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A five year review of established local DRLs for adult CT examinations in Nova Scotia

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INTRODUCTION

Concerns about increasing radiation exposure have encouraged strategies to reduce radiation dose from CT. Implementation of diagnostic reference levels (DRLs) is a powerful tool for identifying unusually high patient dose from radiologic examinations [1]. DRLs are typically set as the third quartile (75th percentile) of dose distribution sampled from the actual practice data. The first national CT dose survey in Canada was performed by the Health Canada Consumer Radiation Protection Bureau in 2013–14, and results were published in 2016 [2]. To establish local provincial DRLs, another data collection was conducted in Nova Scotia. The design of the provincial survey had followed the recommendations of Health Canada for adult examinations. All local DRLs were below national values [3].

AIM

To update provincial diagnostic reference levels (DRLs) established in 2014 for adult CT examinations and to investigate the effect of aging equipment and possible changes in practices.

METHOD

This study included the same five CT examinations as the initial survey: head, chest, low-dose chest (LDC), abdomen/pelvis, and chest/abdomen/pelvis (CAP). Dose data, volume CT dose index ($CTDI_{vol}$) and dose-length product (DLP), were collected from 16 CT scanners. All machines except one, replaced in 2018, were included in the initial dose survey and consequent protocol optimization. Automatic dose modulation options and multislice capability (16–128 detector rows) were available on all scanners. The sample for each protocol included 20 patients of average size. The data were collected for 1560 patients; two hospitals did not have the LDC protocol. The differences in doses for the same examination performed five years apart were evaluated using paired two-tailed Student's t-test.

An AP measurement between 20–29.9cm at the kidneys for abdomen studies (Fig. 1), and at the carina for chests were used as "average patients". The median thickness for each scanner and protocol was 24–25cm for a more accurate comparison of dose (tissue composition was not considered).

Figure 1.

RESULTS

The mean values of the dose distributions (DLP, mGy·cm) from both surveys are shown in Fig. 2 with the dotted lines indicating provincial DRLs. The scanner # 16 was recently replaced, therefore the doses cannot be compared. The scanners in Nova Scotia included 9 models from 4 manufacturers that were installed during 2005 –2018. Ten newer machines implemented iterative reconstruction; automated voltage selection and organ dose modulation were available on three CTs. The updated DRLs were lower than national DRLs (Table 1). The results demonstrated increase by 16% for head and 17% for chest protocols compared to the first survey. The DRLs for abdomen & pelvis remained the same, and the values were decreased by 11% and 26% for CAP and LDC examination respectively. The greatest variation by a factor of 3.7 was found for the LDC examination, however it was an improvement comparing to 5.4-fold from the 2014 data. The differences between the mean values of dose distributions from the first and second surveys were not statistically significant with $p>0.05$ for all examinations. However, dose increase up to 50% was identified at individual hospitals for different protocols.

Table 1. Comparison of the provincial DRLs established in 2014, the updated values from the current survey, and the national DRLs. The DRLs are expressed as the DLP (mGy·cm) values.

Year	Head	Chest C-	LDC*	Abd & Pelv	CAP**
2014	985.7	367.4	178.8	601.2	996.5
2019	1142.5	428.4	131.6	602.0	892.0
Change	15.9%	16.6%	-26.4%	0.1%	-10.5%
p-value	0.088	0.080	0.431	0.978	0.351
National DRLs	1302	521	n/a	874	1269

*Low Dose Chest

**Chest, Abdomen, and Pelvis

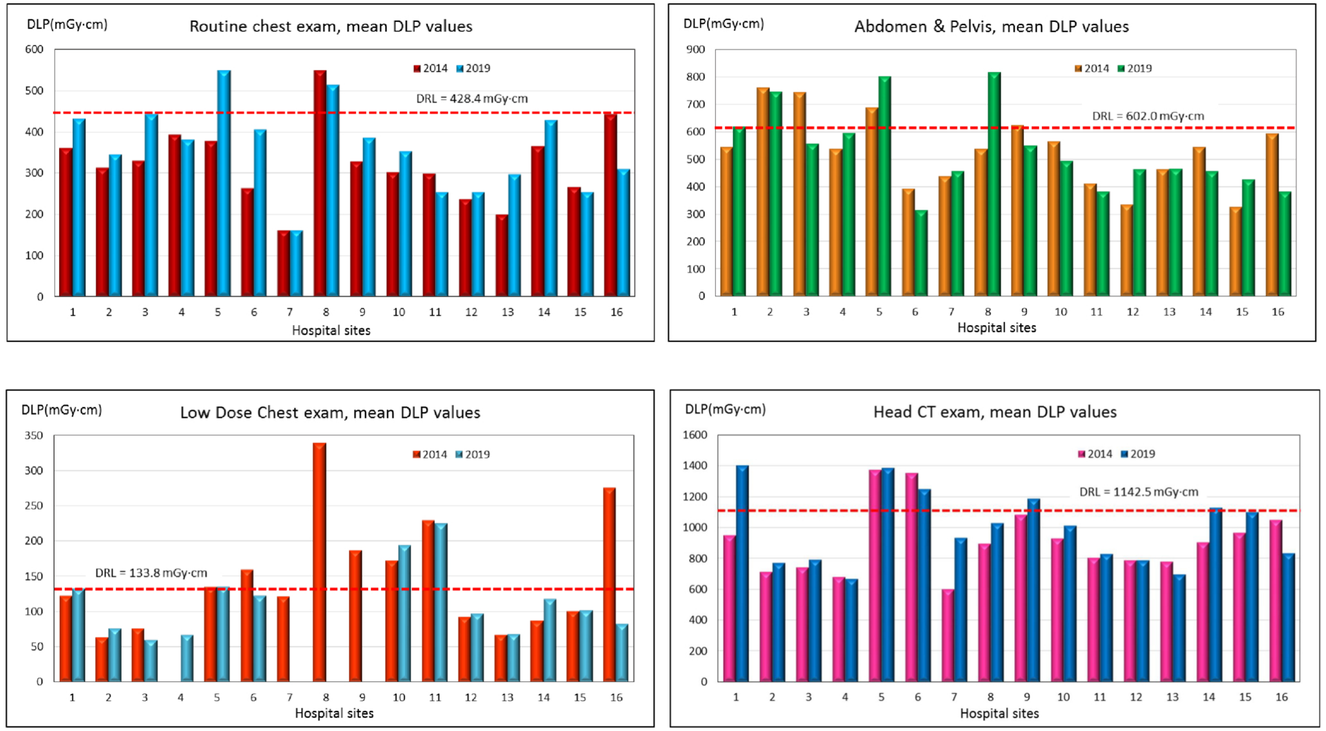

Figure 2. Mean DLP values from each scanner for Chest, LDC, Abd & Pelv, and Head examinations. The DRL are shown in the dashed line.

CONCLUSIONS

There is a general tendency in increasing the dose due to aging equipment with less available dose modulation options. Nevertheless, due to protocol standardization it became possible to decrease dose for CAP and LDC examinations. Some protocols need further adjusting and this process has to be followed up with more dose collecting. Protocol optimization was recommended to the hospitals with the doses above established provincial DRLs, especially at the sites that reported dose increase after the initial survey.

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