

UNIVERSITY OF
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Minimizing CT Double-Coverage to Reduce Radiation Dose

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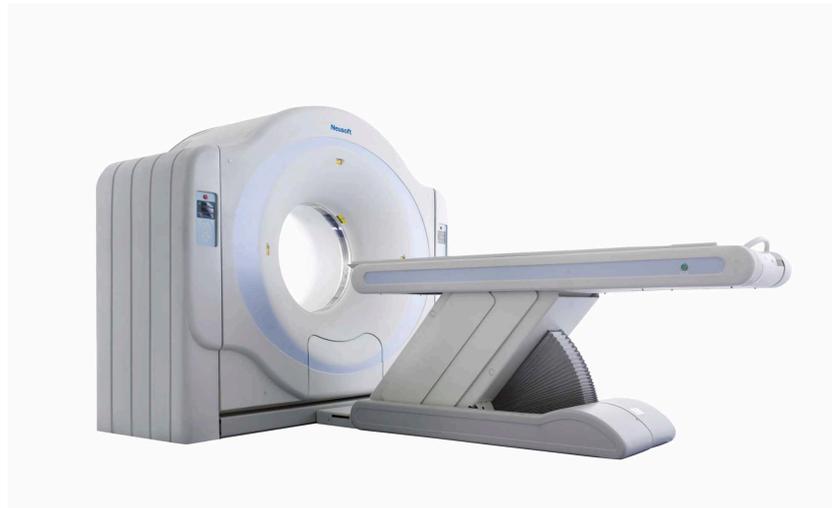
Conflicts & Acknowledgements

- ▶ No conflicts of interest to declare
- ▶ We'd like to thank the University of Saskatchewan Departments of Medical Imaging & Surgery for conference funding



Background

- ▶ Ionizing radiation from CT exams has been linked to malignancy
- ▶ When multiple body regions are scanned, there may be double-coverage of an area depending on CT protocols
- ▶ By minimizing the area of double-coverage, patients' exposure to radiation can be reduced



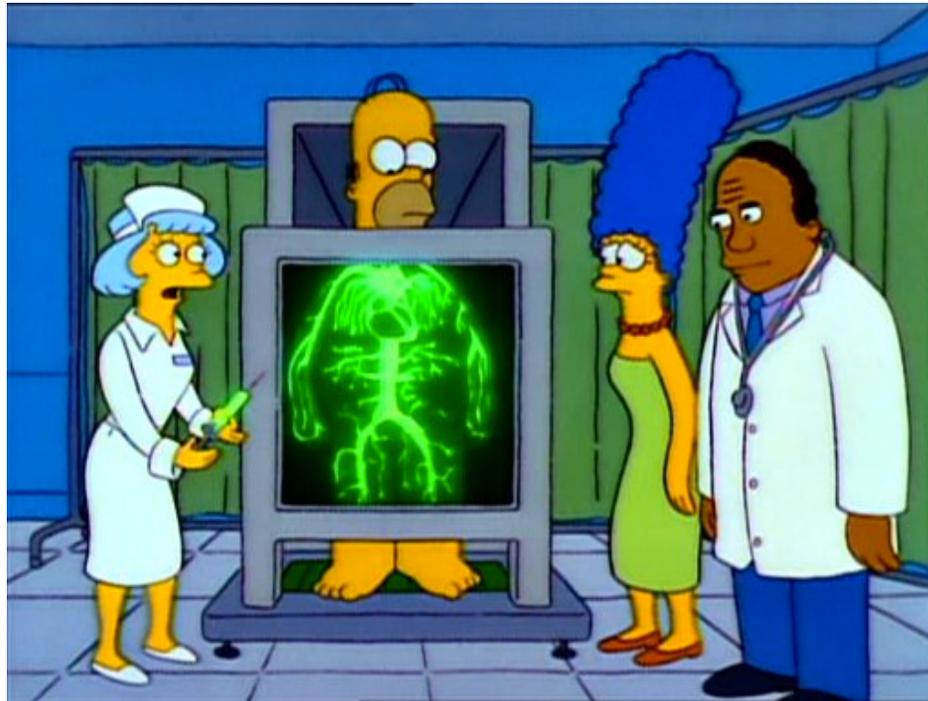
Dose Measurement

- ▶ **CT Dose Index (CTDI)**
 - ▶ Scanner radiation output over single length of scan
- ▶ **Dose Length Product (DLP)**
 - ▶ Total radiation output, calculated as CTDI x scan length
- ▶ **Effective Dose (ED)**
 - ▶ Estimate of effective radiation dose received by the patient. Varies depending on region scanned. Calculated as DLP x conversion factors¹

▶ ¹Huda W, Ogden KM, Khorasani MR. "Converting dose-length product to effective dose at CT." Radiology. 2008;248(3):995-1003.

Aim of Study

- ▶ To determine whether CT protocol redesign can reduce double-coverage in studies of the neck, chest, abdomen, and pelvis, with resultant lower radiation doses

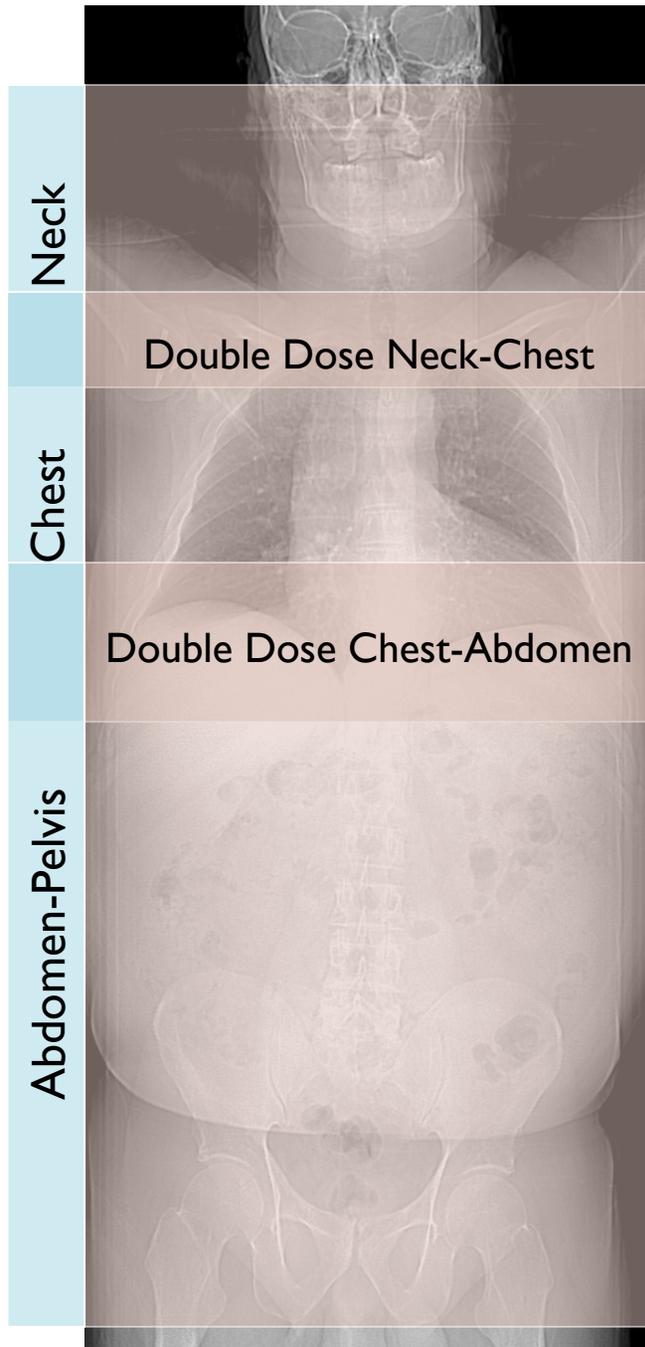


Methods

▶ Pre-intervention (2010):

- ▶ Using Phillips iSite Radiology PACs software, data was collected on CT chest, abdomen, pelvis (CHAP) studies; and CT neck, chest, abdomen, pelvis (NCHAP) studies from the Saskatoon Health Region across three sites
- ▶ Existing CT protocols were used
- ▶ Data collected on: number of scan segments, total cranio-caudal (CC) length of the chest segment, the CC length of anatomical overlap between segments, and the dose length product (DLP) for each segment
- ▶ DLP values converted to effective doses based on conversion factors
 - ▶ 0.0054 mSv/mGy-cm for neck, 0.017 mSv/mGy-cm for chest, 0.017 mSv/mGy-cm for abdomen-pelvis
- ▶ “Doubled-doses” and “% doubled-doses” were calculated
 - ▶ Single-pass dose calculated as total ED minus areas of double-coverage (the ideal)
 - ▶ “Doubled-dose” defined as total ED owing to image overlap
 - ▶ “Percent doubled-dose” defined as % of ED from doubled-dose vs. the ideal single-pass dose





Neck

Double Dose Neck-Chest

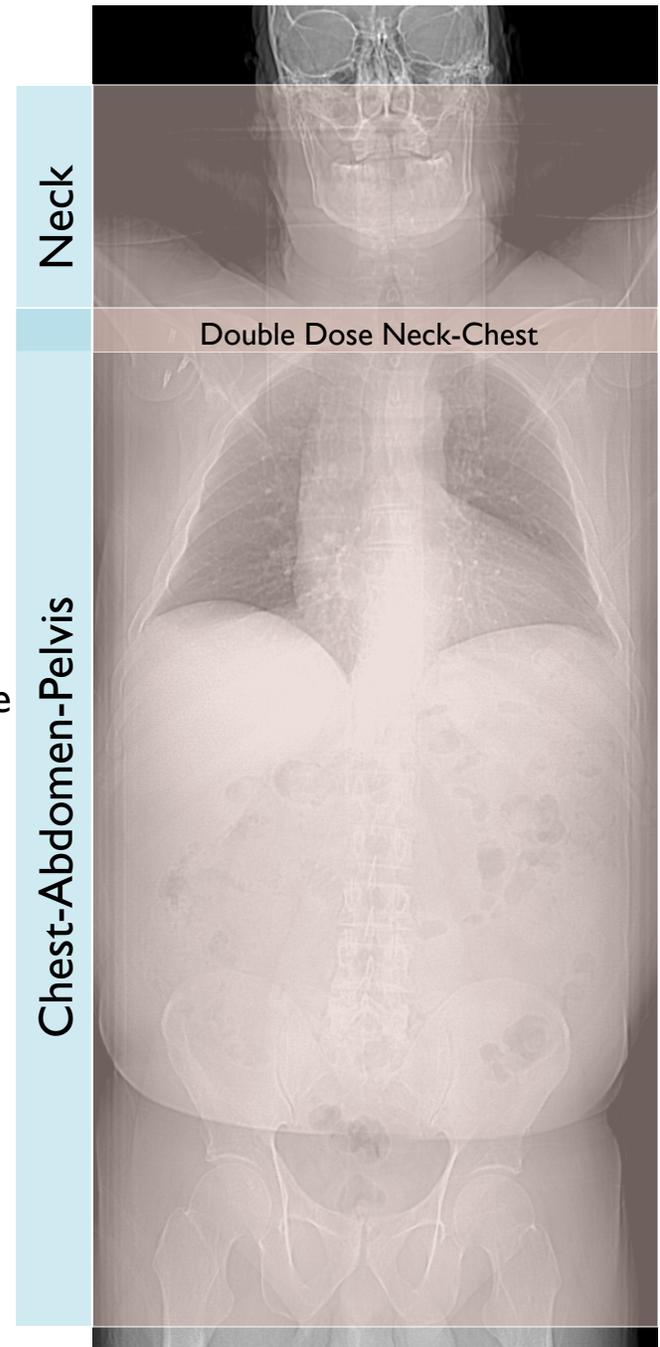
Chest

Double Dose Chest-Abdomen

Abdomen-Pelvis

Ideal protocol
minimizes or
eliminates
areas of double
coverage

Single pass coverage



Neck

Double Dose Neck-Chest

Chest-Abdomen-Pelvis

Methods

▶ Intervention

- ▶ CT protocols for CHAP and NCHAP studies were modified at each of the three Saskatoon Health Region sites
 - ▶ Goal was minimizing overlapping coverage
- ▶ For non-trauma patients, CHAP studies were changed to a single portal venous phase requiring only one scan with no overlap
- ▶ For NCHAP studies two scans were utilized
 - ▶ A separate scan of the neck was required in addition to CHAP since neck is imaged with arms down, and chest with shoulders extended.
 - ▶ Technologists were asked to keep the neck-chest overlap to a minimum.
- ▶ Additional factors:
 - ▶ Site 2 had a scanner upgrade during the study period with multiple lower dose protocols also instituted
 - ▶ Sites 1 and 3 also performed other dose optimization strategies in the interval



Methods

- ▶ **Post-intervention (2014)**
 - ▶ Pre-intervention methods were repeated
 - ▶ Data was compared with pre-intervention results



Results

- ▶ Pre-intervention:

- ▶ 45 NCHAP studies reviewed

- ▶ All NCHAP studies scanned the neck, chest and abdomen-pelvis in three separate segments
 - ▶ Average doubled-dose 4.32 mSv
 - ▶ Average % doubled-dose 24%

- ▶ 145 CHAP studies reviewed

- ▶ All CHAP studies obtained as two separate segments
 - ▶ Average doubled-dose 1.07 mSv
 - ▶ Average % doubled-dose 12%



Results

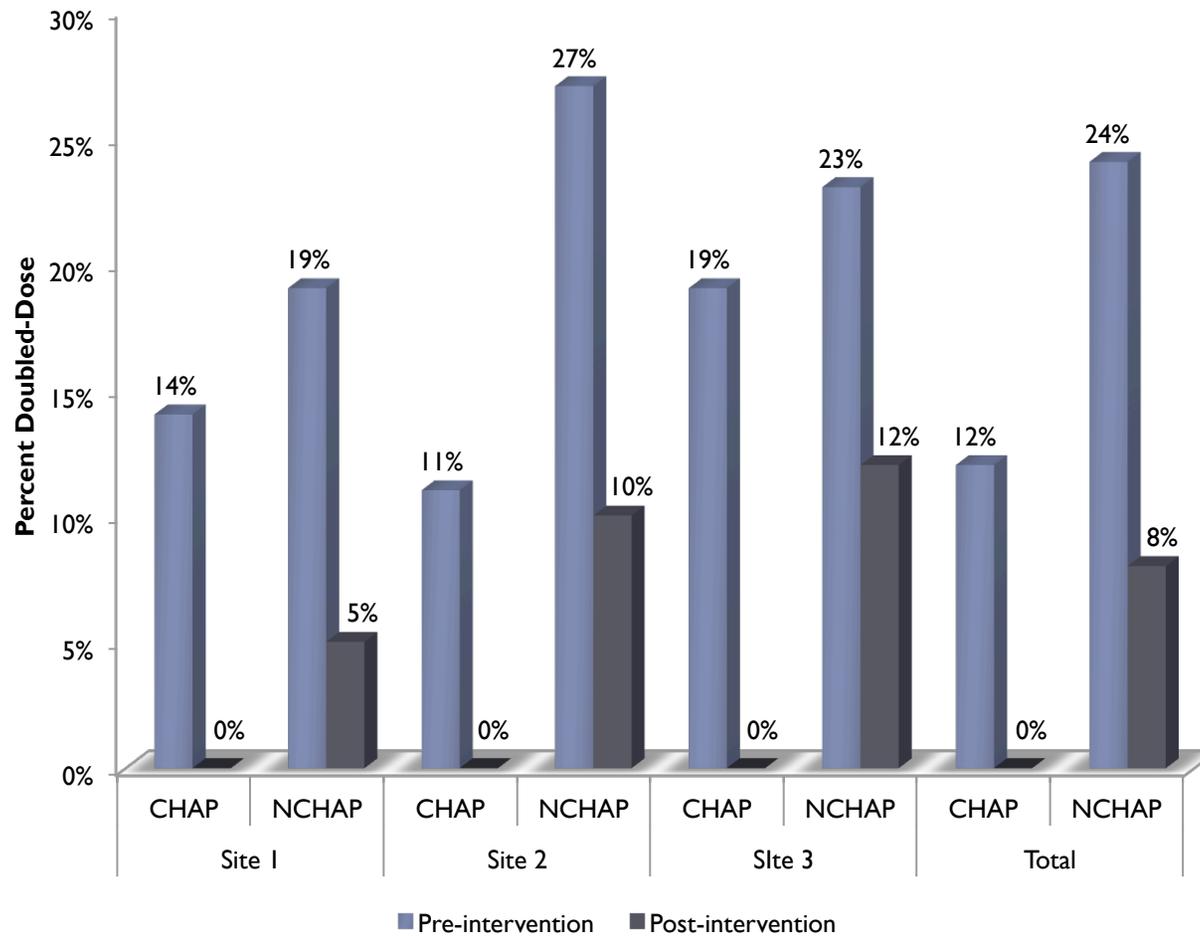
▶ Post-intervention

- ▶ 44 NCHAP studies reviewed
 - ▶ All NCHAP studies scanned in two segments (single scan for chest and abdomen-pelvis)
 - ▶ Average doubled-dose 0.70 mSv
 - ▶ Average % doubled-dose 8%
- ▶ 58 CHAP studies reviewed
 - ▶ All CHAP studies obtained as single scan
 - ▶ Doubled-dose 0 mSv
 - ▶ % doubled-dose 0%



Results

► Pre- vs. Post-intervention



Discussion

- ▶ **Two ways to minimize image overlap in CHAP and NCHAP studies:**
 - ▶ Combine regions into single scan
 - ▶ Reduce area of overlap when multiple scans required
- ▶ **This strategy successfully reduced CT radiation at our centre**
 - ▶ Results correspond to study by Ptak et. al² that found a 17% reduction in radiation when single-pass CT imaging was utilized in trauma
- ▶ **Further benefits of these modified CT protocols include:**
 - ▶ Smoother image reformatting
 - ▶ Simplified process for technologists
 - ▶ Fewer duplicate images for radiologists to review
- ▶ **Drawbacks include:**
 - ▶ Loss of 'bonus' liver arterial phase
 - ▶ Limitations when different passes desired for chest and abdomen (i.e., trauma)

▶ ²Ptak T, Rhea JT, Novelline RA. "Radiation dose is reduced with a single-pass whole-body multi-detector row CT trauma protocol compared with a conventional segmented method: initial experience." Radiology. 2003;229(3):902-5.

Conclusion

- ▶ Our experience demonstrates how CT CHAP and NCHAP protocols can be modified to minimize anatomical overlap and eliminate unnecessary radiation.
- ▶ This technique is neither highly technical nor expensive, and is therefore available to any centre.

