlier, Canadian health care is being reformed and its processes redesigned. Bold actions will take place over the next five years as governments restructure the system. New capital and operational funds will be injected. This poses an opportunity for vendors to participate and exert influence by demonstrating knowledge, building confidence and creating a vital role for technology. Taken from published Canadian research, and academic and provincial papers, the following key concepts lie at the heart of the vision for Canada's health care information:

- regional integrated delivery systems should be implemented to respond to the specific population needs, on a timely basis and in a coordinated manner;
- images, information and communication should be integrated on a regional basis to provide, on an ad hoc basis, knowledge for the management of care delivery processes and resources;
- information and care plan delivery should be integrated across the continuum to support episodic care management and care plan coordination in an outpatient ambulatory regional delivery model that spans buildings, clinical organizations and physical distances;
- across the continuum, care should be delivered by various multidisciplinary specialists and clinicians, whereby the primary care practitioner should be the focal point of health care case management;

- regional wellness and health care programming, efficient and effective care delivery processes, clinical practice optimization, education and research should be the cornerstones of the new Canadian model;
- health care should evolve to a preventative health and wellness model, with the consumer as the focus of the system within a psychosocial-biomedical model;
- care should be delivered in new ways, led by primary care reform and ambulatory models, supported by new technologies and pharmaceutical technologies;
- future funding should move to a population needs-based model, which should be allocated based on program goals and population needs, as reported by accurate and reliable aggregate information;
- health information and its management should be seen as the fundamental building block to support all levels of management and care delivery decision making;
- information should be aggregated based on standard information models, clinical practice measurements, communication streams, data definitions, and procedure and billing codes;
- Web-based technologies should be the fundamental communication infrastructures;
- information should be aggregated and manipulated to empower professionals, build knowledge, and advance research in an aggregate decision-making model;
- governments should be able to compare regions and provinces using balanced scorecards, supported by standardized information formats, billing codes and measurement criteria;
- clinical, financial, operational and resource utilization information systems should be tightly integrated to provide regional management accurate information on a timely basis; and
- disease management information systems focussed at the targeted core disease programs should be developed to support the information needs of patients, clinicians, consumers, physicians, specialists and researchers.

Strategies for Elimination of Barriers

Within the next year, new strategies will be necessary to provide a policy framework and procurement model to deploy integrated diagnostic imaging and communications infrastructures in the Canadian health care industry. A major focus needs to be placed upon breaking down barriers in the following areas:

- multilevel planning and implementation approaches;
- technology procurement strategy and policy;
- multilevel communication of goals, criteria and requirements;
- redefining technology procurement practices for solutions rather than boxes;
- horizontal and vertical consensus building and strategy execution within a provincial and national framework;
- budgetary prioritization and recognition of professional services to successfully implement enterprise solutions;

- interconnectivity and collaboration of technologies and information;
- systems-wide education and continuous learning; and
- refocus on deploying proven technology, while building new information and process capabilities.

In large part, barriers have been created in Canadian health care due to fragmented and parochial approaches to procurement of diagnostic imaging and information technologies. During the 1990s, a large number of Canadian health care technology projects were internalized within institutional budgets, with little professional assistance from external sources. While some technology projects have been successful, many have not delivered their desired outcomes. These cases provide lessons on how to ensure that future results of diagnostic technology projects are positive.

It is important that future integration and diagnostic imaging projects get beyond the ineffective procurement models previously witnessed. In these cases, budgets were frequently insufficient to provide for professional services to ensure successful implementation of the systems. The integration of information systems and the development of new, streamlined enterprise processes have been insufficient. This fact has left organizations struggling to monitor resource utilization schedule activities, manage costs and optimize patient access. In the near future, diagnostic imaging project managers will be required to extensively integrate their systems with clinical information systems, in order to support the demands of a new regional health care delivery model. Medical imaging, therapeutics and enterprise and modality clinical workflow will converge to deliver a new level of health information to support decision making. Projects need to draw upon multidisciplinary teams, consisting of internal and external staff, to successfully deliver these capabilities.

Today, technology development is not the real barrier to improving patient care and disease management. Prioritizing and recognizing the building of competent, multidisciplinary professional teams is becoming critical to successfully implementing, using and supporting medical imaging technologies. The lack of multidisciplinary professional teams to support technology projects has been the Achilles' heel in achieving operational and care efficiencies in the Canadian health care system. Too often, department directors underestimate the necessary resources and complexity of the process changes required. In most projects, today's budgets are not making professional services a high enough priority to successfully implement technologies and effect change. Independent studies by North American chartered accountancy-auditing firms have confirmed that more than 75 percent of Canadian information technology projects are not completed or do not realize the desired outcomes. The same statistical results will be applicable to diagnostic imaging, in light of the technologies' convergence with information technologies. Considering these experiences, it is important for health care institutions to leverage specific expertise available within external technology vendor and system integration organizations.

Canadian corporations have become increasingly careful as a result of adversarial procurement practices in some Canadian health care institutions. Specific case examples can be cited in procurement practices, intradepartmental cooperation, project management, and partnering models. In numerous cases, investments in technology have occurred within silo structures, and multistakeholder outcomes have been ignored. Purchasing departments, or departments sponsoring the projects, need to consider the opportunities for collaboration in each investment.

A number of corporations in Canada successfully design and commercialize medical imaging, communication and information technologies for the worldwide market. For a Canadian technology innovation to be commercially viable, it must be carefully researched to understand its acceptability in a worldwide market where similar health care systems exist. Barriers to proven technology initiatives have been created in numerous Canadian regions by the desire of a few health care organizations to pursue niche technology projects. In the end, a considerable number have become white elephants. Investments must be coordinated so that regions can exchange information and images. Canadian strategists may refer to a successful model, which is starting to deliver new capabilities. The Canadian health infostructure and national health information standards project will allow a new operational and management capability. Other past examples can be found in industries such as aerospace, communications and resources. Arm's length joint ventures and publicly traded corporations have proven to be successful models for achieving results, while ensuring accountability for grants. Teaching hospitals and corporations need to work closer together in the future, while ensuring both are directed toward targeted goals, with public accountability. Governments need to realize that corporate partnerships provide an opportunity to tap into larger research and development opportunities, while allowing health care researchers to focus on clinical aspects.

Canadian health care technology expenditures represent two percent of the worldwide market. The development of hardware and software technologies in a maturing world is requiring increasingly large budgets. Billions of dollars are spent worldwide each year on research and development of medical and health information technologies. These figures require some realism in policy making to address Canadian needs. Considering the complexity of the current state of technology creation globally, research and development dollars ought to be focussed where they will have the largest effect on Canadian society. Within health care institutions, budgets and projects must be focussed on disease research, as well as improving diagnoses, therapeutics, treatment, interinstitutional clinical processes and decision making. In Canada, intellectual property and associated technologies, which enhance clinical knowledge and communication capabilities, have great opportunities in a global market. The development of the Canadian health data model, HL7 version 3, and the Canadian Infoway projects will open up new opportunities.

Fragmentation is occurring within the Canadian health care education system. It is posing a barrier to growth and the movement of professionals. Training programs in the professional radiological sciences lack congruence in education standards, practices and accreditation. When graduates of

diploma programs move, they have difficulty transferring their professional licences between provinces to fill job vacancies. Training requirements for medical records technicians, for example, vary from province to province. Varying standards of practice, naming conventions and policies relating to the adoption of new technology are barriers of which all levels of government and health care executives must be aware. These barriers need to be the centre of attention over the next decade.

In many regions, rural areas are experiencing shortages or an inability to deploy and utilize radiological and information technologies. The reasons noted above are exacerbating the problems. As well, rural areas are experiencing qualified professional staff shortages and are unable to attract staff. Rural regions are having difficulties obtaining the necessary certified vendor support, due to revenues that are insufficient to offset the high servicing costs created by Canada's geography and relatively small market size. A number of global technology companies have elected not to sell in Canada. The majority of technology projects in Canadian health care are in dire need of external and internal specialized skills to achieve the desired outcomes.

The lack of interconnectivity and collaboration across regional health care systems is a system-wide barrier that must be overcome. It is preventing the achievement of efficiencies and improvements inpatient access. Collaboration requires all levels of governments, health care management and care delivery personnel to establish new joint ventures to allow vertical and horizontal integration. Organizational and jurisdictional boundaries must be broken down and integrated if the system is ever to deliver the next generation of health care and wellness capabilities. To achieve these levels of care delivery, the system must establish clear provincial standards for information communication and measurement. At the same time, the system must build the information systems and diagnostic-imaging infrastructures to, via new communication technologies, integrate care processes. Organizations must be able to share and compare information and images in meaningful formats. This is not possible today, given the state of the communications infrastructure.

Changes in Clinical Practices Within the Canadian System

The Canadian health care system is in a state of change, some of which is necessary, some of which is productive, and some of which is counterproductive. The health care system has been a highlight of the Canadian social system for many years, and most people who use this system, whether consumers or providers, want it to continue to provide appropriate health care to the entire population of Canada, without consideration for geography or an individual's racial, social or economic background.

Primary care reform is a current area of focus. While it certainly is an appropriate place to start, there is a minimal understanding in governments that primary care reform is where case management and cost controls can be implemented. Based on evidence accumulated thus far, if

reform of primary care occurs without appropriate reforms to secondary and tertiary care processes, the lack of integration will increase the likelihood of more care delivery failures, as patients will continue to fall between the cracks.

Regional health care reform will focus the development of a regional medical network in which the patient undergoes investigation and treatment for medical problems. Such an infrastructure will allow the community health centres to provide a wider range of treatment options for their patients, and allow the secondary care centres in each region to expand their scope of secondary care options. Ultimately regional integration and primary care information networks and secondary care centres will all take on a larger role, as they will have the means to communicate critical information, and will be provided with the knowledge to support consultative team delivery. Communications networks will integrate care processes and eliminate those barriers that historically have required care to be delivered in the tertiary centres of large cities. Repatriation of care will cause the resources of tertiary care centres to be focussed on leading-edge, relatively complex activities. The system will achieve cost reductions and efficiencies, while proactively managing pharmaceutical costs and eliminating duplicate testing.

The field of medicine is rapidly becoming a global community in which advances in investigation and treatment become available globally in very short order. It would make sense to take the globalization concept and apply it to the application of health care provision within each Canadian health care region. If, for example, a region's health care system consists of one tertiary centre, two secondary centres and multiple primary or community health care centres, the various components ought not to be considered independent entities, each with its own infrastructure and political environment. Rather, they ought to be thought of as one regional medical community, likely centred around the tertiary care centre, but with each component having a more clearly defined role in order to avoid the current wasteful duplication of services.

Each health care region could essentially function as one large hospital corporation, providing all levels of care for the residents of the region. This would require a state-of-the-art system that would allow communication between the tertiary care centre and its most remote community care centre at a level equal to the tertiary centre's own LAN. A communication system of this magnitude would allow true triage of patients, thus assuring that they receive appropriate diagnosis and treatment at the appropriate site within the region. The patient's electronic record, including imaging and, possibly, real-time visual consultation, would do all the travelling, and the consultations would be completed and treatment plans put into in place before the patient has to be moved to receive treatment, when that proves necessary. In the current scenario, the patient is often moved many times before investigations and consultations are completed, and then again, when necessary, for treatment.

If the investigative capabilities of community hospitals are extended within a region to enable them to collect the data required to make an appropriate diagnosis, then the communication

capabilities would easily allow the integration of this data, the development of a differential diagnosis, possible consultations, the refinement of differential diagnoses, the development of a treatment plan, and the scheduling of that treatment to be done remotely from any of the sites within the region while using all of the regional resources. Access to the region's resources means the resources do not need to be duplicated at each of the sites unless there is sufficient use of that resource at a particular site.

Distance has no meaning with this sort of communication capability in place. In fact, the greater the distances, the greater the potential cost savings and the greater the improvement in the delivery of health care to that region.

Integrated information and diagnostic technologies would have a positive impact on the problems with physician recruitment and retention within the rural regions of Canada. It would help to address patient demands for more expeditious assessment and treatment, regardless of their place of residence. It would also demonstrate to consumers that the health care system is responding in a positive way to the advances in communication that they themselves are now making use of on a daily basis.

Transmission and Connectivity Requirements

Future Market Demand for Diagnostic Imaging Communications

The future demand for communication of medical images is just beginning to be acknowledged within the broader health care system. More importantly, the exact nature of the information, and what format is most useful to the health care process (whether image, report, voice clip or graphical representation), is becoming understood. The current formats of film and transcribed reports have served the medical community for decades. These modalities are reaching obsolescence. Electronic communication and storage technologies are quickly displacing costly physical formats.

In Canada, diagnostic image transmission will expand exponentially, once the optical switching infrastructures are installed across the provinces. The Internet and fibre-optic backbones need to be upgraded to provide adequate bandwidth in rural and suburban areas, where the majority of patients live. Over the next 10 years, health care diagnostic imaging will be the largest consumer of bandwidth of any marketplace. Within the scope of this Roadmap, and considering the complexity of the technologies, it is not possible to make bandwidth projections.

Both general education and continuous learning must be a focus of the health care education system. Triage, grand rounds and continuous learning must be expanded outwards from the tertiary centres to the secondary and primary care clinicians, and to practitioners in regional facilities. Regional and provincial health networks need to be developed to integrate care and

ongoing educational practices across the system. Among the many benefits that would result from these changes, standards of practice would become higher and more consistent. The implementation of such improvements can be facilitated through new fibre-optic and Internet communication technologies for multimedia video conferencing. In addition, more complex acute care processes can be moved out to less expensive secondary and primary care facilities. These are strategic capabilities as the system moves to a regional care model, with patients traversing facilities and receiving care closer to home.

In many urban centres, high-bandwidth fibre-optic backbones have been installed. However, switch upgrades need to be completed to meet the operational criteria of the near future. Infrastructure upgrades are necessary in rural environments within many regions in Canada. In those locations, optical switching advancements will enable telehealth, telemedicine and PACS to deliver benefits. In the rural regions, utilities and telecommunication companies will have an opportunity to establish high-speed health care backbones, which can be expanded with security to enable smaller consumption customers to utilize the unused bandwidth for education, video or high-speed business operations. Health information technologies need to focus on integrating with relevant diagnostic imaging information, collaboration and communication requirements. Diagnostic imaging workstation interfaces will be required to be compatible with health information systems to support new expectations around clinical processes, decision making and communication. Clinical processes and associated information models need to be developed within standards if outcomes are to be realized. From that framework, it will be possible to optimize clinical practices and technology utilization for the enhancement of patient access and care.

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Internet-based Radiology Application Service Provider

1. GOALS

The purpose of Internet-based radiology ASPs is to:

- provide the functionality of a traditional picture archiving and communications system (PACS);
- use Internet-based architectures, technologies, networking and standards to provide PACS to radiology departments and image distribution to all others needing access to diagnostic images; and
- reduce both the capital purchase and operating costs as compared to traditional PACS.

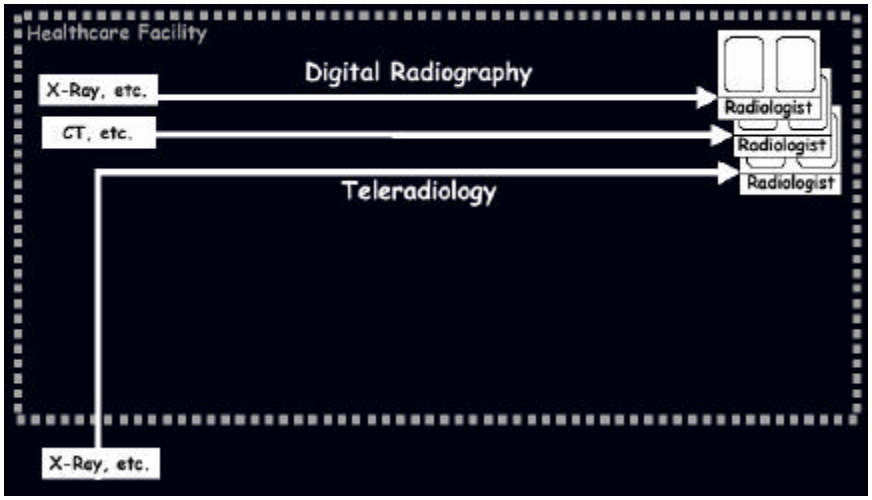
2. DESCRIPTION

2.1 Background

More rapidly than any technology advance in medical history, PACS are changing the clinical and business aspects of radiology practice by delivering substantial cost savings, improved efficiency and quality, and greater access in an era of high demand and severely constrained resources. Systems are available in many variations, from mini-PACS to enterprise-wide PACS, and from a wide variety of vendors. However, in spite of the industry consensus that "you can't afford not to buy a PACS," for most small and medium-sized hospitals and freestanding imaging centres, the potential savings are insufficient to offset the costs.

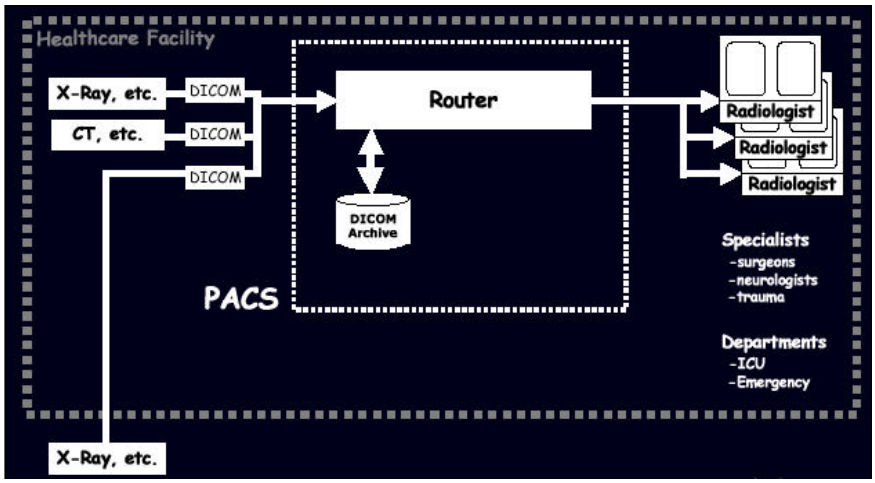
2.2 Digital Imaging

The traditional diagnostic imaging modalities (X-ray and ultrasound) are slowly becoming digital, either through digitization of traditional images or through digital conversion of the diagnostic equipment. Other diagnostic imaging modalities (computed tomography [CT], magnetic resonance imaging [MRI], and positron emission tomography are already digital but most function in a "stand-alone" mode. Teleradiology is the term used when any digital image is moved outside the local environment. This is shown conceptually in the following diagram.



2.3 Picture Archiving and Communications Systems

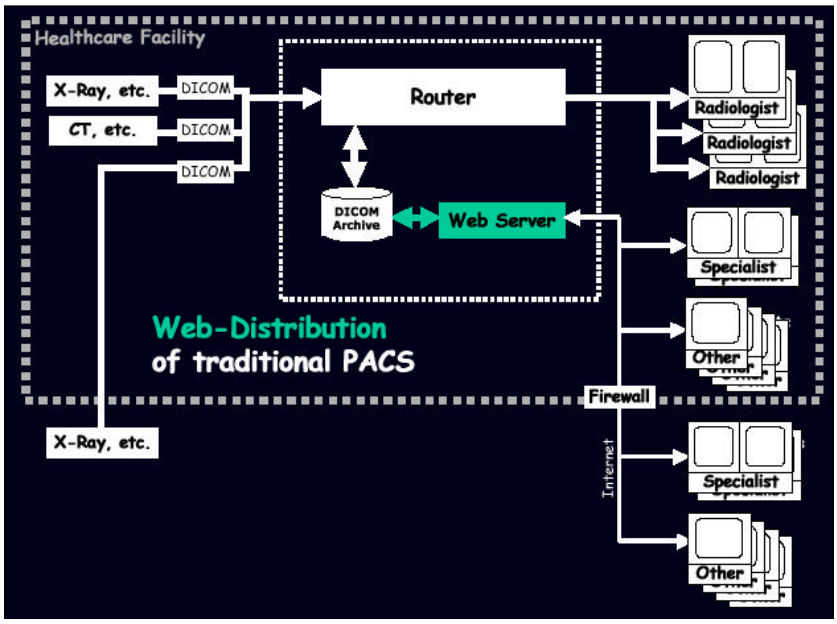
PACS leverage a common infrastructure for all the digital imaging modalities and provide image storage and archiving (as shown below).



These systems are designed to support the radiology department but remain too expensive for most facilities. In addition, there is limited access to images by the broad range of clinicians and specialists who do not work in the radiology department, such as surgeons and referring physicians. To service this need, hard copies of the digital images are printed and manually distributed, which is an inefficient use of time, money and other resources.

2.4 Web Distribution from PACS

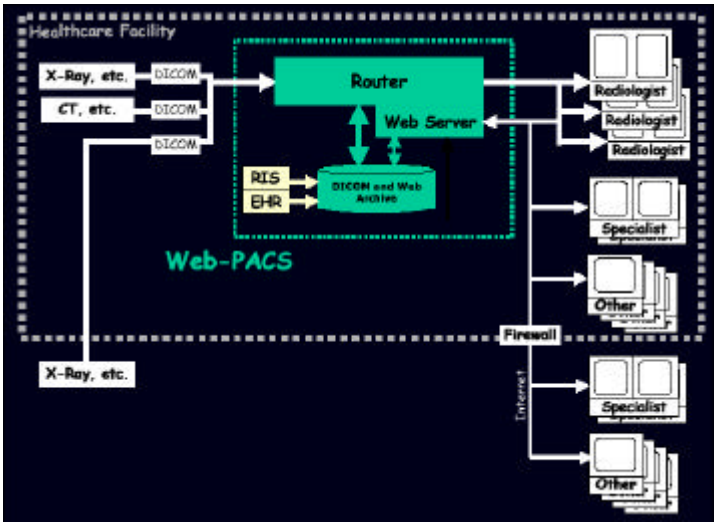
To address this particular concern, PACS vendors have been adding a Web server to their systems. This allows other specialties access to the images, as shown in the following diagram.



The solution often suffers from poor response time, as images must be compressed before they are available. There is also a concern that this additional technology taxes an existing PACS system and may compromise its primary purpose — to provide images to the radiologists.

2.5 Web-PACS

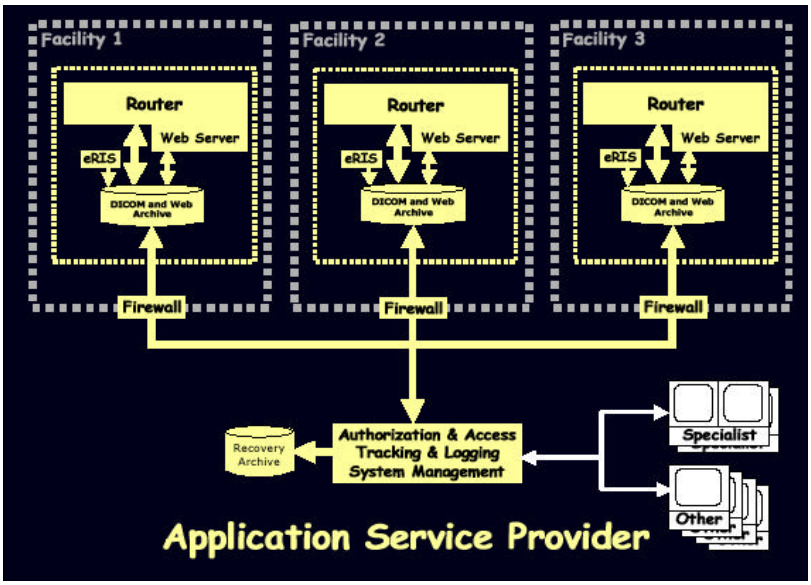
A Web-PACS solution replaces costly PACS infrastructure with technologies based upon Web architectures, providing a cost-effective and efficient means for quick access to diagnostic images. This system uses standard technologies (servers, archives, PCs, networks and Web browsers), supports a large number of concurrent users, and can be integrated into standards-based legacy systems. Since data is housed in a Web-based infrastructure, images can be easily distributed outside a facility's walls.



2.6 PACS from an Application Service Provider

An Application Service Provider (ASP) is a service company that hosts applications, manages them and rents access to them from a centrally managed facility. ASP providers allow an institution to outsource information technology applications infrastructure, management, support and maintenance. As defined by the ASP Industry Consortium, ASP service is designed to "deliver and manage applications and computer services from remote data centres to multiple users via the Internet or a private network."

In an ASP structure, the Web-PACS solution is provided on a per study cost basis. The on-site technology is provided by the service provider and is centrally managed.



With the ASP model, the vendor assumes all responsibility for technology infrastructure, integration, maintenance, upgrades, support and performance. Benefits include faster systems implementation, operational freedom that enables the customer to focus on core business functions, improved performance, and high reliability based upon the ASP's experience in providing these services to multiple customers. Customers can also enjoy minimal to no up-front investment, complete obsolescence protection, and reduced internal staffing needs. This allows all clients to access the solution, regardless of size.

User Scenario for Medical Image Directory Service

This section will attempt to summarize what a radiologist or physician can expect from a Medical Image Directory Service (MIDS).

From early on, it has been felt that the transmission of medical images, within and among health care organizations, has been needed in the radiology community. In 1948, Gershon-Cohen and Cooley transmitted X-rays over the phone between West Chester and Philadelphia, Pennsylvania. Two years later, a teleradiology system was built by Canadian radiologists at Montreal's Jean Talon Hospital.

Early adoption by radiologists may be explained by factors specific to the radiology practice:

- use of mail and courier services for exam distribution to provide consultation, second opinions and primary interpretations, allowing one radiologist to manage two or more sites at the same time from one location;
- early experience in digital technologies with fast growth of computer-based modalities, such as CT, ultrasound, and MRI, and followed soon by PACS;
- in the U.S., Medicare and other coverage policies have allowed payment for radiology consultations.

Teleradiology, even if in constant growth, remains limited to a few institutions, mainly due to the cost of the required infrastructure. Communication has been established on phone lines, when possible dedicated fast lines, in point-to-point mode. Images need to be digitized, which is not yet universal, as many radiology clinics still generate hard copies.

Too often, plain films and hard copies remain in film libraries and cannot be accessed from outside. Transmission of the images is not easy, and in most cases it is the patient who acts as a vehicle. Exams are lost and have to be repeated. For instance, physicians at the University of California at San Francisco noted that before establishing their PACS, 15 to 20 percent of radiographic images were lost and hundreds went unread.[1]

Internet progression, with Web and push technologies, opens new perspectives to image distribution on the network. One expects that there will be more and more PACS, decreasing in

cost and size, and that in the 5 to 10 years to come, most of the medical images will be in digital format. With bandwidth improvements, communication will be faster and easier, and it will be possible to transmit heavier studies in less time and with high quality.

The Need for Image Transmission

1. Case Study

Here are two examples of cases that occurred recently in a Canadian health care institution.

Case 1
A six-year-old boy was brought to the emergency room in the middle of the night with a severe headache and vomiting. There was no fever. In this patient's history, there was a recent fracture treated with a cast. A CT scan of the head was performed at 1:00 a.m. and showed a filling defect in the Cisterna Magna. A venous thrombosis could not be ruled out, and the resident and fellow on call had to phone a staff member to get a second opinion. As there was no means of transmitting the picture to the staff member's home computer, the staff member had to drive to the hospital to view the exam and conclude that the image was a normal variant.

Case 2
An eleven-year-old boy, was brought to the emergency room, which was some 350 km from his home, due to a head injury suffered the day before. He was complaining of a headache. The clinical examination was normal, but as it was not possible to access the CT scan performed the day before at the local hospital where the boy was first treated after his accident, it was necessary to repeat the procedure.

Those two examples underline how useful the transmission of medical images can be.

2. Potential Benefits of Image Transmission

- The ability to refer a matter to a staff member working from home means a decrease in decision and intervention delays, thus improving the care provided to emergency patients.
- In an emergency situation, on-call physicians and radiologists may not have information from any previous procedures performed on the patient. This is often the case when the patient has been previously treated in another institution. The therapeutic decision can be impaired by this lack of information. The physician on call could access all this information from a computer at home and possibly not need to go to the hospital at all, thereby saving both time and money.
- The management and use of medical images would be improved, with reduced probability of loss or incorrect filing.

- The quality of care would be improved through more widely available expert interpretation. More and more, reference centres will be implemented, and these will need to have access to patient's previous exams and images.
- Costs associated with repeated exams and radiological interpretation would be reduced.
- Electronic access to the patient file would eliminate the costs that frequently ensue when a patient moves to another city or province and must undergo the same imaging procedures.

How to Access the Pictures

In order of importance, here are the five critical issues that relate to accessing medical images on the Internet:

1. *Bandwidth*

   The size of medical images ranges from 25 KB to 50 MB, which means that high bandwidths are required for remote consultations. A high-quality compression, adapted to the modality, is necessary for distribution outside the hospital. Wavelet compression offers quality good enough to target compression levels up to 15:1 without significant loss of information.[2,3] Selective image compression may improve the quality of restitution.[4]

2. *Security*

   Confidentiality and integrity of the patient data have to be protected. The security of the network is essential. Security technologies can be used for authentication, access control, data encryption, perimeter control, and attribution/non-repudiation for e-mail procedures, and to resist attacks.

3. *Availability*

   It is essential for patient care that the network be available. For reasons of safety and timeliness, no downtime or lost connections can be tolerated.

4. *Latency*

   Low latencies are required in emergency situations and remote consultations.

5. *Ubiquity*

   Ubiquitous access is important for many clinical applications due to the dispersion of health care providers.

Three technologies need to be implemented to optimize Internet-based access of medical images:

1. *Web Distribution*

   Pull technology makes it possible to query a Web site directory in order to access a patient exam. Digital medical images are posted on a Web server as soon as they are acquired. Access is given to selected users by means of a password. This technology is mainly useful for its ubiquity and availability, and may give access to a complete patient file.

2. *Push Technology on the Internet*

   E-mail solutions make it possible to send selected images through the Internet to one or more addressees, along with written or verbal comments, which will create an Internet exchange desk with multidirectional communication. Security is high, and bandwidth and latency issues are addressed by cable networks, which are faster and safer than modem connections.

3. *Medical Image Directory*

   Such a system will be very useful as digitized image repositories will grow in size and number. To locate a patient's files, particularly if he or she had multiple procedures in different locations, all databases will be queried and a pointer will locate the exam on the server. Access will be given to the exam directly on the Web, or through an e-mail requisition to ensure patient's rights to ownership and confidentiality.

Conclusion

The association of different and complementary technologies to access medical images on the Internet will dramatically improve the efficiency and quality of health care provided to patients, and will contribute to the reduction of health costs related to repeated exams, needless transportation and wasted time.

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ETHICAL ISSUES RELATED TO TELEHEALTH

Introduction

Telehealth is becoming an important, if not essential, component of good health care delivery. It provides a new source of knowledge sharing, which has led to the development of more effective responses to diagnostic and therapeutic problems. Many believe that in the coming years telehealth will enhance the availability and quality of health care, and contribute to the alleviation of human suffering.

Telehealth is not, however, without certain ethical concerns. The most prominent ones pertain to the confidentiality of the information that is gathered and transmitted, and to the protection of one's privacy. The recent developments in information technology, notably in the area of telehealth, have thus generated major concerns in the public about the protection of personal data gathered or transmitted through the provision of health care. Many fear that such data might be misused, or used for purposes others than those stated.

In response to these broad concerns, many jurisdictions in Canada have enacted laws to protect personal health information. Recent years have seen an abundance of privacy legislation emerge across the country. This increasing body of laws and regulations will necessarily have an impact on telehealth. However, the real impact is not yet entirely known. It is nonetheless important that those involved in telehealth develop a proactive approach to the ethical and legal issues raised by this new technology.

Those accessing personal data on individuals have the legal and ethical obligation to ensure that the information accessed will be properly protected. In this area, there is a need for a common understanding and consensus to be reached around basic privacy and confidentiality issues.

The Context of Telehealth

Over the years, both at the provincial and federal levels, legislators have enacted laws to protect the right to privacy of each individual. They have also adopted laws whose object it is to protect not only personal information, but also personal health information. Telehealth has not until now been specifically targeted by the legislation.

For their part, the courts have recognized that an individual's right to personal security under the *Canadian Charter of Rights and Freedoms* encompasses the right to be free from interference with one's physical as well as psychological integrity. This right has been expanded to include the right to be free from the psychological stress resulting from unauthorized disclosure of one's personal health information.

A person who consults a health care professional can thus expect that the latter will take all necessary measures to ensure that the health care information gathered will remain confidential.

Furthermore, a person expects that if the health care professional consults a third party, the same guarantees about the protection of the confidentiality of the information will apply.

In the context of telehealth, the professionals who provide care must thus ensure that information regarding a person's physical psychological condition, health care and treatment will not be released or made accessible without that person's consent or, if such information is released without the person's consent, without informing the person afterwards. Those responsible for the transmission and reception of information must take adequate measures so as to minimize the risk that personal health information could be intercepted by third parties or otherwise misused.

It thus appears that the development of telehealth should be accompanied by the implementation of mechanisms that will ensure that basic ethical problems that can arise from the use of telehealth are addressed in a timely and efficient manner. A governance framework is required, one that specifies the responsibilities of the stakeholders in telehealth, taking into account the laws, regulations, policies and ethical principles likely to apply.

Governance and Telehealth

Governance essentially refers to a process that enables an organization to carry out its responsibilities effectively when accomplishing its mission. The establishment of a governance framework requires that the organization identify the responsibilities of the stakeholders and the actions the organization needs to take to successfully implement its goals.

A governance framework must be comprehensive in that all of the issues raised by an activity, notably ethical issues, are properly addressed. A governance framework should focus on the responsibilities that fall upon all those involved in the realization of the activity. The responsibilities of each stakeholder should be clearly defined in light of the applicable legislation, regulations and policies.

As in many others areas of activity, such as biomedical research, there is a need to develop, within the context of telehealth, a governance framework that will deal with, among other things, the overall ethical concerns that one might have with respect to the development of telehealth, such as the protection of personal health information.

The telehealth governance framework should clearly define such things as:

- the goals that telehealth pursues;
- the principles and values that guide the development of telehealth;
- the responsibilities of the various actors and stakeholders;
- the lines of communications among stakeholders and actors; and
- the risk management measures taken in order to protect personal health information and to ensure that the transmission of personal health information is done according to accepted national and international standards.

Conclusion

If telehealth is to expand harmoniously, it needs to be concerned with the ethical issues associated with its development. Special attention should be paid to existing laws pertaining to the protection of personal health information and privacy rights.

Leaders in the field of telehealth should consider developing a governance framework for telehealth activities, to ensure compliance with existing legislation and regulations. This framework should permit those involved in telehealth to properly understand the ethical and legal issues associated with telehealth, and to assume their responsibilities.

This report has focussed on the ethical considerations of telehealth. Further investigation must be undertaken on the legal aspects of the application of this technology. Legal barriers can be expected to have a profound impact on the sustainability and development of this industry sector. Some of these considerations have come to light in a report commissioned by Industry Canada, CANARIE and Health Canada entitled *The 5th International Conference on the Medical Aspects of Telemedicine* (http://strategis.ic.gc.ca/telehealth). The sections on the medico-legal and ethical aspects of telemedicine are especially applicable, and would be of value to anyone with an interest in this important issue.

APPENDIX A

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