



In Ontario, a Provincial Effort to Improve Care in Imaging Through Patient Dose Optimization



At St. Michael's Hospital in Toronto, optimizing radiation dose for CT patients was already a standard practice when Choosing Wisely Canada launched in 2014. Centered in the Department of Medical Imaging, the imperative has greatly expanded in the years since.

The effort has spawned numerous initiatives, committees and research projects. It has allowed the University of Toronto affiliate (<https://medicine.utoronto.ca/about-faculty-medicine/fully-affiliated-hospitalsresearch-institutes>) to play a decisive role in propelling the dose optimization movement across the province of Ontario.

Further, the department's dose optimization leaders this year authored a scientific study documenting their success championing the capture of CT radiation dose data across multiple hospitals. (See sidebar "St. Michael's Sets a Precedent on Regional Dose Data Analysis.")

In their paper's discussion section, the authors suggest such data captures might drive diagnostic dose reference levels for quality improvement on a regional—and potentially national—level.

The latter would be an especially consequential development in Canada, which does not formally regulate radiation dose for most medical imaging exams, including CT.

Pushing Through the Pandemic

As it happened, the study ran in the May edition of the influential *Canadian Association of Radiologists Journal*.

That timing, of course, was terrible: By the fifth month of 2020, the COVID-19 crisis had become a global public health disaster. Almost two months had passed since Health Canada reported the news that, as feared, local transmissions accounted for most COVID cases in the country.

"After we analyzed the data, we started rushing to publish it and then publicize it," recalls Kate MacGregor, MPH, the St. Michael's epidemiologist and senior research associate who lead-authored the 2020 study. "We succeeded in getting the paper published, but the focus for the hospital was, of course, the pandemic."

Given the momentum MacGregor and colleagues have been building on dose optimization over many years leading up to the present, it's no surprise they didn't shrink from the challenge.

"We're now doing some work in dose reduction specifically for COVID patients," says MacGregor, who additionally serves as biostatistician for the Medical Imaging Metadata Repository of Ontario (MIMRO), which was created in 2018 by St. Michael's radiologists Timothy Dowdell, MD, and Bruce Gray, MD.

"These patients get quite a large number of X-rays, and we had to conserve our PPE, so emergency room physicians and radiologists at Unity Health studied how to image patients through isolation room glass while keeping the radiation dose down." That study also was recently published in *Investigative Radiology* (<https://pubmed.ncbi.nlm.nih.gov/32773486/>; August 2020).

The can-do spirit in the face of adversity says much about the dedication of St. Michael's Hospital doctors and scientists to the dose optimization mission. The medical imaging leadership of St. Michael's in Toronto is working to advance dose management in line with ALARA (As Low As Reasonably Achievable) for patients imaged with ionizing radiation.

Optimal Dose for Optimal Care

Hospitals and freestanding imaging centers across the U.S. as well as Canada can learn more from the work of Dowdell, Gray and MacGregor at St. Michael's Hospital and the University of Toronto. To that end, the team has shared its research findings and firsthand experiences in a series of reports published in peer-reviewed journals over the past five years.

More recently, in a September 2020 interview, MacGregor explained how her department set out to raise the bar on care quality and wound up becoming an exemplar of excellence in the evolution of dose optimization.

"We started this journey as a reaction to studies showing a rapid increase in the number of CTs, knowing that CT uses a higher dose of radiation than other modalities," MacGregor says, referring to a 2009 report from the U.S.'s National Council on Radiation Protection and Measurements (NCRP) showing a six-fold increase in medical radiation dose from the early 1980s to 2006. (Reference: NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States," Section 4, Medical Exposure of Patients.)

"What we initially wanted to do was increase awareness just within our own hospital," MacGregor says. "People knew that the more radiation used in a CT, the better the diagnostic picture. When the radiation dose was analyzed, we realized we were doing more CTs and that our doses could be lower when diagnosing specific problems."

St. Michael's Sets a Precedent on Regional Dose Data Analysis

In a study published by the *Canadian Association of Radiologists Journal* in May, Kate MacGregor, MPH, and colleagues at St. Michael's Hospital in Toronto reported finding variances of up to 97% in mean radiation doses by protocol across eight hospitals in Ontario.

No consistent pattern emerged to explain the gaps among and between mean doses recorded at hospitals of widely varying sizes.

The team arrived at the findings by comparing dose values in three avenues: between hospitals, within and between hospitals by scanner, and against national Health Canada achievable doses and diagnostic reference levels.

They demonstrated how to establish diagnostic reference levels for CT at the province level through a medical informatics metadata repository.

"This electronic data acquisition process could be used to continually update achievable doses for frequently used computed tomography examinations in Ontario and eliminate the need for nationwide manual surveys," MacGregor et al. conclude. "Results compared across institutions will allow hospitals to maintain achievable doses and lower patient exposure."



"We're using DoseWatch™ to aggregate data across the province, giving us a view of how institutions are managing their dose and lowering patient exposure."

**- Kate MacGregor, MPH
Epidemiologist and Senior Research Associate,
St. Michael's Hospital, Toronto**

MacGregor credits hospital leadership with encouraging the imaging department's initiative from its earliest stages. The executives recognized the opportunity they had to fill a gap, which was the need to create directives on radiation dosing.

The St. Michael's stakeholders still feel that way. A 2019 follow-up study by the NCRP showed that from 2006 to 2016 there was an increase in CT studies of 20% nationally in the U.S. without a statistically significant reduction in ionizing radiation per person. Without a regulatory mandate to optimize radiation dose, MacGregor suggests, it remains up to individual efforts by imaging centers in Canada to keep things moving in the right direction.

"Our leadership has been proactive," MacGregor says.

Smart Software as Indispensable Ingredient

The operative concept here is dose monitoring. Along with the research, committee action and site-specific CT scan protocoling at St. Michael's and beyond, MacGregor cites mobilization to introduce monitoring tools as essential.

When she was investigating dose management solutions on the market, she decided along with a committee at St. Michael's that DoseWatch corresponded to what they needed.

DoseWatch is vendor-agnostic, extending beyond CT scanners to imaging systems used in interventional radiology, cardiovascular care, mammography, surgery, nuclear medicine and contrast injection.

While they are considering to grow their approach in those areas, the radiation safety committee at St. Michael's has grown to include representatives from emergency medicine, CT angiography, operating rooms that have C-arms and "anywhere else we have radiation-emitting imaging equipment," MacGregor says.

Big Data to Improve Patient Care

Another area facilitated by DoseWatch at St. Michael's hinges on the previously mentioned Medical Imaging Metadata Repository of Ontario.

MIMRO stores and serves not only medical images and associated reports but also, as its name implies, the metadata needed to determine radiation dose by protocol. Once the repository had sufficiently matured, MacGregor and colleagues used the previous vendor's dose tracking product to compare doses across eight data-feeding hospitals. The researchers found widely varying doses and reported the findings in the study published in *CARJ*.

The Right Repository

Another outside organization with which MacGregor and colleagues are working closely is called the Hospital Diagnostic Imaging Repository Services, or HDIRS. Founded in 2007 by a group of hospitals in the south and east regions of Ontario as an independent, not-for-profit corporation, HDIRS is one of three imaging repositories in the province that collectively make up much of the provincial imaging program that is supported by the Ontario Health Agency. HDIRS leadership understands the importance of dose optimization, and has supported MIMRO.

“Now we’re able to monitor radiation dose across separate institutions in a much easier fashion than we could when we had to keep up with software versions,” MacGregor explains. “We’re working with HDIRS on the technical side so each individual hospital does not have to devote valuable IT resources to the project. We developed data sharing agreements with our legal and privacy teams that worked for each individual hospital, which also helped expedite the set-up process. We’re using DoseWatch™ to aggregate data across the province, giving us a view of how institutions are managing their dose and lowering patient exposure.” After it is analyzed, each participating hospital will know whether their doses are comparable to other hospitals, giving them a powerful tool to demonstrate quality care and a commitment to patient safety.

Because HDIRS is recognized as a shared services provider and service innovation hub for its hospital members, it can slice and dice the data in all sorts of interesting and helpful ways, MacGregor points out.

One of the things HDIRS wants to do with the data is develop quality improvement services in support of member hospital needs,

she adds. “This type of information, collected from a large sample of the population, could eventually be used to understand the imaging pathways that lead to the best patient outcomes,” MacGregor says.

Meanwhile, because HDIRS collects data from all imaging modalities, MacGregor and colleagues plan to expand DoseWatch to interventional radiology sooner rather than later.

Only the Beginning

All this activity coincides with happenings across St. Michael’s. In 2017, the institution merged with Providence Healthcare and St. Joseph’s Health Centre to form Unity Health Toronto, the largest Catholic health system in Canada.

“We’ve become a multihospital network with all CT dose information in one location,” MacGregor says. “We’ve had DoseWatch installed at St. Joseph’s and we’re able to monitor doses and provide information for all hospitals and CTs within the network. This also gives us insight into our imaging workflow to discern whether the correct protocols are being applied and how the equipment is being utilized in emergency, inpatient and the outpatient perspective.”

The international focus on the pandemic “is not likely to change over the next couple of years,” MacGregor says. “There likely won’t be any emphasis on radiation dose until we get through this pandemic. But we’re in the beginning of what we hope will become an assessment of radiation dose in medical imaging all across the province.”

MacGregor’s ultimate hope is to spread dose optimization to all hospitals, “working from what we do with our radiation safety committee and with dose monitoring,” she says. “We want to bring in small hospitals, large hospitals and every size hospital in between.”

For Further Reading

Here’s a sampling of peer-reviewed papers authored by dose optimization leadership in the medical imaging department at St. Michael’s Hospital in Toronto. Along with epidemiologist Kate MacGregor, MPH, the leadership team includes radiologists Timothy Dowdell, MD, and Bruce Gray, MD.

1. Archana Rai, MD, Kate MacGregor, MPH, et al., “Proof of Concept: Phantom Study to Ensure Quality and Safety of Portable Chest Radiography Through Glass During the COVID-19 Pandemic.” *Investigative Radiology*, August 2020.
2. Kate MacGregor, MPH, et al., “Establishing Diagnostic Reference Levels for CT Through a Provincial Medical Informatics Metadata Repository in Ontario.” *Canadian Association of Radiologists Journal*, May 2020.
3. MacGregor et al., “Automated Patient-Specific Dose Registries, or Radiation Dose Index Monitoring Software: Why They Are a Very Good Idea.” *Canadian Association of Radiologists Journal*, November 2015.
4. MacGregor et al., “Identifying Institutional Diagnostic Reference Levels for CT with Radiation Dose Index Monitoring Software.” *Radiology*, April 2015.

In addition to publishing scholarly articles, the team and its collaborators produce materials aimed at imaging technologists as well as clinicians on the job. Recently, for example, the radiation safety committee at St. Michael’s produced a radiation protection program and manual showing acceptable ranges for patient dose alongside those for occupational dose.



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