A SNAPSHOT OF CURRENT COMPUTED TOMOGRAPHY RADIATION PROTECTION PRACTICES IN ONTARIO

E Seto and AC Easty
Departments of Medical Engineering and SIMS, Centre for Global eHealth Innovation,
University Health Network, Toronto.
Institute of Biomaterials and Biomedical Engineering, University of Toronto.

Introduction

The use of Computed Tomography (CT) has increased substantially over the past decade, resulting in growing concern over the radiation dose from CT. After reviewing available evidence on the use of multi-detector CT imaging, the Ontario Health Technology Advisory Committee recommended that the Ministry of Health and Long-Term Care initiate an investigation on how to best balance CT image quality and patient radiation safety. In order to provide meaningful recommendations on how to increase patient radiation safety, it was necessary to first determine the radiation protection methods currently being practiced in Ontario.

Methods

In order to gain an understanding of the current Ontario CT utilization and radiation protection practices, a questionnaire was sent on May 15, 2006 to 20 Ontario healthcare institutions that operated 64-slice CT scanners. The questionnaire was electronically sent to the Director/Manager of the Medical Imaging Department and the Chief Executive Officer of each of the healthcare institutions. Each Director/Manager of the Medical Imaging Department was asked to forward the questionnaire to the appropriate CT technologist(s) and/or radiologist(s) for completion, and to return the responses electronically within a week. Out of the 20 healthcare institutions that were sent a questionnaire, 18 provided a response within a week.

Results

The following describes some of the results found through the Ontario CT survey. A detailed description of the findings from the survey can be downloaded from the following web-site: www.ehealthinnovation.org/files/CT_ radiation _safety.pdf.(1)

CT Scanning Protocols

CT scanning protocols used at the surveyed healthcare institutions varied significantly. Studies have shown that variations in CT scanning protocols are the largest contributor to variations in patient CT radiation dose. These variations have been observed in jurisdictions around the world, and have been found to differ up to 40 times for the same clinical application of CT.(2-5)

Other studies have found that for certain indications, low-dose protocols can be used without compromising image quality. For example, studies have reported a 90% dose reduction of high resolution CT of the face (6), and a 50% dose reduction with low-dose chest CT.(7,8) The Ontario CT survey found that 6 out of the 18 healthcare institutions never used low-dose CT protocols. Of the 12 that did use low-dose CT protocols, the types of protocols widely varied.

New CT scanners are delivered with manufacturer installed protocols. The Ontario CT survey revealed that the manufacturer's protocols

were usually or almost always modified or replaced by 14 of the institutions. Protocols from other healthcare institutions (e.g. paediatric protocols from hospitals that specialize in paediatric patients) were "never" used by one institution, "occasionally" by 14 of the institutions, "sometimes" by two institutions, and "usually" by one institution.

Radiation Shielding Practices

Although some type of patient shielding policy/guideline was followed by 15 out of the 18 respondents, the amount and types of shielding varied significantly. Some institutions responded that they shielded only paediatric patients, some shielded the gonads of all male and female patients of childbearing age as well as paediatric patients, and some shielded all patients whenever possible. The use of 0.25 mm or 0.5 mm lead equivalency aprons, eye shields, and thyroid shields varied between the institutions. At 15 of the institutions, the CT technologists had discretion in the type and amount of patient shielding. The large variability in patient shielding practices found through the Ontario CT survey may be due to the lack of comprehensive standardized guidelines on patient shielding in Ontario for CT examinations.

For paediatric patients, 8 of the institutions provided special shielding, usually by doubling the aprons used for adult CT scanning.

Screening and Shielding Women of Child-Bearing Age

All of the surveyed institutions, except one, questioned women of childbearing age before CT examination as to whether they might be pregnant, and sometimes asked for the date of their last menstrual cycle. If required, blood tests were ordered to determine pregnancy. For pregnant patients who absolutely required CT examinations, 16 of the institutions provided special shielding, usually by doubling or tripling the lead aprons.

Recording of Patient Radiation Dose History

The radiation dose of each CT scan was recorded into a log book or into a Picture Archiving and Communications System by 15 of the surveyed institutions. However, only 6 of the surveyed institutions took the patient's radiation dose history into consideration for the use of CT imaging or the use of the particular CT protocol. Of the institutions that did consider the patient's radiation dose history, the modifications included low-dose protocols used for patients who required multiple follow-up CT examinations and for cancer patients.

Testing and Maintenance of CT Scanners

Of the surveyed Ontario healthcare institutions, 8 reported that periodic CT radiation dose measurements were not taken. Of the institutions that do perform periodic CT radiation dose measurements, the frequency ranged from monthly to annually, and sometimes only after alteration of the CT scanner. The measurements were performed in-house, by a third party, or by representatives from the CT scanner manufacturer.

All of the surveyed institutions indicated that preventative maintenance was performed either monthly (14 institutions) or every 3 months (4 institutions). However, radiation dose was not directly measured during preventative maintenance.

Daily image quality assurance testing was performed by 14 of the surveyed institutions. Two institutions reported that quality assurance testing was performed at least once a week, and one institution reported that it was done less than once a week. One institution did not respond to the question.

Future Directions

Many methods can be employed in Ontario to help standardize CT radiation protection practices and to help minimize the radiation dose from CT examinations while maintaining adequate image quality. For

example, the creation of comprehensive recommendations on patient shielding practices during CT examinations would help standardize the use of appropriate shielding. As another example, detailed instructions on when and how to perform appropriate CT scanner testing and maintenance would help standardize this aspect of CT radiation protection.

Diagnostic reference levels (DRLs) have been used successfully to reduce CT radiation dose in various jurisdictions, such as the United Kingdom (4, 9, 10), British Columbia (11), and the United States (12). To determine DRLs, the radiation doses from various types of CT examinations are collected from different CT scanners within a jurisdiction. Then a threshold, such as the 80th percentile, is chosen as the DRL for the particular type of CT examination. DRLs provide benchmarks of typical dose levels and highlight centres which consistently use unusually high radiation dose. They are not intended to be used as limits of allowable radiation used for particular CT examinations.

A provincial Diagnostic Imaging Safety Committee has been developed to review the issues and recommendations from the CT Radiation Safety Issues in Ontario study (consisting of the Ontario CT survey, literature reviews, and interviews) and to help implement changes in CT radiation protection. A report from the Committee is scheduled to be released in February 2007.

Conclusions

The use of an electronically sent questionnaire was an efficient and quick method to obtain a snapshot of the current Ontario CT radiation protection practices. The survey revealed that there are significant variations between Ontario healthcare institutions in several areas of CT radiation protection practices, including the use of CT scanning protocols, the use of CT patient shielding, and CT scanner testing. The findings from the survey have provided insights on areas of CT radiation protection that require improvements. These insights have been used to create recommendations that will likely be implemented in the near future to enhance CT radiation protection in Ontario.

Acknowledgments

This work was funded by the Ontario Ministry of Health and Long-Term Care and the Ontario Hospital Association.

References

1. Computed Tomography Radiation Safety Issues in Ontario. Healthcare Human Factors Group [cited 2007 January] Available from: www.ehealthinnovation.org/files/CT_radiation_safety.pdf
2. Golding S. Multi-slice Computed Tomography (MSCT): The Dose Challenge of the New Revolution. Radiation Protection Dosimetry. 2005;114((1-3)):303-7.
3. Shrimpton P, Jones D, Hillier M, Wall B, Le Heron J, Faulkner K. Survey of CT practice in the UK. Part 2: dosimetric aspects.: Chilton, England: National Radiological Protection Board; 1991.
4. Shrimpton P, Hillier M, Lewis M, Dunn M. Doses from computed tomography (CT). Examinations in the UK – 2003 Review. Chilton, England: National Radiological Protection Board; 2005.
5. Olerud HM. Analysis of factors influencing patient doses from CT in Norway. Radiat Prot Dosim. 1997;71:123-33.
6. Jackson A, Whitehouse RW. Low-dose computed tomographic imaging in orbital trauma. Br J Radiol. 1993 Aug;66(788):655-61.
7. Prasad SR, Wittram C, Shepard JA, McLoud T, Rhea J. Standard-dose and 50%-reduced-dose chest CT: comparing the effect on image quality. AJR Am J Roentgenol. 2002 Aug;179(2):461-5.

8. Mayo JR, Hartman TE, Lee KS, Primack SL, Vedal S, Muller NL. CT of the chest: minimal tube current required for good image quality with the least radiation dose. AJR Am J Roentgenol. 1995 Mar;164(3):603-7.
9. Hart D, Wall BF. UK population dose from medical X-ray examinations. Eur J Radiol. 2004 Jun;50(3):285-91.
10. Berrington de Gonzalez A, Darby S. Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries. Lancet. 2004 Jan 31;363(9406):345-51.
11. Aldrich JE, Bilawich AM, Mayo JR. Radiation Doses to Patients Receiving Computed Tomography Examinations in British Columbia. CARJ. 2006;57(2):79-85.
12. Gray JE, Archer BR, Butler PF, Hobbs BB, Mettler FA, Jr., Pizzutiello RJ, Jr., et al. Reference values for diagnostic radiology: application and impact. Radiology. 2005 May;235(2):354-8.