

# Canadian Medical Imaging Inventory Service Report

## Mobile Imaging: The Benefits and Challenges

### Context

Health care systems are increasingly using mobile imaging equipment as a means of expanding diagnostic imaging capacity to underserved locations. The extension of advanced imaging equipment to unconventional settings — such as rural and remote communities, targeted urban hot spots, and long-term care facilities — helps reduce disparities in the delivery of health care.<sup>1</sup> The indications for mobile imaging services are similar to those of fixed units;<sup>1</sup> that is, enabling mobile technology to deliver generalized imaging services, or specific services such as for the diagnosis of acute stroke<sup>2</sup> and prostate cancer,<sup>3</sup> or as part of various screening initiatives.<sup>4,5</sup>

Mobile imaging is “portable” imaging equipment that is enclosed in a mobile trailer that can be deployed to multiple sites. It consists of a van or trailer designed to accommodate imaging equipment and facilitate patient throughput. As well, mobile imaging equipment can be leased or purchased depending on the needs of health care services.<sup>6</sup> Often, sites that are considering installing their first permanent CT or MRI unit will lease a mobile unit first.<sup>1</sup>

In Canada, the adoption of mobile imaging with advanced imaging modalities is limited. There are 9 publicly funded CT and MRI mobile imaging units in this country, of which 5 are deployed to rural and remote communities, with the remaining operating as permanent fixed units located in urban settings. There are no publicly funded mobile PET-CT units in operation.<sup>7</sup>

### Objective

This report summarizes information on the use of mobile imaging for the advanced imaging modalities of CT, MRI, and PET-CT. The key objective is to describe the main benefits and challenges to providing mobile imaging services in Canada.

### About This Document

This document summarizes information identified through the Canadian Medical Imaging Inventory and a limited literature search.

### Results

There are 2 broad categories of mobile imaging: provisional and mobile. Mobile imaging units can be shared between several sites with geographic proximity.<sup>8</sup> Provisional mobile imaging is used by hospitals as an interim solution when equipment is out of service.<sup>9</sup> Often, these hospitals already provide these services but are using provisional mobile imaging to maintain their current

service volume until the temporary disruption ends.<sup>10</sup> With provisional mobile imaging, the equipment is delivered to the hospital site and is set up in a fixed location, often a laneway or parking area of the facility. Occasionally, provisional mobile units are fixed to a single hospital, where they operate as permanent units. This usually happens when the configurations of a health care facility cannot easily accommodate the unique requirements of imaging equipment. In some instances, provisional mobile imaging is used to provide additional capacity when there is a backlog or when demand for imaging services exceeds accepted wait times<sup>10</sup>

## Benefits

There are numerous advantages to mobile imaging, many of which focus on how they can be quickly deployed where and when they are most needed. Some common benefits are outlined here.

### Access

Mobile imaging provides a means of reducing disparities and inequalities in the delivery of health care<sup>11</sup> by providing a resource to vulnerable populations that will not typically visit a health care centre yet often carry the greatest burden of disease.<sup>12</sup> Mobile lung cancer<sup>4</sup> and mammography<sup>5</sup> screening programs, as well as mobile health clinics more generally, have reported success in increasing participation in health care to underserved, geographically isolated or undereducated populations.<sup>13</sup>

### Health Outcomes

Mobile imaging may facilitate better health outcomes and contribute to value-based health care by diagnosing disease early,<sup>11,14</sup> which often leads to more accurate patient management, faster patient recovery, and reduced length of hospital stay.<sup>1,15</sup> This is evident in mobile stroke units with onboard CT, which have been shown to substantially reduce time-to-treatment in acute ischemic stroke and may improve patient health outcomes.<sup>2</sup> In the nursing home setting, mobile radiography is associated with a reduction in the onset of delirium, fewer hospital admittances, and more adequate treatment.<sup>16</sup>

### Convenience

Mobile imaging provides convenience to patients by removing travel obstacles associated with journeying long distances from rural and remote locations to imaging facilities in urban centres. Travel burden is particularly important for patients who may be too sick to travel, have different types of mobility limitations (including those living in long-term care facilities, nursing homes, and correctional facilities), or who are unwilling or unable to travel long distances.<sup>17</sup> In some instances, the general state of a patient may worsen due to being transported to distant imaging services.<sup>18</sup> The geography and climate of Canada can make travelling long distances challenging, particularly during harsh winter weather, when road conditions can be hazardous and may lead to appointment rescheduling and last-minute cancellations.<sup>5</sup>

### Out-of-Pocket Costs

Populations in rural and remote communities acquire out-of-pocket travel expenses for diagnostic imaging services delivered in distant locations.<sup>1</sup> Costs are also incurred through work absenteeism and other incidentals<sup>1</sup> by the patient and their caregivers,<sup>19</sup> and may act as a disincentive to seeking a diagnosis.<sup>15</sup>

### Health System Cost

Health care facilities that do not have a large enough volume of imaging exams to justify the cost of an in-house imaging modality are still able to provide patient access to advanced imaging equipment by sharing the cost among 2 or more participating hospitals.<sup>14</sup> As well, the

use of mobile radiography services may result in cost reductions per exam.<sup>1</sup> For some patient populations, such as nursing home residents, cost savings of approximately 30% are reported.<sup>20</sup> The operating costs for mobile radiology services can be higher than those provided by onsite imaging departments; however, because the costs can be shared, the cost burden may be offset.<sup>21</sup>

## Containing the Spread of Infection and Pandemic Recovery

As a measure to prevent the further spread of COVID-19 and to preserve health system capacity, radiology service volumes were lowered by between 50% to 70% at certain points during the pandemic.<sup>11</sup> While services have resumed, radiology departments across Canada are challenged with managing a backlog of examinations.<sup>22</sup> Mobile imaging can be used to help address backlogged appointments and manage the ongoing reduced volume of service resulting from enhanced cleaning protocols.<sup>23,11</sup>

CT has played a role in the pandemic as a tool to evaluate the severity of COVID-19 and to monitor complications.<sup>24</sup> Mobile CT units are being used to help limit the spread of infection by restricting the movement of COVID-19 patients.<sup>24</sup> For cancer or other immunosuppressed patients who are at increased risk of severe illness from COVID-19, knowing that COVID-19 patients are using isolated radiology services provides assurance that it is safe to attend CT appointments.<sup>24</sup>

As well, the health care crisis has sparked innovation in mobile CT with the development of CT-in-a-Box, a type of mobile imaging unit designed specifically to minimize COVID-19 contagion.<sup>23</sup>

## Space and Building Constraints

Mobile imaging allows hospitals to provide advanced imaging services when they may not have the physical space or infrastructure to install a unit,<sup>17</sup> or when they prefer to avoid costly building reconfigurations, by using fixed mobile units located in parking areas or laneways.<sup>21</sup>

## Wait List Reduction

Mobile imaging can assist overburdened, in-house imaging departments to help reduce wait lists<sup>11</sup> in a way that can accommodate different levels of volume demand and scheduling requirements – from a few hours per day to an entire week and in a diverse range of locations.<sup>14</sup> Wait list reduction is important because poorer patient outcomes are linked with delayed diagnosis and may result in reversible conditions worsening to become chronic irreversible conditions or permanent disability.<sup>25</sup> As well, excessive wait times for CT and MRI are associated with economic burden.<sup>26</sup>

## Emergency Preparedness

Mobile imaging can be (re)deployed quickly to diagnose and triage acutely ill patients in emergency situations where there are mass casualties. As well, as mentioned previously, mobile imaging can be used to prevent service disruption when hospital equipment breaks down or when renovations, upgrades, or departmental expansions are undertaken.<sup>9</sup>

## Challenges

Even though mobile imaging can be effective in closing care gaps and promoting health equity, there are some challenges that are unique to the mobile environment. For example, while mobile CT and MRI mostly have the same imaging capabilities as conventional in-house units,<sup>27</sup> only certain types of makes and models are certified for mobile use.<sup>27</sup> Staff may need to be trained so that they can use the mobile equipment with proficiency. As well, coordinating the sharing of schedules between hospitals may result in scheduling conflicts if 2 or more hospitals are faced with simultaneous surplus demand.<sup>1</sup> Some common challenges with mobile radiology are outlined here.

## Site Requirements

There are site specific requirements that may be difficult to fulfill in some mobile environments, especially in rural and remote settings. Examples of mobile site requirements are dependent on:

- high-speed access to electronic hospital networks, including public archiving and communications systems.<sup>28</sup> Poor internet connectivity in rural areas may create delays in archiving images for radiologist review and precludes access to online results<sup>29</sup>
- the climate of the site — especially in areas where there is violent weather such as hurricanes<sup>30</sup>
- a reliable source of electrical power<sup>10</sup>
- a level ground surface — mobile imaging units must be placed on a levelled concrete pad.<sup>10</sup>

## Modality Requirements

There are modality-specific requirements that are unique to the mobile environment. Examples of mobile modality-specific considerations include:

- increased downtime because of higher servicing and quality assurance checks required for mobile technology, with the frequency influenced by the volume of use and by how often the equipment is relocated<sup>31</sup>
- the trailer used to transport mobile radiology requires servicing and the frequency is dependent on how often and how far the unit travels<sup>31</sup>
- mobile CT and PET-CT require different radiation protection solutions for staff and those in the surrounding area or adjacent facilities compared to fixed units<sup>32</sup>
- mobile MRI has different shielding requirements compared to fixed units that limit the field strength to a 1.5 Tesla<sup>27</sup>
- some mobile units require a lift to accommodate patients using a wheelchair or for those with limited mobility<sup>10</sup>
- most mobile units will require appropriate waiting facilities, toilets, and waste disposal arrangements.<sup>28</sup>

## Costs

The operating costs of mobile imaging is higher than for fixed units, although the costs can be offset by sharing the cost between hospitals.<sup>1</sup> As well, there are transportation costs such as mileage and drivers' salaries.<sup>31</sup>

## Staff Recruitment

There is a preference for mobile units to have a dedicated crew with a proficiency in operating the equipment.<sup>31</sup> The recruitment of expert staff to run mobile radiology units can be problematic if working away from home for long periods conflicts with other commitments.<sup>1</sup> At the same time, a dedicated expert crew can mitigate the problem of not having locally available trained personnel,<sup>33</sup> which is a problem in some parts of Canada.<sup>34</sup> Staff for a mobile unit would include a driver and radiology technicians.

## Patient Comfort

A potential disadvantages of mobile imaging from a patient perspective is the possibility of increased claustrophobia felt with the enclosed area in mobile imaging units compared to conventional hospital settings.<sup>1</sup> This pertains not just to the narrower bore size used in mobile imaging equipment,<sup>1</sup> but also to the smaller size of the interior space of a mobile unit.<sup>31</sup> Anecdotal evidence suggests that the cleaning protocols used in mobile units may not be up to the same standard as those followed in fixed radiology services, although the introduction of enhanced cleaning protocols due to the COVID crisis may mitigate this concern.

## Conclusion

Mobile imaging provides a means of delivering vital imaging services to communities in a way that reduces disparities and inequalities in health care, accelerates patient management, and optimizes strained resources. While there are some important challenges, none are likely to be insurmountable. As well, mobile imaging may provide a flexible option to accommodate population growth, health trends, and technological innovations.

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