Multicenter implementation of a CT scanner dose excellence program based on clinical indication, BMI and diagnostic image quality assessment

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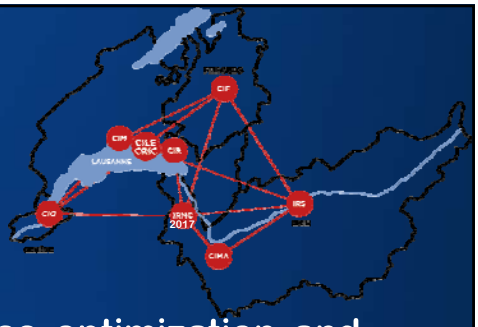
No disclosure

Background

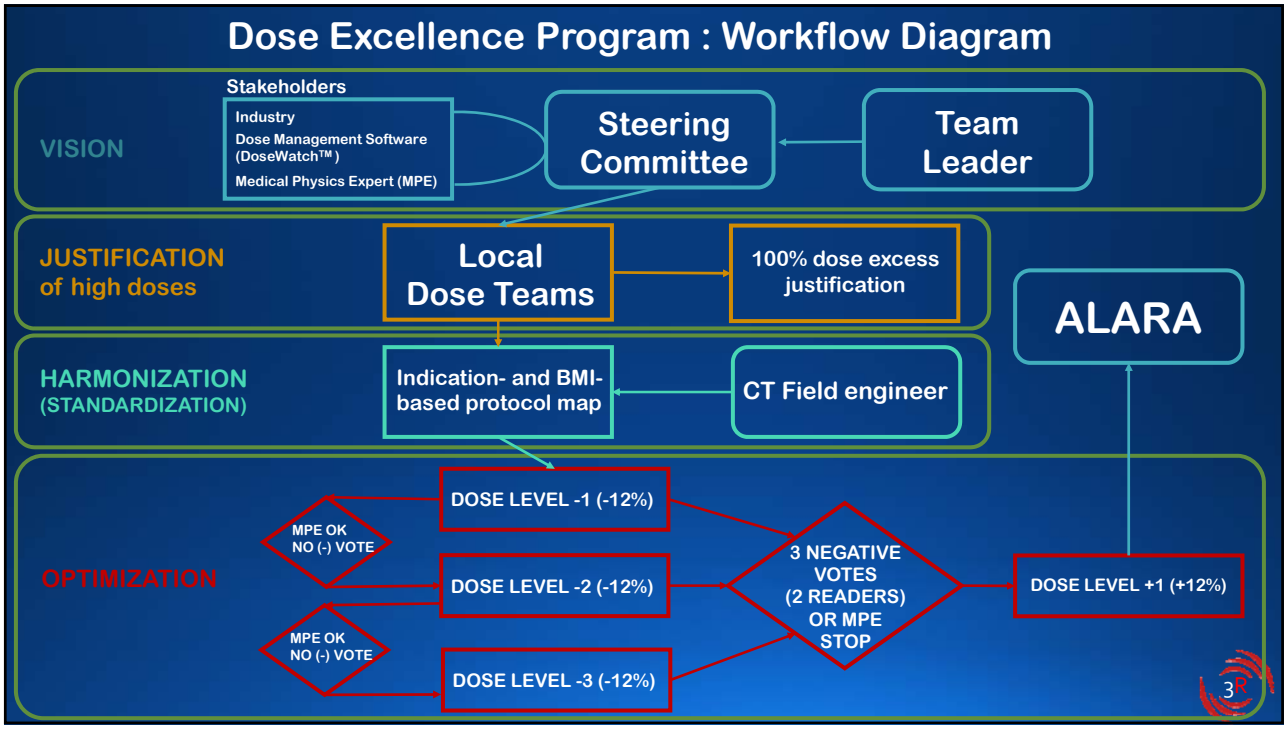
- The revised European Basic Safety Standards Directive (2018) requires :
  - the radiation dose of every CT exam to be recorded with investigation of cases where radiation dose exceeded established reference levels.
  - Radiation protection education and dose optimization training.
- Initial multicenter CT scanner data analysis in Groupe 3R identified :
  - large dose variations,
  - protocol parameters inhomogeneity,
  - lack of staff training uniformity.

Purpose



- Groupe 3R Board priorities (2016)
  - To define and set-up a radiation dose optimization and education program at the group level (7 centers and 7 CT scanners from 3 manufacturers).
  - To implement a "dose culture" by guiding 22 radiologists and 40 technologists towards a change of practice.

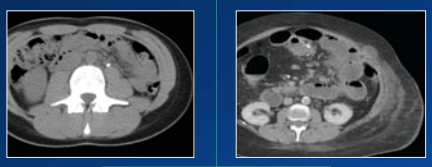
Dose Excellence Program : Workflow Diagram



Step 1 : Harmonization phase

Radlex

Indication-based mapping



BMI < 25 | BMI > 25

- Protocol Radlex mapping
- Design of a clinical indication-based protocol map
- 2 categories of patients for each protocol, according to BMI
- 30 protocols per BMI category

Step 1 : Harmonization phase

Acquisition parameters:
Indication and BMI based

- Detector configuration
- Pitch
- Tube rotation time
- Tube voltage
- Tube current modulation
- Noise index
- Reconstruction kernel
- Reconstruction parameters
- Reconstruction standardization

Purpose

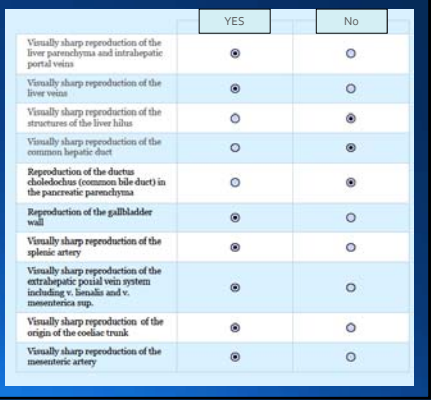
To deliver a $CTDI_{vol}$ value

- Close to P25 DRL when BMI<25
- Below P75 DRL when BMI>25

Diagnostic image quality assessment

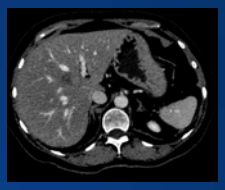
Radiologists prospectively vote for diagnostic image quality using an electronic voting tool in the dose management software

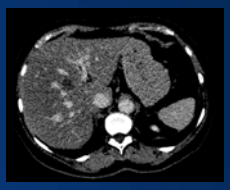
A negative vote needs to be confirmed by a second reader using adapted European image quality guidelines



Step 2 : Optimization phase

- Dose reduction phase
  - 12% step-wise mA reduction for all protocols every 50 examinations of the same indication.
  - In case of 3 negative voting for diagnostic image quality per protocol, confirmed by a second reader, dose was increased by 12% to reach previous accepted dose level (ALARA).
  - In parallel, the Medical Physics Expert quantified with a model observer the low contrast detectability using a anthropomorphic phantom (QRM™ 401 abdomen phantom, Germany) to assess at which mA reduction level a 5mm lesion in the liver would not be diagnostically detectable.


Before optimization


After optimization


Size M, correlated to BMI<25*

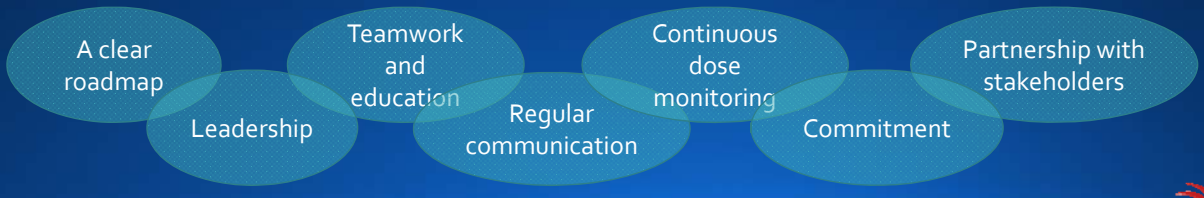

Size L, correlated to BMI>25*

Comparison of clinical and phantom image quality for low contrast liver lesions. SSJ22 Physics : CT Radiation Dose 1, Tuesday 3 PM, Room S403B

Results

- A think tank on image quality related to clinical indication and patient habitus enabled a team commitment in a quality project and a consensual good practice standardization.
- The use of a dose management software combined to Radlex protocol mapping enabled 100% of dose excess justification and protocol comparison in a multicenter setting.
- Protocol harmonization allowed comparison of comparable data (no redundancy), maintained diagnostic image quality and reduced dose by 6% for chest and 7% for abdomen.
- Protocol optimization enabled an additional average dose reduction of 26% (range 20-30%, depending on clinical indication), before hitting the low contrast resolution limit as assessed by phantom measurements.
- Clinical indication- and BMI-based protocols allowed significantly lower dose levels than existing DRL based on anatomical region with a sufficient diagnostic image quality : "The right dose for the right diagnosis".

The complex process of homogenizing CT protocols and optimizing radiation doses without compromising image quality can be achieved with



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