Establishing a dose management strategy in Computed Tomography

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Background/introduction
Computed Tomography (CT) ranks as one of the top five medical developments of the last 40 years. From the first generation of CT scanners in the 1970s to the fourth-generation scanners of today, the technological improvements of CT in speed, resolution and patient comfort have been immense [1]. Owing to technological developments and to broader indications, the use of CT has notably increased around the world and its contribution to the collective dose has risen from 5% to 46% from 1996 to 2009 [2, 3]. According to the European Directive 2013/59/EURATOM “Laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation”, any medical exposure should show a sufficient net benefit, weighing the total potential diagnostic or therapeutic benefits it produces, against the individual detriment that the exposure might cause, taking into account the efficacy, benefits and risks of available alternative techniques having the same objective but involving no or less exposure to ionising radiation [4].
Affidea, the biggest independent provider of advanced diagnostic imaging services in Europe, is present in 16 countries and owns and operates 150 CT scanners. With patient safety being the key driver across the whole network, in May 2014, Affidea launched a CT dose management program, the Dose Excellence Project (DEP). The scope of DEP is to adapt CT examinations practice in 100% of the installed base in order to perform examinations at the lowest possible dose for each and every clinical indication while maintaining diagnostic confidence. The status of DEP in December 2017 is presented in image 1.

Description of activity and work performed
Implementing the Dose Excellence Project within departments, within the country and across different countries has not been an easy task. At first there was a lot of cultural resistance to change, which is not unusual in the medical profession. Evidence base is absolutely critical to underpin new initiatives. Therefore, communication is key to the success of the project [5].
A multi-disciplinary steering committee was set up to clearly outline the strategy, process and goals. Within each country the project is led by a project leader, a Chief radiologist, a Chief radiographer and a Chief Medical Physicist. Within each CT facility of each country there is a named radiologist and radiographer responsible for DEP. All the teams and team members have clearly defined responsibilities and work closely with the Steering Committee so as to achieve compliance to the goals of the project. The main goals of DEP are:
- Create a culture of dose awareness
- Provide comprehensive education on technology and the effects of radiation
- Create standard operating procedures for unified practice and implementation of the project
- Create a standardized and unified list of adult and paediatric CT protocols based on clinical indication
- Define Dose Reference Levels (DRLs) for the Affidea Standardized CT protocols
- Define and set up an adapted high dose level alert system
- Create a justification coding system for high dose level alerts and perform root-cause analysis to minimize alerts
• Optimise acquisition parameters and practices
• Analyze the impact of optimization on dose levels and image quality
• Create standardized and unified contrast media administration protocols
• Combine standardized and unified CT examination protocols with contrast media protocols to define best practice for each clinical indication, CT model and vendor
• Implement best practice across the entire Affidea network

The process of implementation is well defined as shown in Image 2. Affidea has created a list of 105 standardized adult CT protocols with corresponding DRLs. Apart from the importance of a standardized input, a vendor independent tracking and recording software of dosimetric data and more, as BMI, cumulative dose etc., is required. For this purpose, Affidea selected DoseWatch (GEHC, Mil. USA) and created a custom report to analyse the data collected from each CT scanner in collaboration with the vendors’ team. Currently, a project is underway to consolidate the 75,000 examinations collected on average per month from all the countries and centers, to a single database for further analysis.

In parallel, dose optimised protocols from all CT models and vendors and for the three most frequently performed clinical indications are being assessed for image quality to identify the balance between the lowest achievable dose and appropriate image quality (Image 3) [6 – 10]. The framework is the following:

1. Identification of the most frequent examinations per center, vendor and model with at least 20 examinations
2. Selection from the most frequent examinations, the protocols per center, vendor and model which are within Affidea DRLs
3. Exclusion of the protocols per center, vendor and model with p25 below the acceptable limit
4. Definition of image quality assessment criteria per clinical indication to include:
   • Critical anatomical features reproduction (5 scale confidence level scoring)
   • Visualization of anatomical features (comparison to reference, 5 scale scoring)
   • Pathology evaluation
5. Selection of 20 examinations per center, per clinical indication, per vendor, per CT model which comply to the dose levels criteria (steps 2 and 3)
6. Blinded to center, model type and vendor, evaluation of image quality according to defined criteria per clinical indication by three radiologists (step 4)
7. Statistical analysis of image quality assessment results in correlation to dose levels
8. Identification of protocols from the statistical analysis results per clinical indication, vendor and CT model which comply to both image quality criteria and dose levels
9. Objective image quality assessment of protocols from step 8 with respective anthropomorphic phantoms
10. Definition of contrast media protocols wherever applicable, for examination protocols which comply to both steps 8 and 9
11. Identification of each optimized protocol per clinical indication, vendor, CT model and implementation across the network

With DEP we have achieved to improve patient safety by fostering a culture of dose awareness, and by optimizing practice and CT protocols and in parallel to comply to the European Directive requirements.

Conclusion and recommendations
Affidea Dose Excellence Project, as far as we know, is the largest optimization program of its kind. We have shown that with the correct processes, measurements and analytics tool, standards and engagement of staff it is possible to create a culture of dose awareness and evoke change.
References
Affidea’s CT DEP in numbers

- 12 countries
- 72 CT systems
- 4 CT vendors
- 24 CT models
- 52 CT systems with dose reduction algorithms
- 75,000 examinations per month

The process

- Standardized Input: Standardized & Unified Protocols with DRLs, Standard procedures
- Monitoring System: DoseWatch, Track & Record dose data and more
- Optimization: Track & Justify high dose level alerts, Analyze data, Optimize protocols & DRL

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