PACS for CANADIANS

Canadian Association of Radiologists
PACS Position Paper

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Executive Summary

The Picture Archive and Communications System (PACS) is an information technology tool that has emerged as a key enabler of improved access and patient care delivery in Canada today. PACS enables a diagnostic imaging service to manage, store, and distribute digital images from modalities such as CT, MRI, x-ray, and ultrasound.

In order for PACS to work effectively, it must be tightly integrated with other related technologies, such as the Radiology Information System (RIS). The RIS is used to perform essential functions such as patient registration, exam ordering and scheduling and the storage and management of the radiologist’s report. Voice dictation and voice recognition systems are other examples of related technologies that must be integrated to achieve efficient implementations. For the purposes of this paper, the term “PACS” refers to PACS and its tightly-integrated related technologies.

Today, approximately 20 – 25% of all diagnostic imaging exams in Canada are managed with PACS technology, and the results of Canadian PACS implementations have been extremely favorable.

The Canadian Association of Radiologists (CAR) has prepared this report to increase the awareness and understanding of key stakeholders of the Canadian healthcare system in the use and benefits of PACS technologies, and to promote the acceleration of PACS implementation in Canada. These objectives will be met by:

- Assessing the current state of PACS implementations in Canada and describing the benefits realized
- Building a future vision for PACS and its role within the larger vision of a national Electronic Health Record (EHR)
- Describing the obstacles that prevent healthcare organizations from advancing PACS
- Providing recommendations to overcome the barriers facing an expansion of PACS within Canada’s healthcare system.

This report was developed, in part, with the input of representatives from 21 Canadian healthcare organizations. Using telephone surveys, these representatives described their current use of PACS, identified the benefits that had accrued within their organizations, and shared their future plans for PACS. Information describing PACS today in Canada was also gathered from six major PACS vendors in Canada and from Canada Health Infoway, an organization that was created by the Canadian government to accelerate the development and implementation of electronic health information systems in Canada.

The feedback gathered from the healthcare field supported the expanded use of PACS in Canada, as this technology has proven to offer significant benefits to healthcare organizations and the healthcare system overall. Survey participants confirmed that improvements in the quality of care were enabled through the faster reporting and more complete diagnosis provided through PACS. Within a hospital setting, care providers in emergency departments, intensive care units and operating rooms receive the necessary radiological results more quickly and can begin treatment earlier. These patient care benefits are also experienced outside the hospital or clinic walls, as the diagnostic report reaches the referring physician more quickly in an integrated PACS environment. The benefits of PACS are system-wide.

Approximately 20-25% of all diagnostic imaging exams in Canada are managed with PACS technology and the results have been extremely favorable.
A tight integration of PACS and its related technologies improved the effectiveness and efficiency of diagnostic imaging service areas; workflow redesign and the introduction of PACS technology allowed these services to accommodate increased exam volumes much more easily than non-PACS environments. The ability of this technology to enable resource-challenged healthcare organizations to cope with increased demand for diagnostic imaging services is a key benefit to the Canadian healthcare system. Partial or non-integrated implementations of PACS do not produce the same benefits because multiple processes and workflows continue to be required.

PACS organizations reported cost savings and cost avoidance in the areas of film and film processing; further, storage and transportation costs were reduced and virtually eliminated in “filmless” environments. Also, on a system-wide basis, Canada Health Infoway estimates an annual national benefit of $370 million when online viewing of images and reports is available to specialists across the country. The savings result from the avoidance of duplicate procedures and the avoidance of film printing for physicians not affiliated with a facility or practice.

Other important benefits, such as enhancement of staff morale, teaching and research improvements, and reductions in environmental waste, were also described by the survey respondents.

The analysis shows that, the overall qualitative and quantitative benefits of PACS technology far outweigh the costs: the business case for PACS is compelling. This conclusion is founded on the improvements in patient-care quality and system-wide efficiencies and effectiveness gained through successful PACS implementations. Although hard-dollar benefits (e.g., savings on film, storage, and transportation) accrue from implementation, PACS cannot be justified on cost savings alone. PACS investments should be considered as strategic infrastructure investments that enable organizations to provide better care more effectively and more efficiently.

PACS is also a key component of the Electronic Health Record, the secure and private life-time record of an individual’s health history, that is the key focus of Canada’s vision for health information. Recent studies and reports have described the positive impact on diagnoses, treatments, and results when healthcare providers have instant access to complete personal health information and history. The Canadian government has demonstrated its belief in these benefits by investing $1.1 billion in Canada Health Infoway, an independent, not-for-profit corporation with the mission of accelerating the development of EHR and telehealth solutions in Canada.

The goal of Canada Health Infoway is to have the elements of interoperable EHR solutions in place within four to six years, and PACS is one of the key applications that must be integrated into the EHR framework. In the future, referring physicians in their offices must be able to securely access the diagnostic imaging reports and images for their patients as soon as they are available. Because these images and reports will be available to those who require them, referring physicians will be able to consult quickly with other clinicians in reviewing the results and determining the best course of treatment for their patients.

CAR’s vision for PACS calls for a “filmless,” integrated Canadian healthcare system. CAR advocates the expansion of PACS to 80 – 90% of Canada’s healthcare organizations within the next five years. PACS implementations must be tightly integrated with related technologies such as radiology information systems and voice dictation and/or recognition systems to achieve full benefits. PACS will also be a critical foundation system of the EHR, participating as a key system in an architecture designed to enable fully interoperable and shared information systems.
Achieving the vision will be difficult. Some of the obstacles identified include:

- **Funding.** Funding has been identified as the major obstacle healthcare organizations will need to overcome as they strive to move forward with this important patient care and productivity tool. Smaller hospitals and community-based imaging centres have a more difficult task in justifying PACS implementations because of their lower imaging volumes, however they have essential roles in our healthcare system and must be fully integrated into the PACS for the health care system to get the full benefits associated to PACS.

- **Leadership.** Leadership will be required at all levels of the healthcare system and government to create a solid understanding of the benefits of this technology and to develop a commitment to continued investment.

- **Integration.** The integration of PACS with EHR solutions will be challenging at the organizational, jurisdictional, and national levels, and will require the services of skilled resources that are currently difficult to find.

In this position paper, CAR proposes a number of actions to help overcome these obstacles. To acquire the $1 billion plus investment necessary to achieve the CAR vision, all key stakeholders in the healthcare system must be aligned in their view of the importance of this technology. Canada Health Infoway will invest between $220 million and $280 million in diagnostic imaging systems over the next four years and CAR recommends that the provinces match this Infoway investment. CAR also recommends that Canada Health Infoway adopt a more aggressive investment timeline in the diagnostic imaging area than currently planned. Many healthcare organizations and jurisdictions are ready to move quickly with PACS.

CAR recognizes that there are differing levels of diagnostic imaging equipment penetration throughout the country and therefore priorities will differ from place to place. In jurisdictions that have achieved a proper level of diagnostic imaging equipment, portions of the $1.5 billion Diagnostic/Medical Equipment Fund should be allocated to PACS investment. Those that have not must do so in order to position themselves for PACS.

Future investment by the federal government, through Diagnostic/Medical Equipment Fund or through Canada Health Infoway, will be necessary to fulfill the vision of a “filmless” Canada. The CAR recommends that future federal/provincial health accords review key funding concerns to this critical health care delivery system.

CAR recommends a “shared services” model to reduce the overall costs of ownership of PACS. Because PACS systems are much more difficult to justify in low volume settings, smaller organizations and community-based imaging centres will need to forge these new, “shared”, cooperative working relationships to achieve economies of scale.

CAR recognizes the difficulty that community-based imaging centres may have in acquiring the necessary capital investment for PACS since many of the benefits of PACS will not accrue directly to the centre. CAR believes that the provinces and territories must allocate a portion of their PACS funding to these centres. The vision of a “filmless” Canada with full Electronic Health Record capability cannot be met without the inclusion of these increasingly important community-based centers. They cannot be left behind.

CAR will play a significant role in supporting the champions required for PACS expansion in Canada, and, through the establishment of an ongoing PACS Committee, will provide advice and direction on the future of PACS. CAR fully supports the work of Canada Health Infoway in aligning PACS with the EHR, and encourages cooperation between and among
the PACS vendor community, the information technology services industry, and the public sector in developing the skills necessary to perform these complex integration roles. Finally, CAR strongly encourages the diagnostic imaging equipment and technology infrastructure investments that are necessary underpinnings of any PACS implementation and supports the creation of national privacy and security guidelines to guide consistent PACS usage across the country.

In summary, CAR believes that PACS is a technology that enables powerful patient-care and productivity benefits for Canada’s healthcare system. It is also an important piece of the EHR solution set. Investment in PACS is a critical investment in Canada’s healthcare system.
Introduction

Picture Archive and Communications Systems enable diagnostic imaging services to manage, store, and distribute digital images from modalities such as CT, MRI, x-ray, and ultrasound. The important benefits of PACS and its related technologies, such as radiology information systems, need to be communicated to all healthcare and government stakeholders to build support for its rapid expansion across Canada.

The objective of this position paper is to promote the accelerated adoption of PACS and its related technologies in Canada.

Introduction to CAR

CAR, the Canadian Association of Radiologists, is a voluntary organization founded in 1937 that represents the goals and the interests of radiologists in the Canadian medical community.

CAR works to improve the accessibility and quality of patient care in Canada by developing, promoting, and continuously improving standards of radiological practice and by the accreditation of radiological facilities. The organization works to unify Canadian radiological interests through the active collection and communication of information, issues, and trends to Canadian radiologists, decision makers, and patients. In support of these objectives, CAR invested in this analysis of the current status, the benefits, and the future vision of PACS technology in Canada.

Background and Context

Canadians care deeply about their universal access to quality healthcare. Diagnostic services play an increasingly important role in improving both access and quality of care. Access is improved by providing high-quality diagnostic services to remote geographic areas. Quality of care is improved through the use of the sophisticated diagnostic tools that lead to better treatment decisions.

The use of digital imaging devices such as MRI and CT has expanded in Canada over the past few years due to a number of factors, including the availability of improved diagnostic technologies and the increased funding for diagnostic imaging services. This increased investment has resulted in greater accuracy, speed, and efficiency of diagnostic imaging services, as well as improvements in quality of care. However, diagnostic imaging equipment alone cannot deliver full value in service and cost reduction. Second-order technologies such as PACS and radiology information systems (RIS), that support the acquisition and communication of critical information, must also be applied.

Another key trend developing in Canada is the realization of the importance of timely, accurate, secure information in enabling a more effective, more efficient healthcare system. The 2002 Building on Values report called for “more comprehensive use of information management and technology, including health technology assessment, to provide essential information throughout the healthcare system, and a targeted focus on applied research.”
and recommended that all levels of government work to “provide better information to Canadians, healthcare providers, researchers and policymakers – information that they can use to guide their decisions.”

The establishment of the Electronic Health Record (EHR) for Canadians has emerged as a key vision for the country. Canada, like many other countries, including the United Kingdom, New Zealand, and Australia, has embarked upon a journey toward building the EHR. Canada Health Infoway, an independent, not-for-profit corporation, was created by the Canadian government to accelerate the development of EHR solutions. Diagnostic imaging information, contained in PACS and its related technologies/systems, plays an important role in the EHR.

Many Canadian healthcare organizations have acknowledged the benefits that PACS and its related technologies can bring; however, only about 20-25% of Canada’s exams are supported by PACS systems today. There is a long way to go before the Canadian healthcare system enjoys the significant benefits of a largely “filmless” environment.

1.3 Objectives of This Report
The objectives of this report are to increase the awareness and understanding of key stakeholders of the Canadian healthcare system regarding the use and benefits of PACS technologies, and to promote the acceleration of PACS implementation in Canada. These objectives will be met by:

- Assessing the current state of PACS and the benefits that have accrued to date with PACS users;
- Building a future vision for PACS and its role within the larger vision of a national EHR;
- Understanding the obstacles that prevent organizations from moving forward with PACS;
- Recommending action items to counter these obstacles and encourage accelerated adoption of PACS.

1.4 Project Approach
CAR established a Steering Committee in the spring of 2003 to lead the development of this position paper. The CAR Steering Committee contracted with Eastbridge Consulting to assist in the preparation of the report (see Appendix 1 for Steering Committee members).

The report was prepared with significant input from key stakeholders in the Canadian healthcare system. Consultation included:

- Focused telephone surveys with representatives from 21 healthcare facilities across Canada (see Appendix 2 for survey participants);
- Meetings with six major PACS vendors;
- Discussions with Canada Health Infoway.

1 Roy J. Romanow, Building on Values, The Future of Health Care in Canada (November 2002).
Research was gathered from important publications, such as:

- The 2003 First Ministers’ Accord on Health Care Renewal
- *Building on Values – the Future of Health Care in Canada* by Roy J. Romanow
- *The Health of Canadians – The Federal Role* chaired by the Honourable Michael J. L. Kirby
- The Canadian Institute for Health Information’s *Medical Imaging Technologies in Canada*

Additional research and background material were garnered from publicly available material from organizations such as the Radiological Society of North America (RSNA) and the Society for Computer Applications in Radiology (SCAR).
The Canadian Healthcare Environment: Key Trends and Directions

Many recent federal and provincial reports have comprehensively described the key trends and directions in the Canadian healthcare system. The objective of this section is to summarize those trends that are related to the need for increased use of enabling diagnostic imaging technologies such as PACS.

2.1 Shifting Focus of Care

Perhaps the most important overall trend in the Canadian healthcare system is the shifting focus of care. In the past, our healthcare system was focused on the treatment of illness, with delivery systems designed to treat episodes of care. Supporting processes and systems were very provider-focused, and little sharing of information was evident. The new model for our system is based on the maintenance and promotion of wellness, with the patient and family at the centre of the supporting processes and systems that track the full continuum of care. Decisions, in the new model, are collaborative and are based on the best available evidence.

“In the new world we require access to health information not only across different systems but across different jurisdictions and domain boundaries. We require the ability to view clinical information from all sources and to use the infrastructure to initiate orders and referrals to a broader range of care and service providers than currently available through traditional mechanisms.”

Canadian healthcare organizations and jurisdictions continue to reorganize with the aim of improving their ability to deliver services in this new world. Regionalization of hospitals and other healthcare organizations is common in most provinces of the country as the healthcare system’s service delivery agents constantly look for new models to provide better care.

The increasingly important role of diagnostic imaging services in this new model is apparent. Recent technological advancements have significantly enhanced the power of diagnostic tools and their importance in the continuum of care. Canadians understand the benefit and value of these services, and feel strongly that access to them needs to be improved.

“Waiting for care remains an important issue for Canadians. For example, respondents to a November 2002 poll said that reducing wait times for diagnostic services, such as MRI and CT scans should be the number-one priority for new healthcare spending.”

The issue of access to the healthcare system is particularly important in Canada's remote regions. Canada's size and distribution of population present a challenge to the provision of equal access to healthcare for all Canadians. Part of the solution to this problem can be enabled by technology. PACS and other teleradiology applications provide support tools that bridge vast distances, help narrow the equality gap, and support care providers in remote locations.

1 Canada Health Infoway, EHRS Blueprint, an Interoperable EHR Framework (July 2003).
2 Canadian Institute for Health Information, Medical Imaging Technologies in Canada 2003 (September 2003).
2.2 Human Resources Shortages
Canada suffers from an increasingly important problem: the shortage of healthcare personnel. CAR predicts a shortage of at least 500 radiologists across the country by 2006. There are also questions as to whether the supply of Canada's medical radiation technologists will be adequate for tomorrow's imaging services requirements.

Although it is only part of the answer, Canada's medical imaging professionals need the tools and support systems necessary to maximize their effectiveness in the healthcare system. These tools will be essential in coping with the increasing diagnostic imaging volumes.

2.3 Importance of Information: The Electronic Health Record
As mentioned above, the vision of an EHR for Canadians has emerged as a top priority of the Canadian government in recent years. Canada's new healthcare model of collaboration and evidence-based decision-making requires fast, secure access to integrated information.

Reports such as those by Kirby and Romanow in 2002 have pressed for the development of EHR solutions across Canada. These solutions are intended to improve outcomes, increase efficiencies, and optimize patient safety. The patient-centred view of these information systems is essential to providing the right information, to the right provider, at the right time, independent of the organizational location or structure of the patient's current location. Canada's vision of the EHR will be described further in Section 8 of this report.

2.4 Technological Sophistication of Canadians
Overall, the “technological sophistication” of Canadians is increasing. Patients have discovered the Internet as a source of information for health care and can gather data from a variety of available sources on any healthcare problem. Healthcare providers are increasingly willing to use new tools to help deliver care. Younger graduates enter the healthcare workforce expecting information technology tools to help them deliver better-quality care.

2.5 Response from Government
Governments at the provincial, territorial and federal levels are responding to many of the trends and issues in the Canadian healthcare system. A number of task forces and studies have focused on the key themes of the value of our publicly funded health system, the need for reform and the priorities for reform – including access to diagnostic/medical imaging equipment and information technology, and an electronic health record. An example of government's response is the 2003 First Ministers' Accord on Health Care Renewal. The objectives of the accord are:

- To improve the quality, accessibility and sustainability of the public health system
- To provide timely access to all Canadians no matter where they live
- To enhance the availability of diagnostic care by reducing waiting times
The Accord included the establishment of a $1.5 billion Diagnostic/Medical Equipment Fund to improve access to publicly funded diagnostic services.

The Government of Canada has also provided financial support of $1.1 billion to Canada Health Infoway to accelerate EHR solutions and to further develop telehealth applications. The objectives of this investment are to improve the accessibility and quality of information in the Canadian health system, which in turn leads to better quality of care, patient safety, and sustainability.

### 2.6 Conclusions

The trends and directions discussed above point to the urgent need for well-integrated information technology tools and systems in the Canadian healthcare environment. Clearly, enabling information technologies such as PACS will play a supporting role in building the foundations of our new and improved healthcare system:

- In a system requiring collaboration and use of best evidence for decision-making, PACS and its related technologies contribute by quickly providing critical diagnostic imaging results to care providers across the continuum.
- PACS can be configured for community-based imaging clinics, any size of hospital, or any style of region. PACS can be an important part of telehealth solutions in remote areas. As organizations continue to seek the best organizational model for service delivery, PACS solutions can be adapted to support these models.
- The importance of diagnostic services continues to grow in Canada. PACS is the second-order technology required to manage these increasing volumes of digital data. PACS will be an important tool in enabling radiologists and technologists to cope with the increasing demands. New radiologists and technologists entering Canada’s health system will expect PACS.
- PACS and its related technologies are important components of the EHR, a critical underpinning of Canada’s future health system.
3.0 An Introduction to PACS and Its Related Technologies

To understand the benefits of PACS, one must first understand the fundamentals of how this technology works. This section will describe the components of PACS, some of its related technologies, and how the technologies work together.

3.1 PACS Components

PACS is an information system that enables a diagnostic imaging service to manage, store, and distribute digital images from modalities such as CT, MRI, x-ray, and ultrasound. The following diagram illustrates a typical PACS environment:

![Figure 1 Components of a Picture Archive and Communications System](image)

The components of a PACS system include:

- **PACS server** – this is the hardware and software required to integrate all PACS components. It provides for workflow, image storage, and indexing for query and retrieval, as well as system-management capabilities.

- **Acquisition interfaces** – these are interfaces that digitally capture radiology images, convert these images to a standard format, and then store them on the PACS server (a “computed radiography” reader is an example of an acquisition interface).

- **Display station** – this workstation retrieves the radiology image from the PACS server and displays it to the technologist/radiologist/clinician.
Storage/archive – this storage device provides permanent long-term storage for radiology images.

Communications infrastructure – this element provides an electronic medium used for various computer components to exchange information.

Diagnostic report – this is the radiologist’s interpretation of the digital image.

RIS interface – this interface permits data to be transferred between the radiology information system (RIS) and the PACS.

Although the RIS is not a component of PACS, it is considered to be a “related” technology to PACS. An RIS is used to perform functions such as patient registration, exam ordering, and scheduling. It is also used for the entry, storage, and distribution of the radiologist’s diagnostic report. The importance of integrating PACS and RIS will be discussed later in this section.

### 3.2 The “Before and After” of a PACS Implementation

The following diagrams illustrate the workflow from patient registration through to image review both before and after the implementation of PACS.

#### Before PACS

![Schematic of “Before PACS” Processes](image)

*Figure 2 Schematic of “Before PACS” Processes*
As can be seen in the above illustrations, there are several important differences in the “after” scenario. These are:

- There is no routine production of hardcopy film. This greatly reduces the need for film processors and chemicals.
- There is no more physical movement of film between departments or to and from the film library.
- Images can now be viewed by multiple healthcare professionals in many locations simultaneously.
- There is an improved image workflow, thus reducing report turnaround time.
- Less physical storage space is required due to the reduction in quantity of film.
- The need to retake images is dramatically reduced, as there is little opportunity to lose or misplace films. Image retake due to patient transfer is also reduced.

### 3.3 Voice Dictation and Voice Recognition Systems

Other technologies “related” to PACS are voice dictation and voice recognition systems. These systems are designed to reduce the time it takes to record the exam report.

**Voice dictation systems** – these systems enable radiologists to verbally record and store diagnostic reports. A transcription pool may then convert the voice recordings into text and store them in the RIS.

**Voice recognition systems** – these systems translate the radiologists’ spoken words (often a diagnostic report) into text. The resulting digital text is then stored in the appropriate information system (e.g., the RIS), greatly reducing the turnaround time between dictation and report distribution. Voice recognition systems have been evolving for many years and appear finally to be ready for today’s healthcare settings.
3.4 How PACS, RIS, and Voice Systems Work Together

The following example of an average chest x-ray illustrates how PACS, RIS, and voice systems might operate together in a fully interfaced environment.

1) The patient's doctor requests a chest x-ray, and it is scheduled in the RIS.
2) The patient arrives at the Imaging Department reception desk and is registered, and the chest x-ray is ordered in the RIS, creating a unique exam number.
3) The RIS system sends an interface message to the PACS system providing demographic information about the patient and the exam requested.
4) The technologist, either in a direct digital x-ray room (DR) or on a computed radiography unit, receives patient and exam demographics via the RIS/PACS interface.
5) The x-ray is performed and the digital image is transferred to the PACS server, where the RIS/PACS interface provides verification that the patient and exam information is valid.
6) Digital copies of the x-ray are queued for long-term storage (archive) and both diagnostic and clinical distribution.
7) The radiologist reports the x-ray using a diagnostic-quality PACS workstation and dictates the result into the RIS system (using a voice dictation or voice recognition system).
8) The text result is stored in the RIS; once the radiologist signs the report, it is sent to the requesting physician and passed to the RIS/PACS interface, and the exam and report can then be viewed by authorized clinicians.

PACS and RIS can work separately; however, there are significant disadvantages to this configuration. If PACS and the RIS are not interfaced or integrated, patient identification data from the RIS must be re-entered into the PACS. Not only does this add significantly to the diagnostic imaging staff’s workload, but it increases data-entry errors during transcription.

3.5 Telehealth and Teleradiology

Telehealth and teleradiology are also technologies “related” to PACS.

Telehealth – Telehealth can be broadly defined as the use of communications and information technology to deliver healthcare services and information over large and small distances. Telehealth applications can take many forms; examples include telepsychiatry, teledermatology, telecardiology, and teleradiology.

Teleradiology – Teleradiology is considered to be a subset of telehealth. It is the electronic transmission of radiological images from one location to another for the purposes of interpretation and/or consultation.

In the broadest sense, PACS is an example of a teleradiology application. There are, however, many teleradiology applications that do not have a PACS component, and these applications have not been analyzed in detail as part of this report.

It is important to note, however, that there are “stand alone” teleradiology applications in Canada – that is, applications that do not digitally store images and information for future retrieval. These applications should be analyzed with the goal of integration with PACS. This integration would allow the future retrieval of this important diagnostic information.
“The notion of classic teleradiology, involving case-by-case transmission of images and notes, should be rehashed, he [Dr. Thrall] said. Remote workers should instead have full access to their departments’ RIS and PACS under wide area or global networking schemes.”  

4.0 The Evolution of Imaging Technologies and PACS

The following brief history of imaging technologies and PACS demonstrates the speed at which these technologies have evolved over time.

4.1 The Evolution of Imaging Technologies

The Canadian Institute for Health Information (CIHI) report, Medical Imaging in Canada, summarizes this evolution as follows:

“In the past century, we have witnessed dramatic technological changes in the field of medicine, including in medical imaging. For example, x-rays were just starting to be used for medical purposes in the late 1890s. Today, radiologists can read x-rays and other diagnostic images produced thousands of miles away in a matter of minutes. Surgeries that once required several days of hospitalization are now being performed on an out-patient basis. And more sophisticated forms of medical imaging – such as the ability to generate functional images of almost any structure within the body – are becoming essential to the provision of general and specialized medical care and treatment.”

The following lists some of the key developments in imaging technologies, as summarized from the Medical Imaging in Canada report:

- In 1896, in Montreal, x-rays were used to make a diagnosis for the first time in Canada.
- In the same year, Alexander Graham Bell experimented with x-rays and their transmission in Baddeck, Nova Scotia (likely the first ever teleradiology).
- In the early 1900s, the use of orally administered pharmaceutical contrast agents was introduced; after much experimentation, intravenous contrast agents were developed.
- In the early 1940s, ultrasound was first used (ultrasound measures the echoes of high-frequency sound waves).
- In the early 1970s, computed tomography (CT) was invented (CT or “CAT” scan uses x-ray images processed by a computer to create images that are “slices” of the part of the body being examined).
- In 1973, Canada’s first CT scanner was installed at the Montreal Neurological Institute (MNI).
- In 1975, MNI developed and installed Canada's first Positron Emission Tomography (PET) scanner (PET scans create images by detecting subatomic particles emitted from a tracer radioactive substance that has been injected into a patient).
- In 1982, Canada implemented its first MRI (Magnetic Resonance Imaging) device (MRI uses three components to create detailed images of the inside of the body – hydrogen atoms in the tissues, a strong external magnet and intermittent radio waves).

\(^{5}\) Canadian Institute for Health Information, Medical Imaging Technologies in Canada (September, 2003).
CIHI’s National Survey of Selected Medical Imaging Equipment concluded that in Canada, as of January 2003, there were 326 CTs, 148 MRI scanners, 165 angiography suites and 14 PET scanners.

Internationally, the Organization for Economic Cooperation and Development (OECD) has reported large variations in the supply of medical imaging technologies among member countries. OECD figures from the *Medical Imaging Technologies in Canada* report indicate that Canada is below the median when comparing both the number of MRI and CT scanners per million population in selected OECD countries.

4.2 *The Evolution of PACS*

In the late 1970s and early 1980s, new “digital imaging” technologies were evolving that would soon increase the power and communication capabilities of diagnostic devices. The United States government, under the departments of Defense and Veterans’ Affairs, initiated early PACS clinical research and development. “The Department of Defense work was done domestically to provide continuity of care for a highly mobile military-dependent population.” In 1985, the United States Army’s Digital Imaging Network and Picture Archiving Communications System was installed at the University of Washington (Seattle) and Georgetown University/George Washington University.

In 1988, the Toronto East General Hospital installed Canada’s first PACS system. Since then, advancements and improvements in PACS technology and the increased volume of imaging studies (such as MRIs and CTs) deluging healthcare providers have led to widespread adoption of PACS both in Canada and around the world.

PACS vendors in Canada have estimated that the growth rate for PACS in Canada over the past few years has been approximately 10 – 15%.

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6 *Canadian Institute for Health Information*, Medical Imaging Technologies in Canada (*September, 2003*).
7 “U.S. Department of Defense Role in PACS History,” PACSWEB Archives, *May, 2003*
5.0 PACS in Canada Today

In a relatively short period of time, PACS has evolved into a key information technology tool for Canadian healthcare organizations. This section describes the level of PACS penetration in Canada and how the technology has been implemented. Also, Canada's experience to date with telehealth applications is described.

5.1 PACS Penetration

The exact situation with regard to PACS utilization today in Canada is difficult to assess accurately, as key data, such as the total number of diagnostic exams performed nationally on an annual basis, are not readily available. Canada Health Infoway has performed some preliminary analysis on this topic for hospitals. By using PACS vendor data to estimate the numerator (the number of exams stored in PACS across the country) and the population of Canada as the denominator (assuming each Canadian has an average of one exam per year), Infoway estimates that PACS national penetration is approximately 27%. After reviewing these figures with the Canadian PACS vendor community and allowing for the imaging volumes of Canada's community-based imaging centres, it is likely that the penetration percentage across the entire health system is in the 20-25% range.

PACS vendors and surveyed organizations confirmed that PACS is more prominent in larger facilities across the country. Healthcare organizations that perform more than 50,000 exams per year can more easily justify a PACS implementation. Hospitals or imaging centres that perform fewer than 25,000 exams per year have traditionally had a much more challenging task in building a positive business case for PACS, as it is more difficult for them to achieve significant hard dollar savings such as film, film processing and storage. In a later section of this report, the importance of inclusion of these lower-volume hospitals and clinics in PACS expansion will be discussed. The increasingly important roles that these centres play in Canada's healthcare system warrant their full inclusion in Canada's expansion of PACS.

PACS vendors and surveyed organizations also acknowledged that the use of PACS in other modalities, such as cardiology and ophthalmology, is in its early stages. Although many of the respondents acknowledged the potential for PACS to bring the same types of benefits enjoyed by diagnostic imaging to other healthcare departments, the availability of funding for these new modality investments was considered to be a major obstacle. The notion of PACS as an “enterprise solution” is, however, becoming more evident in Canadian jurisdictions as management strives to bring forth enterprise solutions rather than stand-alone applications.

In understanding PACS penetration in Canada today, one must also consider the availability of solutions and vendors in the marketplace. Although PACS is a relatively new technology, the Canadian marketplace offers a fair variety of PACS solutions. Many of the PACS vendors are Canadian divisions of large multinational firms that offer PACS solutions throughout the world. Although a couple of vendors have lead positions in PACS market share in Canada, there are four or five other firms that market competitive PACS offerings and competition for new business is substantial.
5.2 PACS Integration and Image Availability

To better understand PACS in Canada today, it is also important to know the level of integration that exists between PACS and its related technologies. This topic was covered in telephone surveys with 21 healthcare organizations. The survey respondents were classified into three groups for analysis: “Advanced” organizations had substantial PACS penetration throughout (ten organizations), “Limited” organizations had partial PACS implementations (eight organizations), and “No PACS” organizations had not yet embarked on PACS projects (three organizations).

As stated in Section 4, the integration of PACS and RIS is an important factor in maximizing the benefits of a PACS implementation. The vendor community estimated that roughly 75% of their clients had integrated PACS with RIS. Virtually all of the “Advanced” facilities and roughly 70% of the total of “Advanced” and “Limited” organizations interviewed had integrated their PACS environment with RIS. The requirement to streamline workflow and operations within the organizations and to the desire to eliminate the potential error-laden process of duplicate data entry are driving factors for this integration.

Integration with voice dictation systems was also considered an important PACS/RIS consideration for PACS implementations. Eight of the ten “Advanced” PACS organizations and two-thirds of the implemented PACS organizations interviewed had integrated their voice dictation systems. Again, the desire to streamline workflow leads organizations to invest the time and resources necessary for this type of integration.

Voice recognition technologies for diagnostic imaging are still in their early stages of deployment in Canadian healthcare organizations. PACS vendors estimated that fewer than 10% of their clients had implemented voice recognition solutions. In the survey, only a couple of respondents indicated that they had integrated their voice recognition systems with PACS/RIS. This technology, however, has evolved significantly in the last couple of years and is now positioned for rapid growth with diagnostic service organizations in Canada.

Another key element in understanding PACS implementations in Canada is the availability of PACS images throughout the healthcare organization. Most PACS organizations interviewed had enabled clinical viewing of PACS images and reports in key areas such as operating rooms, nursing units, emergency rooms, and associated clinics, mostly through web-viewing capabilities. This feature has helped fuel support from other clinicians, as the availability of accurate diagnostic information and images is an important benefit to referring physicians and specialists.

Seven out of ten “Advanced” organizations provided “preliminary read” capability to radiologists in their homes. This capability provides patient care benefits in emergency situations.

5.3 Telehealth

Health Canada indicates that there are approximately 800 sites in Canada’s provinces and territories that are currently part of telehealth networks; however, the number of these sites that utilize teleradiology applications is unknown. Teleradiology is considered to be an important component of specialty care consultation.

Many jurisdictions view the development or expansion of telehealth networks as vital to the delivery of services in rural and remote areas, primary health care and emergency first response. The benefits of telehealth have proven to be substantial, and the Canadian
government has demonstrated its support by providing $100 million to 150 million in funding through Canada Health Infoway for telehealth initiatives. As telehealth initiatives grow and evolve, there is a growing realization that telehealth applications must be planned within the context of the EHR vision for Canada. Joint application of telehealth and EHR capability can enable service integration across the continuum of care.
The objective of this section is to answer the question “Is PACS a good investment for Canadian healthcare organizations?” In other words, can organizations create a positive PACS business case in which the overall benefits (both quantitative and qualitative) outweigh the costs of PACS implementations? To that end, feedback received from the Canadian organizations that have implemented full PACS will be described and other related research will be shared. Also, a summary of critical success factors that Canadian healthcare organizations believe are necessary to achieve the optimal benefits from PACS technology will be presented.

This report concludes that the business case for PACS is compelling. It is founded on the improvements in patient-care quality and organizational efficiencies and effectiveness gained through a successful PACS implementation. Although there are hard-dollar benefits (e.g., savings on film, storage, and transportation), PACS cannot be justified on cost savings alone. PACS investments should be considered as strategic infrastructure investments that enable organizations to provide better care more effectively and more efficiently.

PACS implementations in Canada to date have been extremely successful. Representatives of advanced PACS healthcare organizations interviewed clearly described important benefits in the improvement of patient care delivery, citing the quality improvements brought about by faster access to images and information. Efficiencies were gained as faster turnaround was achieved and increased throughput obtained. Hospitals and clinics pointed to other important benefits, such as improved staff morale and an enhanced image for the department. These benefits will be described in greater detail.

There are differing views as to whether the quantifiable benefits of PACS, on their own, offset the required capital and operating expenses. There has been very little quantitative analysis done to estimate and track the hard-dollar benefits that Canadian healthcare organizations have realized with their PACS implementations. As with most information technology applications in healthcare, the tasks involved with scientifically estimating the projected benefits and implementing tracking systems to measure the benefits realization are extremely onerous and expensive. Healthcare organizations surveyed as part of this report had mixed views as to whether or not their PACS implementation had saved money overall, cost more, or was revenue neutral. A comment by the Chief Financial Officer of the Children’s Hospital in Boston, Massachusetts, may best summarize the strategic necessity of PACS; “PACS is not a return on investment. It’s not a project that will make money on its own. Instead, PACS should be considered an infrastructure investment fundamental to operating a hospital.”

Although hard-dollar savings alone should not be used to justify a PACS implementation, it is important to note that the size of the organization will substantially impact the cost savings achieved through PACS. Information supplied by Canada Health Infoway and PACS vendors in Canada indicates that it is difficult to demonstrate a “positive” business case for hospitals or clinics that fall below the range of 25,000 to 50,000 exams per year. Larger facilities can demonstrate significant film processing and storage savings; in smaller facilities this is a much more difficult task. The business case justification for PACS in smaller hospitals and clinics is an important issue that will be discussed later in this report.

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Another important element of a PACS business case is a firm understanding of where the benefits of PACS accrue. PACS should not be viewed as benefiting only the diagnostic imaging department or the radiologists in a healthcare organization. PACS benefits are experienced throughout hospitals, particularly in areas such as the emergency department, intensive care units, and operating rooms, as images and reports are delivered more quickly and the resulting diagnoses and treatments begin earlier. PACS benefits are also outside the hospital or clinic walls, as referring physicians gain much-needed information on their patients more quickly. Canada Health Infoway estimates an annual national benefit of $370 million when online viewing of images and reports is available to specialists across the country. The savings result from the avoidance of duplication of procedures and the avoidance of film printing for physicians not affiliated with a facility or practice.

Clearly, the benefits of PACS are system-wide.

“In more recent years, PACS have evolved rapidly, keeping pace with the speed of technology change. PACS have become less expensive, more functional and more standardized from a hardware and software perspective. PACS also have extended their reach with electronic distribution of images to the world beyond radiology. This has caused a rethinking about PACS, and a realization that PACS are a significant healthcare issue that can have a positive impact on the entire healthcare delivery system. Considering the role of the medical image in the treatment and management of patients, PACS have the potential to improve the timeliness and efficiency of diagnosis, treatment planning, therapy and outcomes assessment.”

Moreover, PACS and RIS form an important part of the EHR. Diagnostic imaging information presents part of the overall health picture of an individual. In Section 8 of this report, we will describe Canada's EHR strategy and the key role that PACS plays in its formation.

### 6.1 PACS Benefits

This section describes the key benefits and costs of a PACS implementation. The benefits of PACS have been categorized into four areas for discussion:

- Improvements to the quality of patient care
- Improvements in efficiencies and effectiveness
- Cost savings and cost avoidance
- Other benefits

### 6.1.1 Improvements to the Quality of Patient Care

Canadian healthcare organizations surveyed as part of this initiative highlighted the importance of the patient-care benefits of PACS.

These organizations reported that PACS enables faster reporting and more complete diagnosis. The exam image is available to radiologists faster and is accompanied by prior relevant images and reports and, possibly, other modalities. The ability to change

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Full PACS installations reported important productivity enhancements for technologists.

Intensities and views of the image allows for more detailed analysis of the exam. The speed and quality of the read enables quicker turnaround of information to the attending physician; therefore, better and faster treatment decisions are made. In emergency situations, quicker triage is possible. In the end, patients move through the system more quickly and shorter hospital stays can be the end result.

The communications capability of PACS allows access from multiple locations within an organization. This enables consultation with referring clinicians and/or specialist radiologists. All of the “Advanced” PACS organizations interviewed provided Web access capability from operating rooms, nursing units, and the emergency department. Again, the end result is better diagnosis and treatment decisions.

Remote sites can acquire a radiologist consultation in a more timely fashion due to the access capabilities of PACS. This reduces the potential issues of delayed reporting or non-radiologist interpretation of exams. Better patient care decisions result, particularly decisions related to the transfer of patients.

PACS images are always available. There are fewer lost, misplaced, or stolen films, and the patient is therefore not subjected to as many repeat examinations. The quick access to previous images is an important patient care benefit. The reduced exposure to radiation also benefits the patient.

PACS enables faster reporting, more complete diagnosis, better treatment decisions and improved safety. The patient is the prime benefactor of PACS technology.

The following excerpt from the Health Infostructure Atlantic Project Evaluation Report summarizes some of the key advantages of PACS:

“In the opinion of the stakeholders, early experience with Tele-i4 [Atlantic Canada's PACS project] technology suggests that these diagnostic tools play a significant role in improving the delivery of quality health care to residents of Atlantic Canada. Examples of improved diagnostic accuracy, faster treatment decisions, and reduced patient inconvenience from transfers out of the community or from overnight admissions for observation, were all cited as indications of the potential current and long term benefits of this technology investment.”

6.1.2 Improvements in Efficiencies and Effectiveness

Canadian healthcare organizations interviewed described how PACS made their operations more efficient and effective.

PACS enables improved workflow in diagnostic imaging departments. Organizations described how their diagnostic imaging departments could take on increased exam volumes without increasing staff complement; an important benefit considering staffing issues in radiology. Full PACS installations reported important productivity enhancements for their technologists. The ability of this technology to enable resource-challenged healthcare organizations to cope with increased demand for diagnostic imaging services is a key benefit to the Canadian healthcare system.

These efficiencies were more likely to be attained by organizations that had tightly interfaced or integrated their PACS environments with their RIS(s), voice dictation system(s),

and/or voice recognition system(s). The vast majority of Advanced PACS organizations indicated that the integration of these systems had taken place and were necessary to achieve the overall efficiency improvements.

Also, it is important that organizations move as quickly as possible to a “filmless” environment to achieve these efficiency gains. Organizations caught in a situation of partial PACS cannot attain the same levels of efficiency, as they must support multiple processes and workflows.

Advanced PACS organizations reported an increase in their overall effectiveness, indicating that their service levels had improved. The combination of improved workflows and report/image access capability throughout the enterprise were the key ingredients in this effectiveness improvement. Both the organization and the patients are the benefactors.

**Cost Savings/Cost Avoidance**

There are a number of areas in which cost savings or cost avoidance accrue from the use of PACS. The following four main areas were identified by Advanced PACS organizations:

- Reduction in film purchasing, processing, storage, and transportation costs and reduction in paper forms, file jackets, and other film library supplies. To achieve this benefit, an organization must move to a truly “filmless” environment.
- Reduction in the number of repeated exams due to lost or misplaced films. Manual filing systems are plagued by continuous difficulties associated with human error. The digital storage and retrieval of images virtually eliminates these problems.
- Reduction in film library personnel. As organizations increase their PACS penetration, requirements for film library staff accordingly decrease.
- The avoidance of technologist complement increases to handle increased volumes and workload.

These quantifiable benefits are listed in Appendix 3 of this document.

**Other Important Benefits**

Organizations reported other benefits to their use of PACS, including improvements in staff morale. PACS is felt to be an important tool in helping radiologists and technologists perform their roles to the best of their abilities. Advanced PACS organizations reported that their diagnostic imaging departments enjoyed an improvement in their image with PACS implementation.

From an environmental perspective, PACS reduces human exposure to hazardous waste and chemicals, and accordingly reduces chemical discharge, water consumption, and film disposal.

Organizations also reported benefits in the area of teaching and research. From a teaching perspective, identification and storage of selected exams is much easier in a PACS environment versus a traditional film environment. In addition, research capabilities are greatly enhanced in a digital environment.
6.2 **PACS Costs**

PACS cost elements are well understood and documented, and can be accurately estimated based on an organization's volumes, access requirements, and other factors.

The major elements of the capital cost of PACS include acquisition interfaces, PACS servers, display stations (both diagnostic and viewing), archive storage devices, and network infrastructure.

One-time costs for PACS include project and change management costs for the implementation. Project management entails overall coordination of the implementation, including development of the project's objectives, scope, approach, timeline, team, and deliverables. Change management is focused on the objective of widespread adoption of and support for the new system, and entails redesign of workflows and ongoing communications with the project's stakeholders.

Major operating cost elements include PACS application and hardware support personnel, ongoing license fees, and ongoing hardware maintenance costs. A cost table listing these elements is provided in Appendix 3.

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6.3 **Critical Success Factors in Achieving PACS Benefits**

The Canadian healthcare organizations surveyed were asked to identify the Critical Success Factors that needed to be in place for their organizations to fully reap the benefits of PACS technology. A number of factors were identified.

6.3.1 **Stakeholder Support**

A wide variety of stakeholders must understand the benefits of PACS and support its role in the organization's success. This support must extend from government and organizational leadership (commitment to the funds required for PACS) to stakeholders within the organizations, particularly in the clinical community. Clinical involvement is particularly necessary in redesigning the flow of information throughout the healthcare enterprise.

6.3.2 **Strong Business Plan**

A strong PACS business plan should include a compelling business case and a comprehensive implementation plan. The business case should identify the costs (including future replacement costs) and both qualitative and quantitative benefits of the planned implementation. The implementation plan should describe all key aspects of the implementation, including the overall project objectives, approach, governance structure, risks and deliverables. A strong business plan, fully supported by the stakeholder groups described above, leads to successful implementations.
6.3.3 **Project and Change Management**

Project and change management are essential ingredients for success in large, complex projects such as PACS implementations. Skilled project managers understand their stakeholders’ expectations and build the approach, team, and plan necessary to achieve the benefits anticipated. Change management focuses on the acceptance of the end solution, ensuring that workflows are properly designed, clinical access is understood, and training and communication plans are integrated into the project plan.

6.3.4 **Availability of Skilled Human Resources**

Skilled, experienced resources are required for virtually all aspects of PACS implementation projects. The quality and experience of project managers and change management specialists can have a significant impact on the success of projects. PACS and RIS specialists are required as part of the project teams to design, implement, and support integration and ongoing operations. The PACS vendor must also bring teams with the right levels of knowledge and experience. PACS organizations and PACS vendor organizations interviewed reported that the availability of appropriate skilled professionals in the PACS arena was an issue of concern.

6.3.5 **Integration Plan for Organization or Jurisdiction**

To achieve the full benefits of PACS implementations, PACS will need to be integrated with related technologies such as RIS, voice dictation, and voice recognition and will also need to be integrated with an organization's EHR. The complexity of these integration tasks can be overwhelming, especially in environments that have the complexity of multiple RISs, multiple patient identification systems, and so on. Organizations must provide an overall blueprint as to how the systems will work together, today and in the future. The creation of an application “architecture” is an important step in guiding enterprises through these complex integration challenges.

6.3.6 **Diagnostic Imaging Equipment and Technology Infrastructure**

Organizations must have the proper base of diagnostic imaging equipment and technology infrastructure from which to launch a PACS initiative.

Adequate diagnostic imaging equipment is a fundamental building block of an effective and efficient imaging service. PACS-enabling a poorly equipped imaging department or clinic will not bring about the desired benefits.

Also, PACS demands high-speed networking and high availability systems; a robust technology infrastructure is necessary to support a PACS implementation. An organization should consider the requirements of all of its key information technology applications in creating an enterprise strategy for infrastructure. Diagnostic imaging professionals must work in concert with information technology professionals to design and implement the fundamental infrastructure building blocks required by PACS.
7.0 The Vision for EHR and PACS in Canada

The purpose of this section is to describe the role of Canada Health Infoway, explain Canada's vision for an EHR, and propose a vision for PACS in Canada.

7.1 The Formation of Canada Health Infoway

In the introduction, some of the key trends in the Canadian healthcare sector were described. One of these trends is the national focus on the importance of information in the healthcare sector. Over the past few years, a number of national reports have promoted increased investment in information tools and technologies to improve the Canadian healthcare system.

In 1999, the Advisory Council on Health Infrastructure published the Canada Health Infoway report. This report, built with provincial and territorial input, introduced the concept of a “Canada Health Infoway.” The vision was described as follows:

“The Canada Health Infoway empowers individuals and communities to make informed choices about their own health, the health of others and Canada's health system. In an environment of strengthened privacy protection, it builds on federal, provincial and territorial infrastructures to improve the quality and accessibility of health care and to enable integrated health services delivery. It provides the information and services that are the foundation for accountability, continuous improvement to health care and better understanding on the determinants of Canadian health.” 11

In December of 2000, the Advisory Council on Health Infrastructure created a blueprint or tactical plan consistent with the principles of the 1999 report. The plan emphasized the importance of a pan-Canadian approach in developing EHR, integrated provider solutions and health information for the public.

In June 2001, an independent, not-for-profit corporation, Canada Health Infoway, was launched. With initial funding of $500 million from the Canadian government, Infoway set off to fulfill a bold mission: “To foster and accelerate the development and adoption of electronic health information systems with compatible standards and communications technologies on a pan-Canadian basis with tangible benefits to Canadians. The Corporation will build on existing initiatives and pursue collaborative relationships in pursuit of its mission.” The Infoway vision is a “high-quality, sustainable and effective Canadian healthcare system supported by a Pan-Canadian health infrastructure that provides residents of Canada and their healthcare providers timely, appropriate and secure access to the right information whenever and wherever they enter the health system. Respect for privacy is fundamental to the vision.” 12

Infoway’s approach is to achieve its vision through “harnessing and aligning the collective efforts of governments, the healthcare community and the technology sector, and in so doing will speed development, save costs and avoid duplication.” The organization will act

12 Canada Health Infoway, Health Care Innovation through Information (2002).
as a “strategic investor,” helping to build the essential elements necessary for compatible EHR systems and will also help to define standards and an architectural blueprint necessary to support the pan-Canadian EHR.

Since Infoway was launched, there have been two key reports that have supported the national focus on the EHR. *The Health of Canadians – the Federal Role*, known as the Kirby Report, concluded, “Healthcare technology, electronic health records and the evaluation of quality, performance and outcomes are three areas of health infrastructure that must be given priority by the federal government.”  

Finally, in 2002, the Romanow Report, *Building on Values – The Future of Health Care in Canada*, recommended that government “enable the establishment of personal electronic health records for each Canadian building on the work currently underway in provinces and territories” and “provide better health information to Canadians, healthcare providers, researchers and policymakers – information they can use to guide their decisions.”

### 7.2 Canada’s Vision for the EHR

Canada Health Infoway defines the EHR as a “secure and private lifetime record of an individual’s health history within the healthcare system. They are vital to enabling the delivery of quality care and they represent the backbone of a modern health system. Electronic health records enable providers to have timely access to complete and current information on their patients, including medical files, physician appointments, hospital visits, prescriptions and laboratory tests, while preserving and protecting patient privacy. They need to be available electronically to authorized healthcare providers and the individual anywhere, anytime to ensure the quality, safety and efficiency of patient care.”

The benefits of the EHR in Canada are compelling. The 2002 Commission on the Future of Health Care in Canada supports this conclusion:

Paper records are increasingly becoming obsolete and inadequate. They limit the flow of information, insufficiently document patient care, impede the integration of health care delivery, create barriers to research, and limit the information available for administration and decision-making. They also limit Canadians’ ability to access their personal health records and use their personal health information for making decisions about their own health and health care.

In contrast, electronic health records provide important advantages.

- Diagnoses, treatments and results can be improved when healthcare providers have access to complete personal health information and can link that information to clinical support tools.
- Accuracy of personal health records can be improved. With an electronic health record, information from a variety of healthcare providers is collected and stored on a single record, providing a more complete and more accurate record of an individual’s personal health history.

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13 *Standing Committee on Social Affairs, Science and Technology*, The Health of Canadians – the Federal Role (October, 2002).


15 *Canada Health Infoway*, Health Care Innovation through Information (2002).
Efficiency can be improved.

Electronic health records can provide aggregate data that can be used in health research and health surveillance, tracking disease trends and monitoring the health status of Canadians.

Security can be improved.  

Canada is focused on the development of a national EHR to improve outcomes, to improve efficiencies in the healthcare system, to reduce costs and to improve the safety of patients. The journey toward the EHR will require the focus and alignment of the many stakeholders in Canada's healthcare system.

### 7.3 An Architecture for the Electronic Health Record

The goal of Canada Health Infoway is to have the elements of interoperable Electronic Health Record Solutions (EHRS) in place within four to six years. (EHRS is defined by Infoway to be “the combination of the people, organizational entities, business processes, systems, technology and standards that interact and exchange clinical data to provide high quality and effective health care”).

In July 2003, Canada Health Infoway published its first version of the “EHRS Blueprint, an interoperable EHR framework.” This business and technology architecture blueprint was designed to “form the basis across Canada of our common definition and specification of the business and technical architecture for an interoperable Electronic Health Record Solutions (EHRS).”

The “Blueprint” describes a future vision of a network of interoperable electronic health record solutions deployed across Canada. The guiding principles used in its development stress key fundamentals such as the importance of timely and accurate information, the use of standards, the need to deliver added value to the provider and the patient-centric view of health information. The architecture is based on the assumption that all EHR data will not reside in one system, but will be based on a series of registries, point of service systems (e.g. admission, discharge and transfer systems in hospitals) and domain repositories (systems that store and provide access to specific clinical data).

PACS is considered a domain repository, and has an important role in the EHR architecture. In the conceptual representation of a “regional” EHR architecture in the figure below, the PACS domain is represented in yellow. PACS images can be securely accessed, as part of the EHR, by any of the healthcare users of the information systems tied to the Health Information Access Layer (HIAL). The HIAL performs many of the key technical functions necessary to support the secure interchange of information. As a result of this architecture, referring physicians could, from their offices, securely access the diagnostic imaging reports and images for their patients immediately after the examinations have been reported. Through the use of a series of EHRS “locators,” the architecture enables access to key clinical patient information wherever it exists across the country.

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16 *Roy J. Romanow, Building on Values: The Future of Health Care in Canada (November, 2002).*

17 *Canada Health Infoway, EHRS Blueprint – An Interoperable EHR Framework, Version 1 (July 2003).*
Figure 4 PACS as part of the Electronic Health Record Architecture (developed from the Canada Health Infoway EHRS Blueprint)

7.4 Infoway and Diagnostic Imaging Systems

Infoway has recognized that diagnostic imaging systems are an important element of Canada's emerging healthcare infrastructure and are essential components of interoperable electronic health record solutions. Infoway has designated diagnostic imaging systems to be one of its six investment programs.

The main goal of Infoway’s diagnostic imaging systems investments will be to enable specialists and/or family physicians to view their patients’ test reports and images from any location, regardless of where the test was conducted. Infoway estimates an annual benefit of $370 million when this type of access is available to physicians across the country. The savings come in the avoidance of duplication of procedures and the avoidance of printing of film for physicians not affiliated with a facility/practice. For the healthcare consumer, this immediate access will mean faster turnaround for results and higher quality of care. For physicians, this capability will eliminate hunting for films and provide better access to radiologists’ services.

Infoway has developed an investment strategy for diagnostic imaging systems that is based on the opportunities to promote a lower-cost approach to implementing PACS, to leverage economies of scale and to accelerate PACS adoption and EHR development.

Key to the strategy will be accelerating the availability of PACS function in small to medium-sized facilities by promoting a “shared services model” (allowing smaller organizations to share the costs of PACS solutions). Industry sources indicate that it is difficult to build a business case for PACS in organizations that have fewer than 25,000 to 50,000 exams per year. Since a very high percentage of Canadian hospitals and clinics fall into this category, the need for sharing is evident.
As part of this strategy, Infoway has announced investment in two shared service PACS implementations, in the Fraser Health Authority (12 regional hospitals in British Columbia) and in the Thames Valley region (eight hospitals in southwestern Ontario).

At the time of writing, Canada Health Infoway estimates project investment in diagnostic imaging systems to be in the range of $220 million to $280 million over the next four years. The investment from Infoway will require a significant investment from the implementing jurisdiction or organization as well. Although not finalized at the time of writing, it appears that Infoway will invest approximately 50% of the eligible project costs in approved initiatives. Eligible costs will not include items such as CR.

The timing of Infoway's investments has also been estimated. Overall, Infoway's $1-$1.2 billion will be invested as follows: 10% in Year 1, 20% in Year 2, 30% in Year 3, and 40% in Year 4.

It is also important to note that Infoway will cover “start-up” capital costs only. No ongoing operational costs or solution refresh costs (e.g. replacement of PACS components) are being considered as eligible project costs.

Canada Health Infoway has also announced its intent to invest $100–150 million in telehealth initiatives across the country. Since teleradiology is considered to be a subset of telehealth, it is likely that some of these investments will be directed toward teleradiology initiatives.

7.5 CAR’s Vision for PACS in Canada

Based on the success of PACS adoption in Canada to date, and the exciting potential benefits of a national EHRS, CAR recommends a vision of a “filmless,” integrated Canadian healthcare system. Within the next five years, CAR envisions a Canadian healthcare system in which PACS and its related technologies will be fully implemented for diagnostic imaging in 80–90% of the nation’s hospitals and clinics.

CAR’s vision entails PACS solutions that will interoperate at all levels (organizational, jurisdictional, and national). Within an organization, CAR recommends the tight integration of PACS with RIS and voice dictation or voice recognition systems. This integration will streamline workflow and optimize benefits for the organization. At the jurisdictional or national level, interoperability will be achieved through adherence to industry standards (such as DICOM and HL7), participation in international interoperability organizations (e.g. IHE – Integrating the Healthcare Enterprise), and adherence to Canada Health Infoway’s evolving architectural guidelines.

CAR’s vision for PACS also includes a well-developed resource pool across Canada that will utilize “best practices” project and change management. These resources will be required to satisfy the substantial implementation, support, and upgrade efforts that Canadian healthcare organizations will continue to initiate. The pool will include skilled project and change managers, functional and technical architects, security analysts, PACS administrators, and support technicians.
CAR’s vision also includes a well-developed resource pool across Canada that will utilize “best practices” project and change management.

The CAR vision for PACS includes strong and consistent privacy and security guidelines that frame the use of PACS and its related technologies in Canada. The power and capability of this technology will continue to grow. Privacy and security must anticipate the new uses and benefits of this technology, and ensure that patient privacy is maintained.

PACS opportunities will be exploited in other areas, including echocardiography, ophthalmology, and so on. In each case, the benefits of this technology must be weighed against its costs, to ensure that Canadians are well served by the emerging, expanded capabilities of these digital technologies.
8.0 Obstacles to Achieving the Vision

To achieve CAR’s vision for PACS in Canada, shared commitment will be required from many key stakeholders in federal, provincial, and territorial governments, as well as leaders in the healthcare delivery system. The obstacles that must be overcome are as follows:

8.1 PACS Funding

Clearly, the most significant obstacle to achieving CAR’s vision will be funding. PACS requires initial capital for acquisition, operating funds for ongoing support, and ongoing capital infusion to refresh the key technology components. As discussed in section 7 of this report, the benefits of PACS as a strategic investment are compelling and warrant the sizable investments that Canadian healthcare organizations and jurisdictions must make.

It is estimated that the cost of upgrading all Canadian hospitals’ and community-based centres’ diagnostic imaging services to full PACS would exceed $1 billion. It appears that the Canada Health Infoway commitment over the next four years to PACS will be between $220 million and $280 million; however, the timelines for investment may mean that only 30% of these funds will be invested in the next two years. Healthcare organizations and federal/provincial/territorial governments are the potential sources for the balance of the $750 million plus required investment.

As discussed earlier in this report, the business case for PACS is much stronger in organizations with exam volumes greater than 50,000 exams per year. Therefore, PACS is more difficult to justify in community-based imaging centres. These centres, however, are playing an increasingly important role in Canada’s healthcare delivery system. To achieve a “filmless” diagnostic imaging nation and move towards a “complete” electronic health record, community-based imaging centres will need PACS.

8.2 PACS Leadership

A shared commitment to CAR’s vision of PACS will require a shared understanding of the benefits of PACS. Champions will be required at all levels of government and within Canada’s healthcare organizations. Without champions at the healthcare organization level, PACS will struggle to compete with the dozens of other important information technology or equipment priorities. Without champions in government, the necessary investments will not occur.

8.3 PACS/EHR Integration Plans

The integration of PACS with the EHR at an organizational level can be an extremely difficult challenge, particularly in environments that have the complexity of multiple sites and multiple supporting information systems. To achieve the goal of integration at the jurisdictional level presents added challenges as well. For example, a newly formed region may have multiple patient numbering systems, multiple RISs, multiple diagnostic imaging work processes, and so on.
To achieve PACS/EHR integration, in either an organization or a jurisdiction, a clear vision and strategy must be formulated. An architecture or blueprint is required to map out how the integration will occur.

### 8.4 Adequate Resourcing for Project Management, Change Management, and Ongoing Support

Canadian healthcare organizations have a very good understanding of the importance of effective project and change management. The greater the size and complexity of healthcare information technology projects, the more important these roles become. Effective project management ensures that plans are developed with adequate stakeholder involvement and that milestones are achieved on time and within budget. Change management ensures that stakeholder expectations are understood and managed, new processes are understood and accepted, and effective communications takes place throughout the organization. Effective ongoing support means that skilled resources are able to respond to problems quickly and efficiently, utilizing best practice support processes.

Many of the organizations interviewed identified a lack of resources in these key areas as important obstacles in the advancement of PACS. A high level of knowledge regarding diagnostic imaging, PACS, and information technology is required for a successful PACS implementation and it appears that there is a current shortage of human resources with these skills and experience. Current training programs have been unable to meet the demand for the types of skills that PACS demands.

### 8.5 Diagnostic Imaging Equipment and Technology Infrastructure

The necessary level of diagnostic imaging equipment must be in place to support a department or centre’s service objectives. This should be considered a prerequisite to PACS implementation.

Also, PACS requires a substantial investment in infrastructure. Adequate network bandwidth and reliability are important elements of PACS infrastructure. When a PACS project is forced to bear the costs of these infrastructure investments alone, the business case is weakened.

### 8.6 Privacy and Security

Throughout the country, multiple healthcare organizations and jurisdictions are wrestling with the privacy and security issue. All healthcare organizations and jurisdictions want to ensure that patient information is adequately protected. The lack of a consistent set of national guidelines causes each organization and/or jurisdiction to spend considerable time and resource in developing their own privacy and security policies and processes.
9.0 Bridging the Gaps: Recommendations to Achieve the Visions

In this section, recommendations are put forth to overcome the obstacles discussed in the previous section to achieve the vision of a filmless digital imaging environment in Canada. The recommendations have been grouped into the areas of funding, leadership, integration, adequate resourcing, technology infrastructure, and privacy and security. The following identifies key questions for each category:

**Funding**
- How do organizations and jurisdictions obtain the necessary funding to continue to build PACS?
- How can community-based imaging centres acquire the necessary funding for PACS?

**Leadership**
- How can the champions required to lead organizations and jurisdictions to full PACS be nurtured and supported?

**Integration**
- How can the difficult tasks of integrating PACS with its related technologies and with the EHR be accelerated?

**Adequate Resources for Project and Change Management**
- What can be done to ensure that the necessary skilled resources are available to achieve successful PACS implementations across the country?

**Technology Infrastructure**
- How can organizations and jurisdictions be influenced to lay the necessary diagnostic imaging equipment and technology infrastructure foundations for PACS?

**Privacy and Security**
- How can we ensure consistent methods of securing the privacy of patient data in PACS implementations across the nation?

9.1 Funding

To achieve the PACS vision for Canada, CAR estimates that an investment exceeding $1 billion over the next three to five years will be required. CAR believes that this investment can be achieved through strategic federal, provincial/territorial and jurisdictional investments.

Canada Health Infoway intends to invest between $220 million and $280 million toward diagnostic imaging/EHR initiatives over the next four years. CAR recommends that a matching (50/50) contribution is invested by the provinces.

CAR recognizes that there are differing levels of diagnostic imaging equipment penetration throughout the country and therefore priorities will differ from place to place. In jurisdictions that have achieved a proper level of diagnostic imaging equipment, portions of the $1.5 billion Diagnostic/Medical Equipment Fund should be allocated to PACS investment.

Canada Health Infoway is encouraged to quickly evaluate PACS investment opportunities across the country, so that organizations or jurisdictions can potentially take advantage of the Equipment Fund as a source of its matching investment. Infoway may find that health-
Canada’s physicians should take the lead role in promoting PACS expansion across the nation.

Care organizations and jurisdictions are ready to advance their PACS plans quickly. If this is the case, Infoway is encouraged to reconsider the planned timeline of investment that calls for only 30% of their diagnostic imaging systems allocation to be invested in the next two years. To this end, organizations and jurisdictions are encouraged to prepare fully costed PACS business plans.

Depending on the level of allocation of the Diagnostic/Medical Equipment Fund toward PACS initiatives, it may be necessary for the federal government to increase the Diagnostic/Medical Equipment Fund and/or the Canada Health Infoway Diagnostic Imaging/EHR investments.

CAR recommends the use of “shared services” models to reduce the overall costs of PACS across the country. With lower-volume hospitals or community-based imaging centres, the concept of sharing key components of a PACS system makes strong economic sense. CAR believes that the complexities of forging these new working relationships will be offset by the benefits of the shared service models. To this end, CAR fully supports Canada Health Infoway’s efforts to build detailed business cases identifying the true magnitude of PACS costs and benefits in a shared service environment and to share these results with Canadian organizations as soon as possible.

Also, CAR recognizes the difficulty that community-based imaging centres will have in acquiring the capital necessary to implement PACS capabilities due to their low volumes and lack of formal relationships with hospitals. It is important to recognize the growing importance that these entities have in the Canadian healthcare landscape by including them in the move to the “filmless” integrated environment. Since many of the benefits of PACS will not accrue directly to these centres but to other healthcare entities, CAR believes that the provinces and territories must allocate a portion of their PACS funding for community-based centres. Community-based imaging centres should not be left behind; they must fully participate in achieving the vision of an integrated, “filmless” Canada.

Finally, CAR understands that many healthcare organizations and jurisdictions are restricted in the means by which they acquire technology assets. Lack of flexibility in financing alternatives can restrict investment opportunities. Provinces are encouraged to consider alternative financing vehicles such as technology leases as possible means of acquiring PACS technologies. Also, vendors are encouraged to promote creative means of PACS acquisition, including “Application Service Provider” models that offer organizations a “pay as you go” alternative.

9.2 Leadership

There is a strong need to nurture and support PACS leaders across the country. It has been established that the most compelling PACS benefits are in the area of patient care; therefore, Canada’s physicians must take the lead role in promoting PACS expansion within healthcare organizations and jurisdictions across the nation.

CAR can play an important role in supporting these champions. By establishing a national PACS Committee, CAR will help educate clinicians, health care and government leaders on the benefits of PACS. CAR’s PACS Committee will publish and promote Canadian success stories. Finally, this group can play an advisory role to entities such as the Canada Health Infoway that are playing and will continue to play important roles in the expansion of PACS across the country.
9.3 Integration with the Electronic Health Record
CAR understands the necessity of tightly integrating PACS with related technologies such as RIS and voice dictation and recognition solutions. The additional costs and complexities created by this integration are clearly offset by the benefits of streamlined workflows and efficient organizations. The challenges of this integration are recognized to be substantial, but integration must be fully planned and costed within the framework of an organization’s PACS business plan.

CAR supports the work of Canada Health Infoway in accelerating the integration of healthcare information systems toward the EHR. The introduction of the EHRS blueprint or architecture was an important first step in this progress. CAR strongly encourages the rapid advancement of Canada Health Infoway plans and initiatives that will help healthcare organizations and jurisdictions achieve interoperability at all levels as quickly as possible.

CAR fully supports the work of key standards bodies such as DICOM and HL7, and encourages the continued active participation of Canada in these bodies. CAR also supports the International Health Exchange initiative that strives for improved interoperability of healthcare systems and promotes a Canadian chapter of that organization.

9.4 Adequate Resources for Project Management, Change Management, and Operational Support
CAR understands the importance of effective project management and change management in PACS implementation projects and the need for skilled resources to support production PACS environments. The availability of skilled human resources to perform these roles will be a key issue in accelerating the implementation of PACS across the country.

CAR promotes increased cooperation between and among the PACS vendor community, professional information technology services firms, and the public sector in developing creative ways of increasing this required expertise. The combination of diagnostic imaging and information technology knowledge required to perform important roles in PACS implementation and support is unique. Educational offerings will be required to train this new breed of PACS professional. Examples of much-needed education will be in the areas of PACS administration courses and project and change management courses for diagnostic imaging professionals.

New teaching delivery methods will be required to provide “just in time” training for these professionals. The use of distance education offerings will play an important role in providing this type of education.

9.5 Diagnostic Imaging Equipment and Technology Infrastructure
CAR encourages investment by healthcare organizations, jurisdictions, and provincial, territorial and federal governments to support the diagnostic imaging equipment and technology infrastructure necessary for PACS.
Adequate diagnostic imaging equipment is a fundamental building block of an effective and efficient imaging service and the necessary level of investment must be made for this perquisite equipment.

Similarly, a sound technical infrastructure must be in place to support PACS. In remote areas of the country, this investment may be significant as low transaction volumes may make large, capital investments unattractive to infrastructure providers. Since the provision of a high-speed, robust technology infrastructure is a prerequisite for PACS, and since the provision of equal access to health services for all Canadians is a critical underpinning of our health system, governments must work closely with infrastructure providers to find the most cost-effective means of delivering this capability to our remote regions.

9.6 Privacy and Security

The time and energy spent on creating individual healthcare organizations’ policies and procedures regarding privacy and security are substantial. As the country moves toward the concept of an EHR, it will be important to establish consistent and uniform guidelines for privacy and security.

CAR promotes the creation of national privacy and security guidelines for PACS that ensure consistency across the country and save considerable time and effort in each organization and jurisdiction. These guidelines will ensure that Canadians’ diagnostic imaging information is secure. Canada Health Infoway may be the appropriate organization to lead the development of these guidelines.

9.7 Summary of Recommendations

In summary, CAR proposes the following recommendations to achieve a vision of a “filmless”, integrated Canadian healthcare system:

1. CAR recommends that Canada’s provinces match Canada Health Infoway’s investments of $220 to $280 million over the next four years.
2. In jurisdictions that have achieved a proper level of diagnostic imaging equipment, CAR recommends that portions of the $1.5 billion Diagnostic/Medical Equipment Fund be allocated to PACS investment.
3. CAR recommends that Canada Health Infoway accelerate its current plans for PACS investment.
4. CAR recommends that the Government of Canada consider increasing its investment in PACS technology through additional Canada Health Infoway or Diagnostic/Medical Equipment Fund investment.
5. CAR recommends the use of a “shared services” model to reduce the overall costs of PACS expansion in Canada.
6. CAR recommends that provinces allocate adequate PACS funding to ensure community-based imaging centres fully participate in achieving the PACS vision.
7. CAR recommends the creation of a national PACS Advisory Committee that must support PACS champions, publish and promote success stories and advise key stakeholders regarding PACS advancement.
8. CAR recommends integration of PACS and its related technologies so that full benefits can be derived from PACS implementations. CAR also strongly supports the work of Canada Health Infoway in accelerating the integration of healthcare information systems toward the Electronic Health Record.

9. CAR recommends cooperation between and among the PACS vendor community, professional information technology services firms, and the public sector in developing creative ways of increasing the expertise necessary to support the expansion of PACS in Canada.

10. CAR recommends necessary investment in diagnostic imaging equipment and technology infrastructure that are prerequisites for PACS.

11. CAR recommends the creation of national privacy and security guidelines for PACS.

This report and the analysis of PACS implementation shows that the overall qualitative and quantitative benefits of PACS technology far outweigh the costs: The business case for PACS is compelling. This conclusion is founded on the improvements in patient-care and system-wide efficiencies and effectiveness gained through successful PACS implementation. PACS investments should be considered as strategic infrastructure investments that enable organizations to provide better care more effectively and more efficiently. It is also an important piece of the EHR solution set. Investment in PACS is a critical investment for the improvement of Canada's healthcare system.
Appendix 1

Steering Committee Members

The following individuals participated as Steering Committee members for the project:

- Dr. Richard Rankin (Chair)
- Dr. Benvon Cramer
- Dr. Andrew Ross
- Dr. Robert Sevick
- Mr. Normand Laberge
- Mr. Frank Vassallo
- Mr. Laurie Rogers
- Ms. Maria Kalivas
- Mr. Stewart Gray

Project Team Members: Mr. Stewart Gray, Ms. Carole Arsenault, Mr. Rick Nickerson
Survey Participants

The following table lists the organizations that participated in the CAR PACS survey:

Vancouver General Hospital, Vancouver BC
University Health Network, Toronto ON
Winnipeg Regional Health Authority, Winnipeg MB
Montreal University Group, Montreal PQ
Calgary Health Region, Calgary AB
Saskatoon Health Region, Saskatoon SK
Hamilton Health Sciences Center, Hamilton ON
Peterborough Hospital, Peterborough ON
Atlantic Health Sciences Corporation, Saint John NB
Hôpital Sainte-Justine, Montréal PQ
Provincial Health Service Authority, Charlottetown PE
Red Deer Regional Hospital, Red Deer AB
Cape Breton Regional Hospital, Sydney NS
Peace River Health Region, Peace River AB
Health Care Corporation of St. John’s, St John’s NF
Scarborough General Hospital, Scarborough ON
Clinique Radiologique de la Capitale, Charlesbourg PQ
Hys Centre Office of Medical Imaging Consultants, Edmonton AB
Merivale Medical Imaging Inc. Nepean ON
Capital District Health Authority, Halifax NS
Reso Concorde Clinic, Laval PQ
# PACS Costs and Quantifiable Benefits

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Type of Cost Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PACS Initial Implementation Costs</td>
<td>Software</td>
<td>PACS Vendor Software Thid Party Software Acquisition Interfaces (for analogue devices) RIS/PACS interface software</td>
</tr>
<tr>
<td></td>
<td>Hardware</td>
<td>CR readers DICOM printers PACS servers Network infrastructure (eg. hubs, switches) Archive storage devices (local, regional or provincial, e.g. DLT jukeboxes, storage area networks) Display stations (diagnostic reporting) Display stations (clinical viewing) Workstations (PCs) RIS/PACS interface</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>Project management Change management (e.g. workflow design, communications, etc.) RIS/PACS integration services Technology planning and architecture</td>
</tr>
<tr>
<td>Annual operating/ongoing costs</td>
<td>Software</td>
<td>License and maintenance fees Software upgrades</td>
</tr>
<tr>
<td></td>
<td>Hardware</td>
<td>Hardware upgrades Support and maintenance fees Archive media</td>
</tr>
<tr>
<td></td>
<td>Network</td>
<td>Network utilization costs Maintenance and support fees Ongoing network management personnel and/or service fees</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>Ongoing PACS operations, Administration and support personnel (on-site and archive) Training</td>
</tr>
</tbody>
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# PACS Quantifiable Benefits

<table>
<thead>
<tr>
<th>Type of Benefit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film</td>
<td>Film purchasing costs&lt;br&gt;Film processing costs (cost of chemicals, processing)&lt;br&gt;Transportation costs</td>
</tr>
<tr>
<td>Film library</td>
<td>Reduction in staffing&lt;br&gt;Elimination of film library, storage space&lt;br&gt;Cost of forms, file jackets, other supplies</td>
</tr>
<tr>
<td>Offsite storage</td>
<td>Cost of storage services&lt;br&gt;Film transportation costs</td>
</tr>
<tr>
<td>Paper forms</td>
<td>Cost of requisition and log forms</td>
</tr>
<tr>
<td>Lost film</td>
<td>Cost of staff searching for misplaced films&lt;br&gt;Cost of retaking exams due to lost films</td>
</tr>
<tr>
<td>Productivity</td>
<td>Radiologists ability to read more exams per day&lt;br&gt;Radiology techs able to process more exams per day</td>
</tr>
<tr>
<td>Other</td>
<td>Reduction in patient transport&lt;br&gt;Reduced length of patient stay</td>
</tr>
</tbody>
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