

Issue Brief

Critical Infrastructure in Canada's Health Sector Part A – Surveying the Landscape

2017

Modern society depends on robust and resilient critical infrastructure. Our health system relies on energy, water, transport, information and communications technology, and other services, just as those sectors depend on essential services from health organizations and providers. Interdependencies within and between sectors are becoming increasingly complex. The rate and severity of natural disasters is also increasing, as is our overall connectivity and dependence on information and communication technologies¹.

Understanding and mitigating risks posed by potential hazards is essential to the resilience of our critical infrastructure. This requires an integrated perspective since vulnerabilities in one area can have cascading effects across organizational boundaries, sectors, and borders.

Our Approach

A HealthCareCAN Steering Committee formed to guide the development and implementation of a Health Sector Critical Infrastructure Network under the auspices of Canada's National Strategy for Critical Infrastructure oversaw the preparation of this *Issue Brief*. In addition to advice from members of the Steering Committee, key inputs included:

- A rapid review of the literature on critical infrastructure in the health sector, with a focus on cybersecurity;
- A survey of HealthCareCAN members conducted between November 2016 and February 2017 (24 responses for a response rate of 46%);
- Key informant interviews with health sector leaders across the country, authorities on critical infrastructure and emergency preparedness; and cyber-security experts; and
- Validation of outcomes with selected interviewees, members of the Steering Committee, and HealthCareCAN's Board of Directors.

Critical Infrastructure and Canada's Health Sector

The health sector both operates and uses key elements of the country's critical infrastructure. Natural, intentional, and accidental hazards can affect this capacity. For instance, many of the 174 significant natural disasters tracked by Public Safety Canada over the last decade – floods, wildfires, storms, epidemics, and more – have affected the health sector's operations and tested its resilience.ⁱ Similarly, human-generated hazards (e.g., human errors that affect the power grid, malware attacks on computer systems, or bioterrorism) could harm health system infrastructure, threatening the health and safety of Canadians.

Issue

Our health system depends on robust and resilient critical infrastructure. Understanding and mitigating risks posed to our health system by potential hazards is essential to the resilience of our critical infrastructure.

HealthCareCAN has prepared this *Issue Brief* for the Health Sector Critical Infrastructure and Cyber Security Steering Committee (under the auspices of the National Strategy for Critical Infrastructure).

Part A of this *Issue Brief* provides an overview of critical infrastructure in the health sector in Canada and beyond. Part B of the *Issue Brief* focuses specifically on cybersecurity considerations.

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i. Individual events have involved evacuations of up to 100,000 people and costs to governments and insurance companies of up to \$2.2 billion. Source: [Canadian Disaster Database](#).

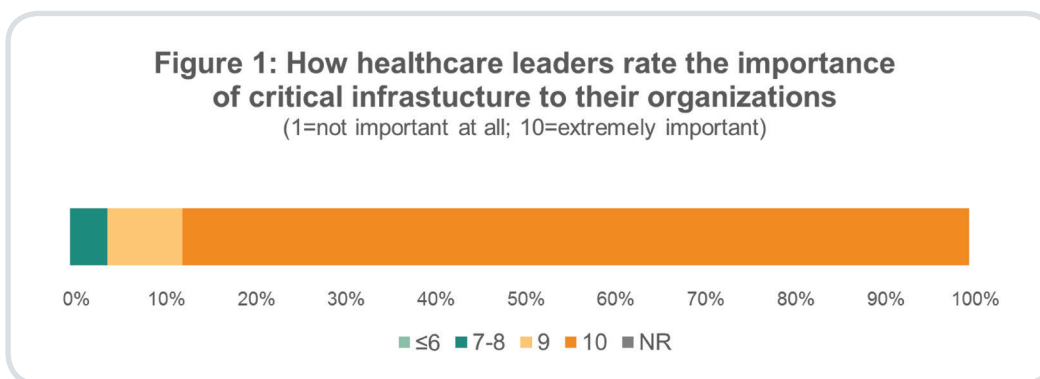
The impact on the health sector of different types of events varies. Some also have multiplier effects, simultaneously triggering increases in local demand for care and reductions in service capacity. Risk assessments and modeling can help clarify relative risks. For instance, RAND Corporation – a public policy research organization based in California – assessed the extent to which a variety of scenarios would affect the blood system in the United States ². Considering the likely magnitude of impact, the short-term and long-term reserve vulnerability, and the national system absorption capacity, the authors estimated that a global pandemic would have a higher overall risk for the blood system than a terrorist attack or natural disaster.

Almost 9 in 10 health leaders say that critical infrastructure is extremely important to their organizations (see Figure 1).ⁱⁱ The scope of what survey respondents included in this assessment varied. Some defined critical infrastructure as including both physical and digital assets key to the safety/security of the organization and delivery of services, some included digital assets only, and others interpreted the term in the context of ensuring the continuity of their operations.

For comparison, Public Safety Canada’s definition of Critical Infrastructure is provided:

Critical infrastructure: Processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence. (Public Safety Canada)

Key informants raised several examples of events that did not involve disasters but nonetheless affected health system critical infrastructure. For instance, Royal University Hospital in Saskatoon experienced an unexpected partial failure of power distribution equipment in June 2014 during planned electrical upgrades. The outage affected medical systems (suction, medical air), critical ventilation and heating equipment, steam services (supporting hot water, heat, and surgical instrument sterilization), and parkade elevator services.



From a systems perspective, critical infrastructure tends to be defined broadly, with interdependencies and linkages across infrastructure elements and sectors. Public safety stakeholders tend to focus on emergency preparedness when defining critical infrastructure, but health sector stakeholders also define critical infrastructure in terms of the ability to ensure continuity of high quality health services. From this perspective, protecting critical infrastructure is not only about preparing for hazards, but is also about mitigating risks, wherever they reside. One respondent went so far as to define critical infrastructure as “anything that would have an impact on the delivery of services or put our patients at risk.”

The hospital initiated emergency response protocols and executed contingency plans. These led to rescheduling planned/scheduled surgeries in the short-term and equipment maintenance and contingency plan updates to improve longer-term preparedness and resilience.

Likewise, two large hospitals in St. John’s, Newfoundland experienced issues that affected care in the winter of 2015-16. In their case, brown staining on surgical instruments and associated packaging prompted an extensive investigation, postponement of elective surgeries, and new sterilization protocols. While the issues were determined to be aesthetic rather than safety-related, their cause could not be proven definitively. One hypothesis was that contaminants from freeze-thaw may have entered the municipal water

ii. Based on a survey of HealthcareCAN members conducted between November 2016 and February 2017. There were 24 responses to the survey, a response rate of 46%.

supply and affected the sterilization process. As in Saskatoon, resolving the situation required deep engagement of clinical teams, regional leadership, a variety of internal and external experts, and many other individuals and organizations.

Understanding Health System Critical Infrastructure Interdependencies

Critical infrastructure resilience depends on a series of steps undertaken at macro, meso, and micro levels to protect against different types of natural, accidental, and intentional hazards. While these steps create layers of defense, each has the potential for failure. Ideally, weaknesses in one area are balanced by strengths in another, reducing the chances that a hazard will impact patients and communities. For example, strategies that foster societal resilience – including the creativity and adaptive behaviour of individuals and groups – may enable effective decision-making in the immediate aftermath of an emergency situation³.

In this respect, there are parallels with efforts to understand and improve patient safety. As James Reason describes in his “Swiss Cheese Model” of system failure, an error may mean that a problem passes through a hole in one layer, but if the holes in the next defensive layer are in different places, it will catch the problem before it causes harm⁴. Some holes arise through active failures, while others reflect latent conditions in the environment.

Protections and risks outside of the health sector also affect health’s resiliency, given the many interdependencies and linkages with other critical infrastructure sectors. Examples include:

Water

Effective functioning of this sector is essential to public health in general and any failures would immediately affect health sector operations (e.g. because of need for sterile conditions, cleaning, and waste disposal);

Energy

Energy is required to power medical equipment and devices, as well as to heat and light health facilities (note: even when facilities have back-up electricity generators, they can still be affected by prolonged electricity grid failures since for many, the backup power window is shorter than what would be required in a significant critical infrastructure incident);

Information and Communications Technology

The organization and delivery of health services relies increasingly on computer-based assets and networks, as well as communications infrastructure;

Transportation

Roads and other transportation infrastructure provide access to health facilities for patients and families, health care providers, and essential supplies (e.g. moving supplies from an area with resources to a region where an emergency has exhausted resources), as well as ensuring that home and community care staff can reach those they care for; and

Manufacturing

Many health services depend on ready access to supplies such as pharmaceutical products and medical equipment, some of which are sourced from outside of Canada, an increasingly important consideration for emergency planning given growth in the use of ‘just-in-time’ supply chain management⁵.

Failures in these sectors directly affect the operation of health services and may change needs for care. They also affect the lives of the people who work in the health sector, influencing their ability to deliver high quality care and their capacity to respond to challenges affecting their workplace. Where physical, digital, geographic, or logical links between sectors are tight, they may offer little or no flexibility to respond to changes or failures⁶. This can worsen problems or cascade the impact of infrastructure failures from one sector to another.

Canada’s Critical Infrastructure Strategy and Action Plan

Endorsed by all federal, provincial, and territorial governments, Canada’s [National Strategy for Critical Infrastructure](#) aims to “build a safer, more secure and more resilient Canada.” It focuses on ten key sectors – including health. The strategy advocates for a collaborative approach that includes appropriate security provisions, business continuity practices, and emergency management planning. Key elements of include:

- **Building partnerships** to enable and support critical infrastructure resiliency including a forum for collaboration and communication across sectors as well as sector-specific networks;
- **Implementing an all-hazards approach to risk management** (defined by the strategy as “the continuous, proactive, and systematic process to understand, manage, and communicate risks, threats, vulnerabilities and interdependencies across the critical infrastructure community”);

- **Sharing and protecting information among key stakeholders** before, during, and after disruptions or emergencies to promote effective risk management and identify/address interdependencies.

This Strategy is consistent with international disaster risk reduction efforts, such as the United Nations' [Sendai Framework for 2015-30](#). This framework emphasizes the importance of understanding disaster risk, strengthening governance, investing in disaster risk reduction for resilience, and enhancing preparedness for effective response and to ensure effective recovery, rehabilitation, and reconstruction.

For Canada, the more detailed [Action Plan](#) for 2014-2017 identifies specific steps to deliver on this strategy, as well as associated timelines. This includes the development of tools and capacities from which all sectors can benefit, including a Critical Infrastructure Gateway for information sharing, support for resilience assessment, and exercises to strengthen readiness and response efforts. See the *Find Out More* section at the conclusion of this brief for information on some of the *Action Plan* resources relevant for the health sector.

Under the *Action Plan*, each sector develops and maintains its own sector network. These networks promote timely information sharing; identify issues of national, regional, and/or sectoral relevance; leverage subject matter experts to provide guidance on current and future challenges; and develop/share tools and best practices for risk prevention, mitigation, preparedness, response, and recovery. The Public Health Agency of Canada is the identified federal lead for the health sector.

The State of the Health Sector's Critical Infrastructure

To better understand the current state of the health sector's critical infrastructure, we undertook key informant interviews with health, government, and emergency management leaders from across Canada. They told us that a core set of preparedness activities are undertaken on a broad basis. For instance, Accreditation Canada standards include priority processes related to emergency preparedness to plan for and manage emergencies, disasters, or other aspects of public safety. One element requires that "an incident management system is developed and implemented to direct and coordinate actions and operations during and after disasters and emergencies." Likewise, many interviewees

described participating in [pandemic preparedness](#) planning and other activities focused on rare but significant scenarios.

Beyond this core, there is wide variation in the priority and resources devoted to understanding and mitigating potential risks to critical infrastructure, as well as resilience in the face of critical infrastructure challenges. This variation persists both within the health sector and in terms of its collaboration with other sectors. In some cases where jurisdictions have systematic health infrastructure risk assessments, there have been efforts to learn from past events (e.g. from the [Lac-Mégantic rail disaster](#)), and regular cross-sector preparedness exercises have been scheduled. But these activities are not employed consistently across Canada and in some cases involve only specific stakeholders. Learnings from these exercises are often only shared on a local or regional basis.

Interviewees identified a number of common areas of critical infrastructure vulnerability. Aging physical and technological infrastructure were cited as a key risks by most of those consulted. While some noted significant investments made in selected facilities in recent years (e.g. hospital building re-development), the variable nature of capital spending and challenges in prioritizing replacement of some types of 'invisible' infrastructure – such as boilers and communication systems – were highlighted in several interviews.

Comprehensive estimates of the state of the country's health infrastructure and what would be required to bring it to a state of good repair do not exist⁷, but some jurisdictions have undertaken province-wide reviews. For instance, a 2013 assessment of health care facilities in Saskatchewan found that they were valued at \$6.5 billion⁸. On average, the facilities were 39 years old, had an average condition score of 33% (equivalent to 'fair to poor condition'), and capital requirements of \$2.2 billion. Likewise, a 2016 report from Nova Scotia's Auditor General found that "infrastructure challenges in Nova Scotia hospitals have existed for many years"⁹ and reported that at least \$85 million would be needed to meet urgent infrastructure needs across the province.

Examples of other critical infrastructure vulnerabilities, exposures, and risks commonly cited by interviewees were:

- Just-in-time supply chain management may lead to shortages in essential health supplies such as drugs and medical devices if there are weather-related or other disruptions in supply;

- Increased use of health information technology to support time-sensitive care processes increases reliance on the information infrastructure;
- Shifts to community-based care increase reliance on transportation, telecommunications, and utilities infrastructure across the community to ensure continuity of care (e.g. someone using home dialysis needs reliable sources of water and electricity; home care providers need to be able to reach their clients in a safe and timely way);
- Small, remote, and isolated communities may be particularly vulnerable to business continuity disruptions, including those related to human resource shortages or transitions;
- Down-sizing reduced surge capacity in some areas, e.g. because of a decline in available resources;
- There are few formal exercises (and in some cases limited information sharing regarding those that do take place) to develop capacity for emergency response and identify potential risks that need to be addressed; and
- Growing cross-sector interdependencies means that vulnerabilities in one sector can cascade more quickly/easily to others.

These vulnerabilities are aligned with the priorities highlighted in the *Sendai Framework*, which emphasizes building disaster risk management policy based on “an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment.”

Health Sector Resiliencies and Lessons Learned

Interviewees also highlighted critical infrastructure strengths and sources of resilience. For example, many welcomed the opportunity to learn from leading practices that exist across organizations and jurisdictions, e.g. via provincial roundtables and regular provincial/territorial Health Emergency Management Directors’ meetings. They also pointed to resources that could be used for risk assessment and mitigation (e.g. from Public Safety Canada and provincial risk registers that prioritize vulnerabilities and mitigation strategies). Likewise, there was consensus on the value of simulations and exercises to increase awareness, refine plans, and strengthen preparedness generally.

In addition, several interviewees noted that although the increased use of digital health had the potential to result in some risks, as described above, it is also a potential

source of strength. For instance, digital channels can help to map emergencies and communicate key information; patients may be able to receive services through virtual care even if local services close; and shared information systems can ensure continuity of care when patients cannot access their usual places of care.

Similarly, we heard about the potential for more distributed community-based health services to support local health needs in the case of a disruption to more centralized hospital services. The reverse is also true.

Lessons Learned from the 2013 Floods in Southern Alberta

Rising flood waters inundated large areas of Southern Alberta in June 2013. The rapid onset, scope, and magnitude of the disaster represented the worst flooding event in the province’s history. Over 30 communities were affected and Alberta’s first-ever Provincial State of Emergency was declared for the Town of High River.

Mandatory evacuation orders were issued, and a range of hospitals, medical facilities, and other types of health services were impacted. A field hospital was set up in Medicine Hat. Two urgent care clinics were opened. And health inspectors, public health, and other professionals worked during and after the emergency to ensure health and safety.

In a post-event review of the province’s response and recovery capabilities, most stakeholders rated the overall health and safety response as “effective”¹⁰. However, some First Nations communities “felt that if there had been significant emergency medical concerns or additional safety concerns then the province did not have sufficient resources to assist the communities.” The report also pointed to specific areas of strength and opportunities for improvement that could bolster preparedness, response, and recovery for future events. Alberta’s experience also highlighted the importance of the post-event recovery and the efforts needed for longer-term rebuilding.

Lessons learned shared by individual health care providers involved in responding to the emergency are also instructive. For instance, many patients who lost medications in the floods sought replacements/refills from health care providers in nearby communities, one of which was the Okotoks Shoppers Drug Mart. Prior to the floods, the pharmacy did not have an emergency plan, but following the High River evacuation was on

the frontlines of the disaster, filling 3-4 times more prescriptions than usual¹¹. This surge was possible thanks to the prescribing authority held by one of the pharmacists, province-wide access to electronic medication profiles to confirm prescriptions, a decision to provide limited quantities of medication to preserve supplies, and the dedicated efforts of health care providers. Challenges such as a temporary power outage that paused services and difficulties retrieving a hard drive from a pharmacy in High River highlighted the need for backup infrastructure in emergency situations.

In describing their experiences, the pharmacists also noted that while there was an urgent need for immediate action, support for those affected by the flood was required on a long-term basis, well into the post-emergency recovery period. Based on their experiences, the pharmacy has reviewed and revised contingency plans and new communications and other resources have been developed and deployed to facilitate future emergency response needs.

Looking Ahead and Recommendations: Enhancing Cooperation with a Health Sector Roundtable

Preparation, planning, and communication are essential enablers of critical infrastructure resilience and therefore the effective functioning of the health sector in the face of potential hazards. To support this process, the Public Health Agency of Canada and HealthCareCAN established a Steering Committee in 2016 to guide and direct key elements of the development of a pan-Canadian Health Sector Network focused on critical infrastructure issues. The Committee has provided guidance on the development of this *Issue Brief*. Members will also inform the Network's terms of reference and membership, as well as its first-year deliverables and priorities.

As was the case for this *Issue Brief*, it is recommended that on-going efforts to strengthen critical infrastructure preparedness and resilience engage and draw on the expertise of a diverse range of stakeholders – including front-line clinicians, emergency preparedness leads, and senior leaders responsible for core elements of the health sector's critical infrastructure and policy. It is also important to include experts from outside the health sector given the growing inter-relationship of critical infrastructure sectors and the opportunity for

cross-learning and exchange. With healthcare's growing emphasis on cybersecurity (Part B of this *Issue Brief*), inclusion of those with expertise in this domain is also important.

The common areas of vulnerability, exposure, and risk identified by interviewees provide useful starting points for more detailed exploration of risk, options, and strategies to strengthen critical infrastructure resilience. Aging physical and technological infrastructure was cited as a risk by most of those consulted in the preparation of this *Issue Brief*. A range of other issues – from the potential for failures related to disruptions in just-in-time supply chain management to reductions in surge capacity – were also commonly cited (see pages 4 and 5). At the same time, it is important to consider and leverage critical infrastructure strengths highlighted by interviewees when developing future strategies. It is this balanced approach of recognizing and addressing risks, while building on sources of resilience, that will ensure the robust and reliable health services that Canadians expect and deserve.

Find Out More

- Canada's [National Strategy for Critical Infrastructure](#) and [Action Plan for Critical Infrastructure \(2014-2017\)](#)
- Public Safety Canada's [All Hazards Risk Assessment Methodology Guidelines](#)
- [Canadian Critical Infrastructure Information Gateway](#)
- National Institute for Science and Technology [Framework for Improving Critical Infrastructure Cybersecurity](#)
- [Sendai Framework for Disaster Risk Reduction 2015–2030](#), adopted at the Third United Nations World Conference on Disaster Risk Reduction

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