

CADTH ENVIRONMENTAL SCAN

Diagnostic Imaging Equipment Replacement and Upgrade in Canada

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Authors: Leigh-Ann Topfer, Louis de Léséleuc

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Context

All medical equipment eventually needs to be replaced as a result of wear and tear, technological progress, or changes in clinical practice. This includes medical or diagnostic imaging (DI) equipment. Some of this equipment can cost millions of dollars. Careful management prior to replacing or upgrading equipment can improve the efficiency and safety of DI services, reduce costs, and ensure that equipment meets both the needs of clinical services and the objectives of organizational strategic plans.¹

The 2013 Canadian Association of Radiologists (CAR) guidance, *Lifecycle Guidance for Medical Imaging Equipment in Canada*, proposes a framework for determining the life expectancy of DI equipment.² Individual jurisdictional budgets, priorities, and health services may adapt these guidelines, or use other criteria that meet their needs. Explicit and transparent processes for prioritizing and funding DI equipment replacement can help with making decisions that are equitable and fiscally responsible, while mitigating negative impacts on patient care and health services delivery.

At the provincial, regional, or local levels, various processes and criteria may be used to prioritize DI equipment for replacement or upgrade. Considerations for replacing equipment can include the age of the equipment, regulatory or legal obligations, usage volume, intended use and related clinical impact, availability of effective alternatives, cost-effectiveness of upgrades, and the need for capital renovations or changes in service delivery. Information about these processes and criteria is not readily available.^{2,3}

This Environmental Scan was undertaken to identify the criteria and processes used across Canada to identify, prioritize, and fund DI equipment for replacement or upgrade.

Objectives

This report will summarize Canada-specific information obtained through a literature search and survey of key informants. The objective of the Environmental Scan is to address two main questions:

1. What are the processes in Canadian jurisdictions for making decisions on replacing or upgrading DI equipment?
2. What are the Canadian criteria and principles used in the context of funding or purchasing processes related to DI replacement or upgrade?

Methods

The findings presented within this Environmental Scan are informed by responses to the Diagnostic Imaging Equipment Replacement and Upgrade Survey (Appendix 1), gathered between November 10 and December 14, 2015, and by a limited literature search.

The literature search was conducted to identify recent Canadian literature on this topic. The peer-reviewed literature search for published literature used PubMed. As the search built on an earlier 2013 review prepared for CAR,² we restricted the PubMed search to English- or French-language publications within the last five years (January 1, 2010 to November 11, 2015). No other filters or limits were applied. Monthly PubMed alerts were run until the completion of the last draft of the report, in February 2016. Citation searches were made for key references and reference lists from relevant papers were scanned to identify additional papers. Grey (unpublished) literature was identified by searching relevant sections of the *Grey Matters* checklist (<https://www.cadth.ca/resources/finding-evidence/grey-matters>).

Canadian authors and associations working in this field, as well as survey respondents, were consulted at the first draft stage of the Environmental Scan report to help identify any missing information.

Table 1: Selection Criteria for Literature Search

Population	General population using the public health care system
Setting	Canadian publicly administered health care institutions
Intervention	Clinical diagnostic imaging modalities
Results	Replacement or upgrade criteria and processes used for funding decisions, implementation considerations (information technology, staff, renovations, and maintenance needs), sources of technology-related evidence

Survey responses were collected from key jurisdictional informants involved in the management of medical equipment assets. Informants were identified by CADTH staff through professional and clinical networks, or referred through other respondents. A 13-question survey was developed and revised following internal review. It included dichotomous, nominal, and free-text questions. Quantitative dichotomous (for example, Yes/No) and nominal variables (for example, a list of options) were summarized descriptively by jurisdiction. Open-ended qualitative responses were categorized by theme and summarized narratively. The final survey was distributed via email to 30 individuals in all provinces and territories across Canada. Survey recipients were also asked to distribute the survey further to their colleagues, as appropriate. The survey questionnaire is shown in Appendix 1.

In total, 15 completed survey responses were received. Information on processes in two other jurisdictions (the Winnipeg Regional Health Authority [WRHA] and

the Children's Hospital of Eastern Ontario [CHEO]) was received during the stakeholder review period. Most provinces were represented by the survey responses. Six provinces (Alberta, Manitoba, Quebec, Ontario, Nova Scotia, and Prince Edward Island) were represented by one response each, but for others (British Columbia, Saskatchewan, and New Brunswick) responses from two to four regional health authorities (RHAs) were received. Although only one response was received from both Alberta and Nova Scotia, they represent the single health authority for these provinces. The single response from Manitoba combined information from several respondents on behalf of the Ministry of Health. Four jurisdictions did not respond to the survey. Organizations represented in the survey are listed in Appendix 4.

Findings

1. Jurisdictional Context and Processes

Canada

The main Canadian guide on DI upgrade and replacement is the *Lifecycle Guidance for Medical Imaging Equipment in Canada*, developed for CAR.² The 2013 guidance, an update to earlier (2001) CAR life cycle guidance, combined the results of a literature review and an environmental scan (survey and interviews). It noted that decisions cannot be based solely on the age of the technology — rather, a broader range of considerations and stakeholder involvement is needed. Assessment criteria and weights for the different criteria should be selected to suit the local setting (for example, budget, staffing, and clinical needs in large or small, urban, or rural settings). However, within an organization, common standard life cycle guidance for DI equipment should be used.²

The survey respondents for the CAR life cycle guidance document also commented that:²

- National life cycle guidance would be useful, and this should be updated regularly.
- Equipment life cycle guidance should accommodate ranges of utilization.
- Guidance should be easy to use.
- Quality of care, and patient and staff safety were of primary importance.
- Technological advances were a consideration in DI equipment upgrade or replacement, and upgrades may provide a viable option that should be explored.
- Equipment planning should project at least five years forward, with annual updates.
- Weighting criteria can help determine priorities, but weights should be set to meet the needs of the individual organization.
- The financial context and equipment depreciation should be considered when planning upgrade or replacement with newer or emerging technologies.
- Discontinuing the use of obsolete technologies should be part of the planning process.²

The CAR guidance provides further information on aspects to consider when developing a planning process for DI equipment, including initial purchase, upgrade, replacement, and the acquisition of new or emerging technologies. In addition, alternative options that may be considered are described; for example,

redeploying or reallocating equipment, leasing equipment, purchasing used equipment, and optimizing the use of existing equipment. The CAR guidance also reviews older literature on this topic and provides an overview of international guidelines and processes.²

British Columbia

In British Columbia (BC), DI equipment planning is managed at the RHA level. The four RHA survey responses received (these represent all five of the BC health authorities) indicate that processes are in place to manage specialized equipment replacement or upgrade, including DI equipment.

In the RHAs, the process for replacement or upgrade is not distinct from that of procuring equipment for new or expanded services. Two of the RHAs included consideration of significantly different DI equipment, such as point-of-care devices to replace central imaging, when replacing outdated equipment.

There is a separate process for dealing with unplanned, immediate equipment requests. This is done through contingency funding that is approved by the health authority capital committee or senior executive.

With the exception of one RHA (Vancouver Coastal Health), there are separate processes and funding, such as a picture archiving system capital budget or an information technology (IT) budget, for replacement or upgrade of IT components (e.g., software or communication technologies). The Northern Health Authority mentioned that IT receives an annual budget allocation to prioritize equipment and upgrades.

All RHAs use mechanisms for minimizing costs or maximizing purchasing power when implementing DI equipment replacement. These mechanisms include “bundling” equipment purchases and using the services of the provincial purchasing group (Health Shared Services BC) to establish provincial contracts with equipment vendors.

The process for DI equipment replacement or upgrade in the Vancouver Coastal Health Authority involves the submission of a DI equipment list to the major capital steering committee. In its case, submissions from its RHA are combined with those of a partner RHA (Providence Health Care).

In Interior Health, planning takes place over approximately 15 months:

- **January to February:** submission of requests
- **March to April:** prioritization of requests by DI administrative directors, managers, and radiologists
- **May to August:** estimation of request budgets
- **September to October:** combination of prioritized lists from different services and allocation of funding
- **April:** funding.

The Vancouver Island Health Authority has an annual process that involves a region-wide committee of medical and administrative directors, chief radiologists from different sites, and site leaders, with input from radiation safety personnel and biomedical engineering. Their process begins in September with submissions for the following fiscal year.

Alberta

Alberta Health Services (AHS), the sole, province-wide health authority, has a process for replacing or upgrading specialized medical equipment, which includes DI equipment. This process is distinct from that used for procuring equipment for new or expanded services.

Significantly different devices, such as point-of-care devices replacing central imaging devices, may be considered by AHS when assessing the replacement of outdated equipment.

A separate process is used to deal with unplanned or emergency equipment requests. For this purpose, contingency funding is set aside (approximately 10% of the overall budget). If unexpected equipment failure occurs, an approval request is submitted to an equipment working committee, which assesses the urgency and validity of the request. There is no separate process for replacement or upgrade of IT components.

Mechanisms to minimize costs and maximize purchasing power are used. All requests are collated for provincial-level purchasing. AHS has a complete province-wide database inventory of DI equipment. A list of DI equipment for replacement is prioritized from this source. Requests for proposals include multi-modality strategies for multiple centres, such as purchasing five computed tomography (CT) scanners and five interventional radiology angiography suites at one time over a three-year period. Province-wide cross-sectional analysis allows AHS to consider redeploying equipment to other centres, and consolidation of equipment through analysis of utilization and workload.

Saskatchewan

The province of Saskatchewan has 12 RHAs, excluding the Athabasca Health Authority and the Saskatchewan Cancer Agency. Two RHAs, Prairie North Health Region and Five Hills Health Region, responded to the survey. Both have processes in place to manage replacement and upgrade of specialized medical equipment that include DI, but they do not have a separate process for DI equipment. In Prairie North Health Region, the process for replacement or upgrade is distinct from that used to equip new or expanded services. Both health authorities noted that they consider different types of devices to replace outdated equipment.

Health authorities in Saskatchewan have a separate process for dealing with unplanned or emergency requests. One respondent noted that a business case is still required to back up the urgency of the request, and it should include alternative options to replacement. The other respondent explained that emergency requests are still considered as capital requests, but as “emergent capital requests,” and that there is a contingency fund for this purpose.

A separate process for dealing with replacement or upgrade of IT components is in place in the Prairie North Health Region, but not in the Five Hills Health Region. In Prairie North Health Region, staff work in collaboration with their IT department to plan and cost projects. The IT project plan must be completed prior to project approval.

Mechanisms to minimize costs and maximize purchasing power include province-wide group purchasing of capital equipment (through the provincial purchasing agency 3sHealth [Shared Services Saskatchewan]).

DI replacement or upgrade requests are submitted prior to budget review. One health authority notes that a five-year plan is presented, when possible. This plan includes the prioritization of equipment requests for the region. Senior leadership,

with assistance from finance personnel, evaluate equipment requests and make final funding decisions. If provincial funding is involved, it follows the same process, with each region presenting their priorities and the Medical Imaging Collaborative Council recommending which equipment should be purchased. Guidelines for this process are in place.

Manitoba

In Manitoba, there is a general process in place at the provincial government level to manage the replacement or upgrade of specialized medical equipment; this is Canada's only province-wide process dedicated to DI equipment. This process is also distinct from that used to procure equipment for new or expanded services.

Different devices are considered when replacing outdated equipment. A separate process is used for urgent replacement of specialized equipment that cannot be repaired and that affects either the delivery of services or patient safety. The health regions submit the required document describing the equipment replacement need and identifying the costs involved. This request is submitted for provincial health department approval. Of the total approved equipment budget, 10% is kept aside for contingency purposes.

IT components of DI equipment follow a separate process. Although these are considered when replacing DI equipment, ongoing upgrade and enhancement of IT systems occur throughout the life cycle of the equipment. This can be challenging and may sometimes be an oversight in the procurement process, as most new DI equipment has some form of IT capacity. The basic types of categories for IT components are:

- Workstation equipment (such as for diagnostics or a picture archiving system)
- Equipment that requires software updates (i.e., an embedded microprocessor; thus, an information and communications technology [ICT] component)
- Equipment that interfaces with an ICT (i.e., storing and/or analyzing data)
- Equipment that uses a local area network (LAN), a wireless LAN, or a wide area network.

The technology infrastructure is a key component of ongoing support for DI equipment. Manitoba has an Infrastructure Renewal Program that focuses on developing a consistent approach to replacing and upgrading old, obsolete, or failing technical infrastructure in health information systems, including DI systems. Its purpose is to provide ongoing investment in the province's ICT infrastructure to ensure Manitoba eHealth has the necessary capacity for provincial and regional health care applications. Priorities for ICT renewal are selected annually by Manitoba eHealth. The current ICT infrastructure is complex, and numerous vendor contracts, hardware and software, and maintenance agreements are in place. Without an ongoing investment in infrastructure, DI applications would be unusable and service disruptions would negatively affect health care delivery.

Manitoba also has mechanisms in place to minimize costs and maximize purchasing power. Requests for proposals are used and the lowest compliant bidder is selected. Manitoba's five RHAs negotiate as a group with potential vendors on price points for the purchase of similar equipment ("bulk purchasing"). DI replacement or upgrade in Manitoba involves two levels of health care: regional and provincial. At the regional level, an annual prioritized list of DI

equipment, categorized by modality (e.g., computed tomography/magnetic resonance imaging [CT/MRI], ultrasound) and by sector is sent to Manitoba Health, Healthy Living and Seniors. The provincial review involves two types of review — first, through four subcommittees that represent each sector: General Radiology, Ultrasound, CT/MRI, and Nuclear Medicine. Each prioritized listing is reviewed and evaluated and a further prioritized list is submitted by each subcommittee to the Provincial Imaging Advisory Committee. The chairperson of each subcommittee presents their requests, and these are reviewed and discussed by the Committee, including assessment of the budget and optimizing DI equipment province-wide.

Ontario

Medical equipment management is decentralized in Ontario and decisions are made at the hospital level. Requests for advanced imaging equipment, such as CT, MRI, or positron emission tomography [PET] scanners, must obtain approval through the Local Health Integration Network.

One survey response, from CHEO, was received from Ontario. Further details of the CHEO process are outlined in a 2014 paper.¹ A second Ontario example, from the published literature, describes the process used at Hamilton Health Sciences.³ At both hospitals, processes are in place to manage and prioritize replacement and upgrade of specialized medical equipment. These processes include procurement of equipment for new and expanded services.

CHEO's survey response notes that there is a separate process for unplanned or emergency requests. This is through a contingency fund that is set aside each year, as part of the capital allocation process. Requests for proposals are used to acquire equipment.

Since 2001, CHEO has operated with a five-year replacement plan for medical equipment. Equipment replacement or upgrade is planned in accordance with available financial resources.

Quebec

Quebec has a provincial-level process in place for replacement or upgrade of specialized medical equipment, but it does not have a separate process in place for DI equipment. This process is different from the one used to purchase new equipment or expanded services. In Quebec, different devices are considered when replacing outdated equipment, and there is no separate process for determining the replacement of IT components. In the event of an urgent replacement request, a distinct process will rapidly call upon biomedical engineering expertise and the affected care unit to determine whether the need is urgent, in which case the device will be replaced. Otherwise, replacement will be prioritized along with other requests.

Group purchasing is used to minimize costs and maximize purchasing power. The provincial ministry of health requires health care institutions to participate in these strategies. Cost-benefit analyses are conducted as part of the process.

New Brunswick

Both of the health authorities in New Brunswick have processes to manage the replacement or upgrade of specialized medical equipment, but there is no separate process for DI equipment. This process is distinct from that of procuring equipment for new or expanded services. The health authorities will consider different devices to replace outdated equipment.

Unplanned or emergency requests are dealt with through a separate process. In Réseau de Santé Vitalité/Vitalité Health Network, a contingency fund is set aside

and this is made available for purchasing if the funds have not already been used. In Horizon Health Network, these requests are part of the capital equipment process, which has a provision for the emergency replacement of certain capital equipment items (depending on the funding available and the criticality of the equipment needing replacement).

Health authorities have a separate process for replacement or upgrade of IT components. In New Brunswick, this comes under the responsibility of Service New Brunswick, which handles IT systems for all government ministries. The RHAs have processes for prioritizing their demands, but Service New Brunswick manages the system-type requests. However, Horizon Health Network noted that there are also two streams through which IT may be considered under capital equipment procurement: one for items with a unit value of less than \$100,000, and another for those more than \$100,000. Horizon Health Network also reported two processes: one for major capital equipment, and one for IT-related technology that is reviewed by an IT prioritization governance committee. Regardless of the process, final approval by the executive leadership team is required.

Mechanisms to minimize costs and maximize purchasing power are used by the health authorities. Capital Equipment Program (CAP) sourcing was mentioned by one health authority. Purchasing power may also be maximized through:

- Participating in national group purchasing initiatives
- Participating in provincial group purchasing initiatives
- Regional (such as the Atlantic Procurement), RHA, or departmental initiatives.

DI replacement is planned using a five-year plan with annual updates, following the annual fiscal budget cycle; funding is allocated annually. Horizon Health Network also factors in CAP sourcing cycles. The process involves prioritization by area, region, and then provincial or national sharing of lists to see if there are opportunities at the higher level (i.e., CAP sourcing). Capital equipment requests of more than \$100,000 must be reviewed and approved by the provincial ministry of health.

Nova Scotia

There is a process to manage replacement or upgrade of specialized medical equipment in the Nova Scotia Health Authority, the sole provincial health authority. As in most other provinces, there is no separate process for DI equipment. Their process is distinct from the one used for procurement of equipment for new or expanded services. Consideration is given to replacing outdated equipment with different types of devices.

Unplanned or emergency equipment replacement requests are dealt with through a separate process. There is also a separate process for replacement or upgrade of IT components. A single, common submission process is used for replacement or upgrade of DI equipment, IT, and capital renovations; however, these requests then follow different routing and have separate funding allocated.

Mechanisms to minimize costs and maximize purchasing power are used. Purchase of multiple devices is consolidated into a single procurement initiative, and standing orders are established to leverage other opportunities. Provincial master service agreements are in place with each original equipment manufacturer.

DI equipment replacement needs are identified at the local facility level. Each facility functions within one of four zones in the Nova Scotia Health Authority. Facility needs are collated within the zone, and a zone departmental priority list is developed. The four zone priority lists are collated at the provincial program level to develop a program priority list. This list is submitted to the Nova Scotia Health Authority for prioritization within the annual business plan submission. This is an ongoing, iterative process within the department, but most of the activity occurs over the late summer or early fall for submission in the annual program business plan in October.

Prince Edward Island

Prince Edward Island (PEI) has a process to manage replacement and upgrade of specialized medical equipment, including DI, but it does not have a separate process specifically to manage DI equipment. The process used is the same as that for procurement of equipment for new or expanded services. Devices of a type different from that of the outdated equipment can be considered for replacement.

A separate process is followed for unplanned or emergency replacement requests. In PEI, most DI equipment is funded through hospital foundations. Urgent equipment replacement is submitted through a different route and, if approved, it is funded by the provincial government.

Replacement or upgrade of IT also follows a separate process and is not funded by the hospital foundations. Once IT requests are approved, they are funded from within the provincial IT budget and the overall health budget.

DI equipment replacement processes include cost minimization procedures. For example, if the plan is to purchase similar equipment in the future, vendors are asked to make a two-year pricing commitment. DI is a provincial service and this allows for awareness of replacement needs and the ability to bundle equipment purchases.

The provincial DI team reviews all equipment requests annually and makes recommendations for equipment replacement. Hospitals all have their own approval process, through which the request must go first. The hospital selection committee will notify its DI department of what has been approved for purchase in the upcoming year and when the request for proposal (RFP) may be posted.

CADTH

Table 2: Medical Equipment Management and Diagnostic Imaging Equipment Replacement and Upgrade Processes: Summary of Responses

Province	Decision-Making Level			Process Type		Procurement		Ancillary Processes		Cost
	Provincial government	Regional health authority	Hospital	General process	DI-specific	Distinct from new equipment	Replace with different device	Unplanned requests	IT process	Cost control process
British Columbia		✓		✓			✓ ^a	✓	✓ ^b	✓
Alberta		✓		✓		✓	✓	✓		✓
Saskatchewan		✓		✓		✓ ^a	✓	✓	✓ ^a	✓
Manitoba	✓			✓	✓	✓	✓	✓	✓	✓
Ontario			✓	✓			^c	✓	✓	✓
Quebec	✓			✓		✓	✓	✓		✓
New Brunswick		✓		✓		✓ ^b	✓ ^b	✓	✓	✓
Nova Scotia		✓		✓		✓	✓	✓	✓	✓
Prince Edward Island	✓			✓			✓	✓	✓	✓

DI = diagnostic imaging; IT = information technology; RHA = regional health authority.

^a In one RHA.

^b Not in one RHA.

^c Depending on the equipment.

2. Prioritization Criteria and Algorithms

Canada

Many criteria cited by the survey respondents correspond with criteria described in the published Canadian literature. The CAR life cycle guidance determined that the following factors are most commonly involved in decisions on DI equipment upgrade or replacement:²

- Life expectancy (including age of the equipment, functionality, and operational costs)
- Prioritization (such as clinical program needs)
- Replacement (safety and efficiency)
- Risk assessment
- Government policies (such as licensing and radiation safety)
- Purchase versus lease of equipment
- Cost recovery
- Revenue potential
- Utilization.²

A 2014 review by the Canadian Association of Nuclear Medicine (CANM) assessed equipment life expectancy for gamma cameras (single-photon emission computed tomography [SPECT] and SPECT-CT), positron emission tomography (PET and PET-CT), and bone densitometers.⁴ The report noted that the term “equipment” includes IT and software components — which become out of date more quickly than the mechanical equipment itself. These components should be updated every five years.⁴ The CANM review includes a life expectancy evaluation tool and scoring scheme to prioritize equipment for replacement.⁴ In addition to the base level values of life expectancy for each type of equipment, the other main elements of the evaluation tool are:⁴

- Maintenance costs
- Manufacturer support
- IT updates
- Material updates
- Anticipated rate of evolution of the technology and/or clinical practices
- Technical obsolescence
- Impact on the health care facility if the equipment fails
- Productivity (whether the equipment can meet the utilization needs of the facility)
- Image quality versus administered dose
- Types of examinations provided.⁴

Scoring for each criteria and sample calculations are also provided in the CANM report.⁴

National Resources Canada is a governmental stakeholder with a focus on resource sustainability. In 2015, ICF International prepared a report titled *Energy Savings Opportunities for Medical Equipment* for the Office of Energy Efficiency at Natural Resources Canada.⁵ Although the implications of energy consumption or potential savings on DI equipment replacement or upgrade were not

suggested by the survey responses or in the literature, this issue may become an important future consideration.

British Columbia

RHAs in BC noted that the following criteria are used in determining funding for DI replacement and upgrade:

- End of manufacturer support
- Frequent equipment failures
- Technological change (in particular, that results in new features or improved safety)
- Volume of patients served
- Geographical distribution and access to services
- Operational impact (workflow, cost, and downstream implications)
- CAR guidelines for replacement
- Equipment cost
- Renovation or construction cost
- Funding and operating budget implications
- Information management and IT requirements
- Patient safety
- Workplace safety
- Service delivery
- Requirements for academic, research, and centres of excellence

The Interior Health Authority developed its own DI equipment replacement guidelines, which are updated annually. The CAR life cycle guidance was used in a recent adjustment of the equipment life expectancies.² In general, most equipment is used until it is no longer supported by the vendor, and sometimes longer. If there is a significant change in the technology, such as dose reduction in CT, the equipment may be replaced earlier. This particular health authority does not use a scoring system to rank DI equipment for replacement, but instead considers the criteria above, and discusses and prioritizes the equipment. The priorities and the rationale are then reviewed by the radiologists.

Input from medical and operational leads was cited by the Northern Health Authority. In this health authority, prioritization of equipment is determined by the Health Services Delivery Area working groups, with input and recommendations from the regional program.

Use of the CAR life cycle guidance² was noted by all of the BC health authorities; however, in times of fiscally restrained capital budgets, this guidance cannot always be followed and much of the equipment is beyond the recommended useful life.

The Vancouver Coastal Health Authority shared its Capital Committee prioritization tool. Each piece of equipment is rated by biomedical engineering staff using the following criteria and scoring system:

1. Strategy (35%)
2. Safety (25%)
3. Obsolescence (10%)

4. Innovation (5%)
5. Financial (15%)
6. Patient outcome (10%).

Alberta

As a provincial organization, AHS has a complete inventory of DI equipment across the province categorized by modality, age, make, service repair frequency, utilization, and cost (including renovation costs). Criteria used to set priorities for replacement or upgrade include:

- Characteristics of the technology
- Patient population and patient demographics
- Budgets and budget options
- Setting
- Acuity of centre served
- Age of equipment
- Repair frequency
- Utilization
- Redundancy
- Cost of equipment
- Cost of renovations
- Service costs
- Equal allocation of equipment across the province
- Risk tolerance
- Cost-benefit.

The American College of Radiology⁶ and CAR guidance² are used to define DI life expectancy. However, to maximize the accuracy of ascertaining life expectancy, other factors — including age of equipment, service frequency, and utilization — are also considered, as well as economic benefit, technology efficiency opportunities, and opportunities for consolidation.

Saskatchewan

The criteria used to decide on funding DI replacement or upgrade in Saskatchewan include:

- Age of equipment
- Repairability or availability of replacement parts
- Utilization based on volume
- Proximity of next available site with the equipment or service
- Budget available
- Services provided.

The CAR guidance and provincial ministry guidelines are used to define DI life expectancy. No formal algorithm is used to integrate or prioritize the criteria. One health authority mentioned that this is determined through general discussion and voting at medical imaging committee meetings, and then sent on to the provincial ministry of health.

Manitoba

At the provincial level, the criteria used to decide on funding DI life expectancy and to prioritize for replacement or upgrade in Manitoba include:

- Characteristics of the technology
- Volume of utilization or demand (including the patient population)
- Age of equipment
- Vendor support
- Maintenance and repair records (cost, number of times the equipment was not available)
- Number of similar equipment available, or if in a rural setting, the proximity to the nearest centre where the equipment is available.

No formal algorithm is used to integrate criteria. Each region prioritizes its equipment list before submitting it to the provincial department for approval. The province does not reprioritize the items on the list. The criteria and considerations for departmental funding include:

- Justification between the equipment request and patient outcomes (i.e., volume or patient safety)
- Equipment cost
- Construction and ICT costs associated with the equipment
- Operating implications
- Quantity requested.

The WRHA uses the following prioritization criteria as a tool to rank equipment requests prior to submitting them to the Provincial Imaging Advisory Committee:

- Estimated end of life (based on CAR guidance² incorporating both age and utilization)
- Manufacturer and vendor support
- Reliability and condition of the equipment
- Clinical capability of the equipment
- Patient impact if equipment is down (incorporates both usage and availability of backup).

Equipment is prioritized and submitted on a year-by-year basis. There is not yet a formal five-year plan for WRHA DI equipment, but it is a work in progress, in collaboration with Diagnostic Services Manitoba (DSM). The DSM uses a similar, but less formal process in that they do not assign points or scores for the criteria (personal communication: Rebecca Austman, WHRA; 16 Feb 2016). Other work in Manitoba led to the development of a Medical Equipment Replacement Scorecard (MERS),⁷ based on a previous scorecard used in the Northwest Territories.⁸

The Manitoba scorecard allows objective criteria to be combined with “subjective prioritization,” the use of amortization data from the equipment inventory database, and technology assessment information (as needed).⁷ One of the benefits of such a system is that it allows for early awareness of equipment approaching the end of its lifespan, ensuring there is time to properly assess the technology and the replacement options.⁷ The Northwest Territories MERS paper notes that replacement planning needs to occur about two years before the end of the equipment’s lifespan to allow time for budget planning and approval.⁸

The MERS system also makes the complex elements of equipment replacement planning more manageable. Although it is not specifically for DI equipment, the Manitoba MERS uses the following criteria:

- Age of equipment
- Reliability
- Risk and safety
- Alerts or hazards
- Availability of replacement and backup equipment
- Manufacturer support for the equipment
- Critical importance of the equipment
- Maintenance history and costs.⁷

The MERS scoring system is shown in Appendix 3.

Ontario

CHEO's survey response listed criteria used at its hospital to determine DI replacement or upgrade:

- Legal considerations, patients and staff safety and risk management
- Long-term corporate priorities
- Technological or material obsolescence. Age of equipment, physical condition, and reliability
- Impact on productivity and service delivery
- Impact on patient experience
- New technology. Best-practice
- Impact on staff work and life
- Whether the item is listed on the five-year plan, and which year it is to be replaced.

The budget for equipment is determined through market research. The CAR life cycle guidance² was not mentioned as a source for determining the life expectancy of DI equipment; however, the American Hospital Association guide, *Estimated Useful Lives of Depreciable Hospital Assets*,⁹ was cited.

Further information on the CHEO criteria for prioritizing equipment for replacement is outlined in a recent paper by Greenwood et al.¹ The article describes the development of the hospital's technology management program, based on work by Groupe Vega in Quebec hospitals during the 1990s. It began with an analysis of the corporate strategic plan and identification of the equipment required for new services and programs. The next steps were compiling an inventory of all clinical capital equipment, and conducting interviews with clinical stakeholders. Seven criteria were used (each with a score of up to 100 points) to rank priorities:

1. Legal considerations: patient and staff safety and risk management
2. Corporate priorities
3. Technological obsolescence or material
4. Impact on productivity and service delivery
5. Recruitment and retention of clinicians
6. New technology
7. Teaching requirements.¹

Once the scoring and ranking have been completed, the following three components of the long-range technology management plan can be developed:

1. **The theoretical replacement plan:** the estimated life expectancy of the existing inventory of clinical equipment. CHEO uses the American Hospital Association guide⁹ and the hospital's experience to estimate life expectancy. The actual age of each piece of equipment is subtracted from the estimated life expectancy to determine the remaining theoretical life expectancy projected for the next five years.
2. **The emerging technology plan:** this involves assessment of emerging clinical technologies identified through the stakeholder interviews, review of the corporate strategic plan, and prioritizing the technologies identified in a "fair and equitable manner."
3. **The fleet equipment plan:** this involves classifying similar equipment into categories to "better manage their use, maintenance, standardization, and replacement."¹

Several advantages of this long-range planning have become apparent over the three planning cycles completed to date. These include improved equipment standardization, a reduction in the average age of clinical equipment, and a substantial reduction in the contingency funds required (from an initial 15% to 25% to currently 5% of the overall budget).¹

Another article from Ontario outlines the Hamilton Health Sciences centre prioritization plan for replacing medical equipment (not specifically for DI) based on data rather than subjective information.³ The plan starts with an assessment of the equipment inventory and assigning a score for each criterion that can enable ranking by replacement priority. This process can also be used to identify priorities for using contingency funding. The paper presents a case study from Hamilton Health Sciences' Perioperative Services.³ The department's master equipment database was used to create a static spreadsheet that can be sorted by different categories. This was used to create a "Priority Index" list with scoring values for each (Appendix 2). The Priority Index score assumes that the criteria are of equal value. However, an individual criterion can be given additional value, if desired, for a Weighted Priority Index score. Details of weighting are described in the case study.³

More expensive items need to be highlighted for replacement sooner as these are both more costly and likely to be more important. Also, requests for higher-priced items, such as equipment costing more than \$100,000, may be considered by different committees.³

The Hamilton Health Sciences centre article cites the following criteria:³

- Use (physical wear and tear on the equipment, and utilization)
- Physical condition of the equipment
- Risk
- Failure or repair history
- Product discontinuation
- Age of the equipment and vendor support
- How the equipment is used, how much, and the quality and condition of the unit
- Failure rate

- Comparability of the equipment to new products that may offer increased efficacy or efficiency
- Risk factors
- Importance of the equipment to service delivery.³

Quebec

At the provincial government level, the criteria used to determine DI equipment replacement and upgrade include:

- Age or obsolescence of the technology
- Cost of maintenance
- Cost of replacement
- Criticality of the equipment
- Utilization
- Impact on health care personnel
- Impact on patient health.

The life expectancy of DI equipment is based on guidance from l'Association des médecins et ingénieurs biomédicaux du Québec. Cost-benefit analyses are conducted for all DI equipment to determine the end of their useful life, and for all new equipment to assess their potential to improve performance.

New Brunswick

The criteria used to determine DI equipment replacement and upgrade include:

- Age of the equipment
- Utilization (present and projected for the future)
- Cost of equipment installation and renovations needed
- Staffing resources
- Budget or funding available
- Clinician or service needs
- Patient safety
- Risks to staff in operating the equipment
- Availability of alternate equipment and technology
- Operational efficiency
- Cost reductions associated with equipment replacement
- Regulatory or accreditation requirements
- Impact on patient care
- Access to services
- Strategic plan
- Urgency of request.

CAR life cycle guidance² is used to determine DI equipment life expectancy, as well as professional or medical specialty publications, clinical engineering reports, and vendor information on service and equipment performance. No formal algorithm is used to integrate the criteria.

While most DI equipment requests are submitted for major capital equipment funding, some will be sent to foundations for their consideration. When equipment approaches the end of its life, planning for its replacement begins. If the use of this type of equipment is still justified, the health authority considers whether replacement of a part can suffice, or whether new equipment would be more efficient.

Nova Scotia

The criteria used to determine DI equipment replacement and upgrade include:

- Age and condition of equipment or end of life or obsolescence
- Advantages of newer technology (e.g., functionality, efficiency, and effectiveness)
- Manufacturer support for the technology
- Risk of adverse events to patients
- Clinical impact of the technology
- Patient demographics, population health impact, and population served
- Patient flow impacts
- Availability of backup equipment or geographic proximity to similar equipment
- Impact of not replacing or upgrading equipment on patient care services
- Net new operational cost and staffing implications (full-time equivalents) — cost savings or increase

Life expectancy is a factor in equipment planning. The CAR life cycle guidance² is used by the Nova Scotia Health Authority.

Nova Scotia has an online submission process for capital equipment requests. Once the information — based on the previously cited criteria — is submitted, this tool automatically scores the request using a pre-set scoring algorithm and weighting. Submissions are then ranked by score, and the highest scoring submissions are assessed by the Nova Scotia Health Authority Capital Committee for final budget allocation.

Prince Edward Island

The provincial diagnostic imaging team uses the following criteria for DI equipment replacement or upgrade:

- Age of equipment or end of life
- Number of procedures performed
- Service issues.

The CAR life cycle guidance is used when considering equipment replacement.² A summary of the main criteria mentioned by survey respondents is shown in Table 3.

Table 3: Summary of Criteria Used by Survey Respondents for Diagnostic Imaging Equipment Replacement and Upgrade

<ul style="list-style-type: none"> • Technological change or obsolescence (for example, new features, improved safety or image quality) • Manufacturer or vendor support (or end of support) and availability of replacement parts • Repairability and support for the equipment (can the vendor or biomedical engineering ensure reasonable uptime?), as well as frequency of equipment failures or repair • Utilization, demand, volume of patients served, patient population, and redundancy • Setting, geographical distribution, access to services across service area or province, and availability of similar equipment in-house or nearby if needed • Age of equipment, physical condition of equipment, Canadian Association of Radiologists equipment life expectancy estimates, and high or low usage • Cost of equipment • Cost of repair and maintenance • Cost of renovation or construction • Cost-benefit • Cost of service • Cost and other requirements of information management and information technology • Budgets, operating budget implications, and funding • Risk assessment, safety for patients and staff, and legal considerations • Service delivery, operational impact or efficiency workflow, productivity, downstream implications, and staffing implications • Need to support academic, centres of excellence, research, institutional or corporate priorities • Criticality of the equipment (clinical impact on patient health and impact on health care staff)
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Information Sources

The survey also sought to identify the types of information used to inform decisions about DI equipment replacement or upgrade. As shown in Table 4, a variety of sources are considered. Interestingly, no single source of information is used by all respondents. Most provinces reported using manufacturer information and clinical practice guidelines. Business cases are often required to support the acquisition of replacement equipment.

Table 4: Types of Information Used to Inform Diagnostic Imaging Equipment Replacement or Upgrade Decisions

Province	In-house business case	HTAs and or SRs	Peer-reviewed clinical and/or economic studies	Non-peer-reviewed clinical and/or economic studies	Information provided by manufacturer	CPGs	Consultant report
British Columbia	✓	✓	✓	✓	✓	✓	✓
Alberta	✓	✓			✓	✓	
Saskatchewan	✓		✓		✓	✓	
Manitoba						✓	
Ontario	✓	✓	✓		✓	✓	✓
Quebec	✓	✓	✓	✓	✓	✓	
New Brunswick	✓	✓	✓		✓	✓	✓
Nova Scotia	✓	✓	✓		✓	✓	✓
Prince Edward Island		✓			✓		

CPGs = clinical practice guidelines; HTAs = health technology assessments; SRs = systematic reviews.

Alternative Settings

Following a decision in favour of replacing a capital medical device, further decisions may need to be made regarding the most appropriate setting for the new equipment. Survey respondents noted that a number of circumstances may result in a change of setting for DI equipment. These are shown in Table 5.

Table 5: Situations That Can Lead to a Change of Setting for Diagnostic Imaging Equipment Replacement

Province	Changes in staff requirements	Changes in installation requirements	Changes in demand for services	Other	None ^a
British Columbia	✓	✓	✓	✓ ^b	✓
Alberta	✓		✓	✓ ^b	
Saskatchewan	✓	✓	✓		
Manitoba		✓	✓		
Ontario	✓	✓	✓		
Quebec	✓	✓	✓		
New Brunswick	✓	✓	✓		
Nova Scotia		✓	✓	✓ ^b	
Prince Edward Island			✓		

^a I.e., setting for replacements must remain the same.

^b Other: for example — notice of end of support from vendor, sudden catastrophic failure, new technology, recognition of best clinical practice, repair frequency, utilization, purchasing opportunity, or change in facility health services plan or services within a region.

Limitations

The findings of this Environmental Scan are not intended to provide a comprehensive review of the topic, but rather to present an overview of current processes used for decisions concerning the replacement, upgrade, and funding of DI equipment in Canada. The Scan does not provide information about the federal or provincial legal or regulatory context surrounding DI equipment replacement, including safety or quality inspections, accreditations, and audit aspects. Not all jurisdictions or provincial RHAs responded to the Environmental Scan survey, so the results may not provide a complete representation of processes throughout Canada. In particular, the information from two hospitals in Ontario may not reflect the processes used at other centres in the province. Following up with individual key respondent interviews, as was done for the CAR life cycle guidance survey, may have provided further useful information. Nevertheless, the survey responses provide examples of current processes and criteria used for DI equipment replacement and upgrade at various levels of health care across Canada.

Conclusions

Across Canada, DI equipment replacement and upgrade decisions generally follow the same processes used for other specialized medical equipment. Most survey respondents mentioned the use of contingency funds for emergency replacement requests. In general, this was still considered within the overall process for equipment replacement, although the decisions may be made by executive management or by a capital steering committee. IT and software are usually funded through a separate budget, and these typically go through a distinct prioritization process, although the departments or staff involved work together. However, some jurisdictions noted that these processes have recently been integrated.

The use of group purchasing organizations was mentioned by several respondents from different provinces. Group purchasing may be done at the national level, through provincial group purchasing, and at the RHA or hospital level. For example, Health Shared Services BC is the provincial purchasing agency that contacts vendors and arranges RFPs on behalf of the health regions. Organizations may either issue RFPs directly or join a group purchasing organization. Several jurisdictions also mentioned bundling equipment purchases or issuing RFPs to reduce equipment purchase costs.

Most of the jurisdictions that participated in this survey reported an annual process for medical or DI equipment replacement that corresponds with budget cycles. Some respondents mentioned an overall five-year plan or cycle (with annual submissions or recommendations for replacement). When purchasing through RFPs, Alberta reported generally using a three-year time period. In BC, requests are submitted in January or February for the following fiscal year (i.e., 15 months away). CHEO follows a similar cycle in its Capital Priority Process. Much of the prioritization and, in some provinces, the funding of DI equipment, is managed at the regional or local level. In other provinces, funding decisions are made at the provincial level such as in Alberta, Manitoba, Nova Scotia, Quebec, and PEI.

Various types of information (e.g., from manufacturers, business cases, health technology assessments, and clinical practice guidelines) are considered as part of the decision-making process in most jurisdictions. Likewise, various circumstances, notably changes in installation requirements and demand for services, can lead to replacement DI equipment being installed in a different setting.

Although the processes vary across Canada, and sometimes within jurisdictions, the criteria used to determine DI equipment replacement and upgrade are similar. This is true regardless of the level of health care. These criteria were also identified in the published literature, including articles from Ontario,³ Manitoba,⁷ and the Northwest Territories,⁸ as well as in the CAR life cycle guidance.² Working within current budget restraints does not allow many organizations to fully follow the CAR life cycle guidance; however, the guidance is clearly well recognized and used across Canada.

While the prioritization criteria and processes for replacing or upgrading DI equipment were captured fairly well by the survey, information on how final funding decisions are made is less apparent.

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Appendix 1: Diagnostic Imaging Equipment Replacement and Upgrade: Survey

A. Medical Equipment Management

1. **In your organization, is there a process to manage or prioritize the replacement or upgrade of specialized medical equipment — including diagnostic imaging (DI) — involving a large capital outlay (e.g., more than \$10,000)?** Please answer by replacing the circles with an “X”.
 YES NO
2. **If YES, is there a separate process used to replace DI equipment?**
 YES NO

B. Diagnostic Imaging Replacement and Upgrade Process

Complete this section only if you have answered YES to Question 1.

3. **Is the process for replacement or upgrade distinct from that of procurement of equipment for new or expanded services?**
 YES NO
4. **Does your organization consider significantly different devices to replace outdated equipment (e.g., point-of-care devices replacing central imaging devices)?**
 YES NO
5. **Is there a separate process for dealing with unplanned, immediate requests?** If YES, please describe.
 YES NO
6. **Is there a separate process for replacement or upgrade of information technology (IT) components (i.e., software, communication, and processing modules)?** If yes, please describe the process and how IT implications are addressed.
 YES NO
7. **In your organization, do DI replacement processes include any processes or mechanisms for minimizing costs or maximizing purchasing power?** If YES, please briefly describe.
 YES NO
8. **Please describe how DI replacement or upgrade is planned in your organization and what timelines are involved.** If the process comprises multiple levels (i.e., local, regional, provincial), please outline them.

C. Prioritization Criteria and Algorithms

9. **If processes for DI replacement or upgrade exist, what criteria or principles are used to decide on funding?** These can include aspects related to the technology, patient population, budgets and the setting, or other considerations.
10. **What kinds of clinical or economic information (if any) are used to inform replacement or upgrade decisions?** Select one or more of the following by replacing the boxes with an “X”:
- In-house business case
 - Health technology assessments or systematic reviews
 - Peer-reviewed clinical or economic studies
 - Non-peer-reviewed clinical or economic studies
 - Information provided by manufacturers
 - Clinical practice guidelines
 - Consultant report
 - Other (*Please describe in the box below*)
11. **Please indicate what general guidelines and principles are followed to define DI device life expectancy, should it be a consideration for replacement or upgrade in your organization.**
12. **Please describe the method or algorithm used to integrate all criteria and considerations into your prioritization and funding scheme.**
13. **Please indicate all situations in your organization that can lead to a change of setting for an equipment replacement.** Select one or more of the following by replacing the boxes with an “X”:
- Changes in staff requirements
 - Changes in installation requirements
 - Changes in demand for services
 - Other(s):
 - None — setting for replacements must remain same.

Appendix 2: Hamilton Health Sciences Biomedical Technology Priority Index & Scoring

Priority Index (Maximum Value = 23.27)

Criteria	Value	Description	Score
Price	1 to 5 (5 is highest): 5 = > \$100,000 4 = > \$50,000 3 = > \$25,000 2 = > 10,000 1 = > 0	Equipment with higher capital value should be flagged sooner based on difficulty in obtaining funding and also an indication of relative importance.	
Condition	1 to 5 (5 is very poor): 1 = very good 2 = good 3 = fair 4 = poor 5 = very poor	The condition indicates possible need for replacement based on function, safety, and efficacy.	
Support	1 to 5 (5 is out of support): 1 = fully supported 2 = supported 3 = nearing end of manufacture or sale 4 = nearing end of support 5 = out of support	The vendor's ability to support the equipment's use, service, and parts availability determine a device's practical life expectancy.	
Age	1 to 6 (6 is oldest): 1 = > 0 years 2 = > 3 years 3 = > 5 years 4 = > 10 years 5 = > 15 years 6 = > 20 years	Condition is important but can be difficult to determine accurately. Age in years can indicate when components are more likely to fail due to wear and age. (Additional score of 6 is to cover the few devices that have extraordinary lifespans of more than 20 years.)	
Labour	0 to 5 (based on average hours labour): 0 = 0 average hours 1 = > 0 average hours 2 = > 1 average hours 3 = > 2 average hours 4 = >3 average hours 5 = >4 average hours	The biomedical or vendor hours spent on a device indicate the attention it has required for repair and/or maintenance (with or without parts being replaced). It may indicate how problematic a device is. It is calculated by taking the life-to-date hours divided by the age in years, and adjusted to factors of 0 to 5.	
Parts	0 to 5 (based on average parts cost as a % of cap value): 0 = 0% 1 = > 0% 2 = > 1% 3 = > 2% 4 = > 3% 5 = > 4%	The accumulated cost of parts purchased may indicate the equipment's replacement priority. The value is represented as a percentage of the capital cost and given a factor of 0 to 5 based on the average percentage.	

Criteria	Value	Description	Score
Risk	0 to 5 (based on relative risk levels) 0 = 0 1 = > 0 2 = > 20 3 = > 40 4 = > 60 5 = > 80	The risk level of devices in hospitals is usually recorded in the equipment database. It is derived using factors such as function, consequence, lethality, frequency of use, required maintenance, and protective safeguards. It ranges from 0 to 89 and is adjusted to factor of 0 to 5.	
Utilization	0 to 5 (5 is very frequent use): 1 = very infrequent 2 = infrequent 3 = moderate 4 = frequent 5 = very frequent	The amount of use that equipment receives is proportionate with its priority of replacement. More use adds wear and tear, demand for use, and better justification for the cost of replacement. Clinical managers were asked to assign these numbers. Frequency of use is subjective and should be considered based on the type of equipment — is its use minimal or excessive based on what type it is?	

Reproduced with permission: Capuano M. Prioritizing equipment for replacement. *Biomed Instrum Technol.* 2010 Mar-Apr;44(2):100-9.

Appendix 3: Medical Equipment Replacement Scorecard

Manitoba MERS Scorecard ^{7,8} (Total MERS score from 1.0 to 55)	Score
Technical component score = (Condition/Reliability + Lifespan) x Discontinuation	
Medical equipment condition or reliability subcomponent:	
1 – very good (no reliability issues) 2 – good (minor service issues) 3 – fair (increased service issues. Perhaps standardization beneficial, lack of essential safety features) 4 – poor (excessive maintenance support) general principle: if service cost is 50% of the value of the device, it may need to be replaced) 5 – unsafe (decommission or replace)	
Medical equipment lifespan subcomponent:	
0 – age < 3 years 1 – age 4 to 5 years 2 – age 6 to 7 years 3 – age 8 to 9 years 4 – age 10 years 5 – age > 10 years For devices with a lifespan of less than 10 years, pro-rate. Two years prior to purchase of a new item, consider health technology assessment.	
Product discontinuation multiplier subcomponent (relates to manufacturer support):	
1 – manufacturer support available 1.3 – end of support date issued by manufacturer 1.7 – < 2 years of support left from manufacturer 2 – no manufacturer support (no parts, training, or consumables or expertise available)	
Device safety component score (Physical risk x TRI multiplier) (total device safety score is from 1 to 20)	
Physical risk subcomponent (clinical risk should the device fail):	
5 – possible patient or operator death 4 – possible patient or operator injury 3 – possible inappropriate therapy or misdiagnosis 2 – possible delay in therapy or diagnosis 1 – limited to no risk	
TRI quantifiers (the potential of the equipment to cause harm. Based on 5 common alert recalls from the manufacturer, Health Canada, FDA, ECRI, and MHHL):	
1 – no known incidents, alerts or recalls 2 – minor manufacturer recall where some or no corrective action is required 3 – minor Health Canada, FDA, ECRI, MHHL notification 4 – documented regional health authority incident that could have resulted in a patient safety issue	

Manitoba MERS Scorecard ^{7,8} (Total MERS score from 1.0 to 55)	Score
5 – important safety notification documented manufacturer, Health Canada, FDA, ECRI, MHHL alert that if immediate action is not taken, patient or operator safety could be compromised	
Mission critical component score (the impact of having or not having the device in service = Mission x Backup)	
Mission critical subcomponent:	
1 – zero-impact devices (extremely limited impact on providing health services) 2 – low-impact devices (equipment which, if there is a failure, would be inconvenient but have limited impact on providing therapy or diagnosis [e.g., electronic thermometers]) 3 – general service–related devices (equipment which, if there is a failure, could result in problematic issues for clinical users but do not require extreme administrative intervention measures to rectify [e.g., pulse oximeters, vital signs monitors]) 4 – mandatory service–related devices (equipment which, if there is a failure, could result in problematic issues for the facility and result in extreme system-wide efforts on the part of clinical users as well as administrative and support staff to rectify [e.g., portable X-ray equipment, physiological monitors, lab devices]) 5 – Priority Service–Related Devices (equipment which, if there is a failure, would result in the loss of a critical primary service and result in non-scheduled medical evacuation of patients [e.g., anesthesia machines, defibrillators, ECG machines, X-ray rooms])	
Backup technology multiplier (necessity of medical device based on whether backup is available):	
1 – if necessary medical device is available 2 – if no backup medical device is available	

ECG = electrocardiogram; MERS = Medical Equipment Replacement Scorecard; MHHL = Manitoba Health, Healthy Living and Seniors; TRI = technology-related incident.
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Appendix 4: Information on Survey Respondents

Table 6: Provinces and Organizations That Responded to the Survey

Province	Organization
Alberta	<ul style="list-style-type: none"> Alberta Health Services
British Columbia	<ul style="list-style-type: none"> Interior Health Northern Health Vancouver Coastal Health Vancouver Island Health Authority
Manitoba	<ul style="list-style-type: none"> Manitoba Health, Healthy Living and Seniors
New Brunswick	<ul style="list-style-type: none"> Horizon Health Network (2 responses) Réseau de Santé Vitalité
Nova Scotia	<ul style="list-style-type: none"> Nova Scotia Health Authority
Ontario	<ul style="list-style-type: none"> Children's Hospital of Eastern Ontario
Prince Edward Island	<ul style="list-style-type: none"> Health PEI
Quebec	<ul style="list-style-type: none"> Ministère de la Santé et des Services sociaux
Saskatchewan	<ul style="list-style-type: none"> Five Hills Health Region Prairie North Health Region