

*Anatomical and clinical Diagnostic
Reference levels; an update*



**Large repositories:
Opportunities and challenges**

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Repository

A repository is a managed directory for storing and describing digital objects for a digital archive.

In information technology, a repository is a central place in which an aggregation of data is kept and maintained in an organized way, usually in computer storage.



Examples of repositories at IAEA

DIRAC

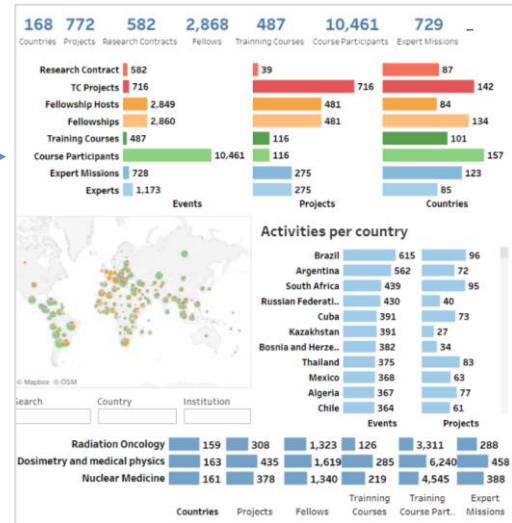
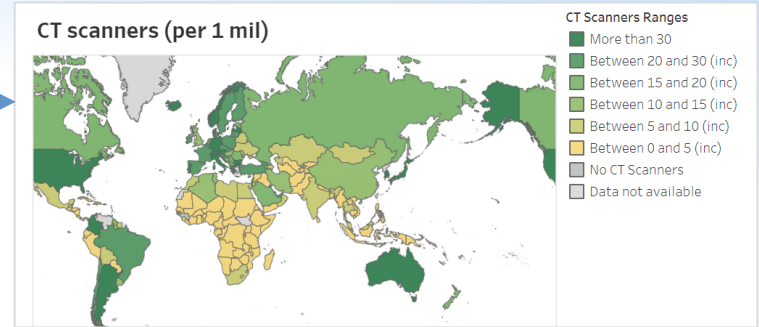
IMAGINE

DOLNET

GLOBAL
DATABASE

NUMBAD

DAN

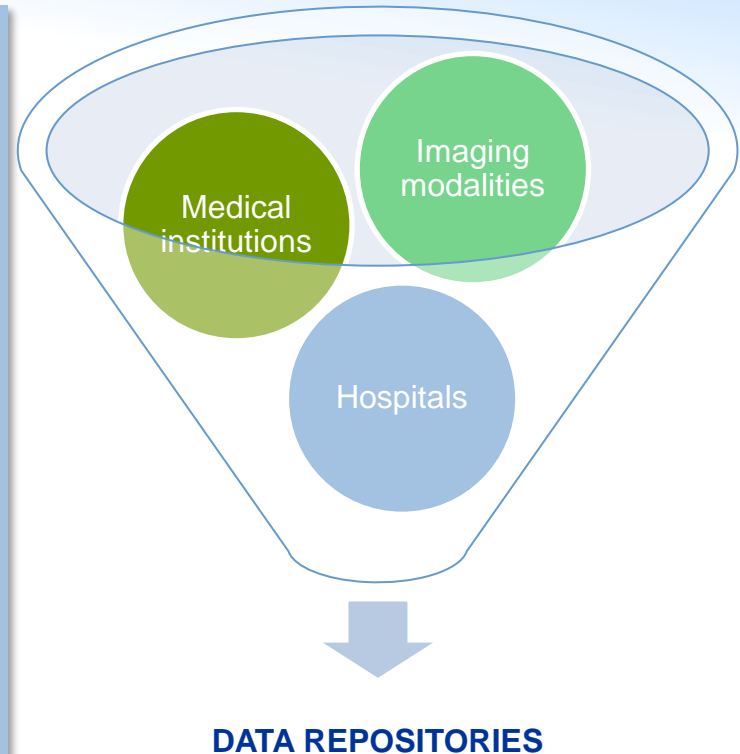


Clinical Data Repository

A Clinical Data Repository is a real time database that consolidates data from a variety of clinical sources to present a unified view of a single patient. It is optimized to allow clinicians to retrieve data for a single patient.

Typical data types include:

- clinical laboratory test results
- patient demographics
- radiology reports and images
- radiation parameter and dose reports
- etc



Patient data repositories

Patient data repositories are becoming more and more popular

They can be at an institutional, multicenter or even at a national level



Examples of repositories



Qualified Clinical Data
Registry »




Lung Cancer Screening
Registry »




Dose Index Registry »



Interventional
Radiology Registry »




National Mammography
Database »



General Radiology
Improvement »



CT Colonography
Registry »



Clinical Decision
Support Registry »

Dose repository




Dose Index Registry »

Certified Software Partners



April 2018
50 million exams from more
than 2100 facilities



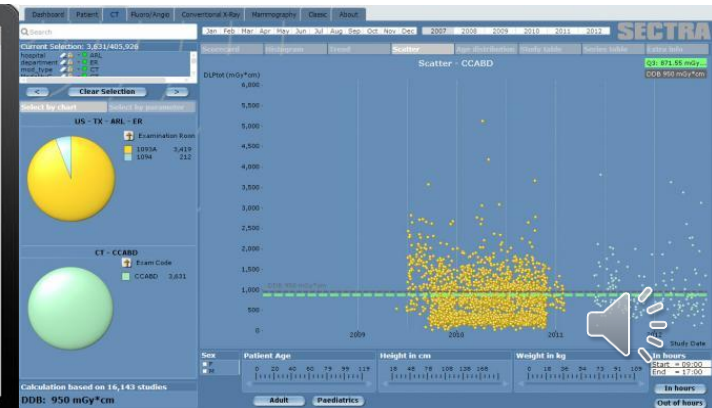
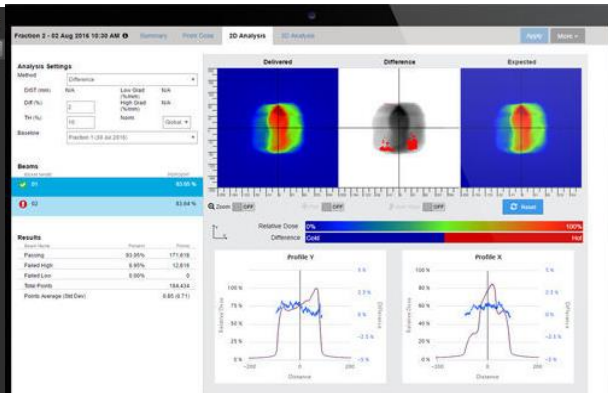
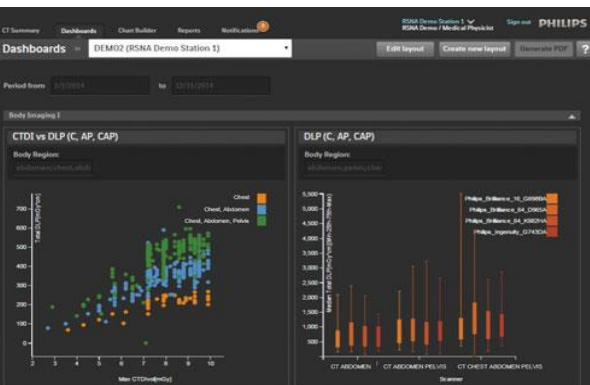
Examples of such data repositories are dose management software



It is a software tool that can be connected with different medical ionizing and non-ionizing radiation machines to consolidate all available data into a single configuration where every examination is analyzed and archived.

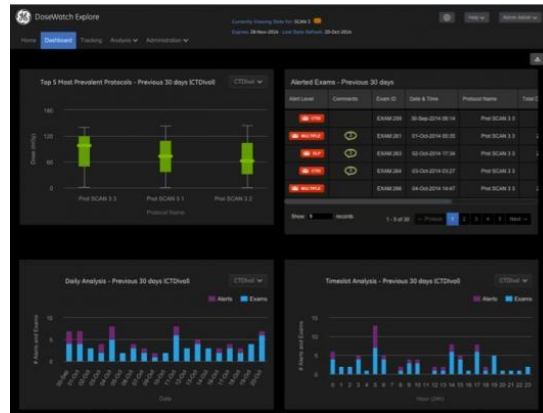
The collection is performed following standards and good practices, using Digital Imaging and Communications in Medicine (DICOM) and Health Level Seven (HL7) standards, integrating the Healthcare Enterprise (IHE) Radiation Exposure Monitoring (REM) profiles.

It provides a direct overview and makes information available at any time for all users, depending on their level of authority.

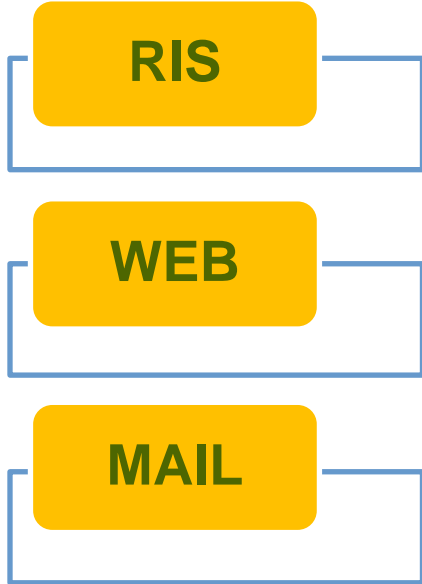


Every imaging equipment can be connected to the DMS

Dose management software



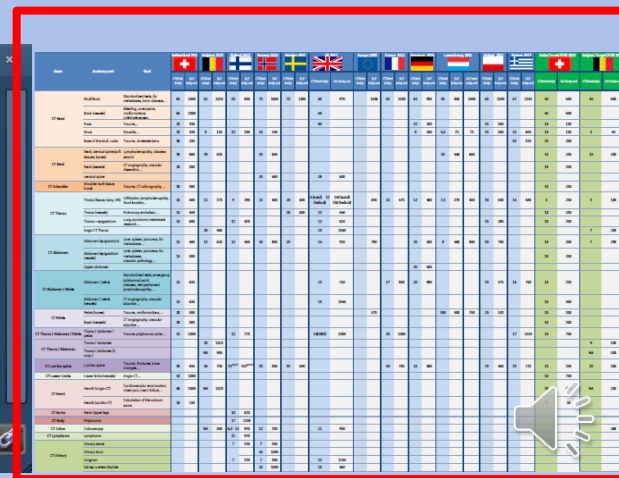
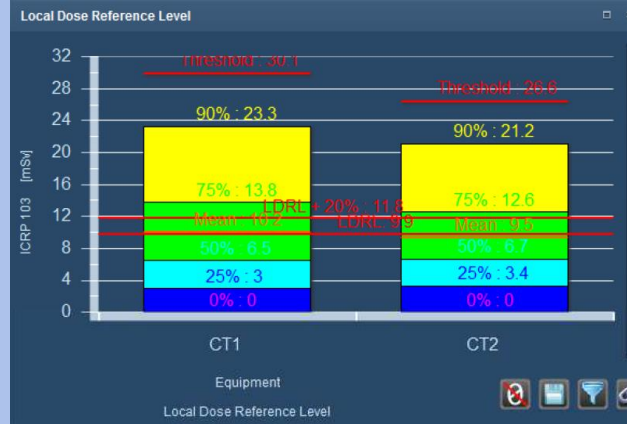
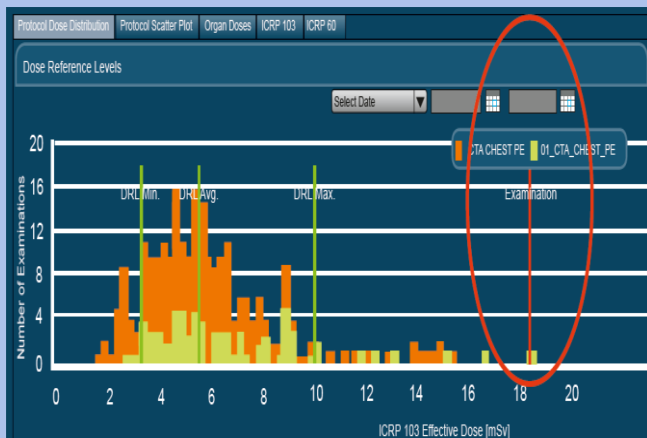
Dose management software



DMS and DRLs

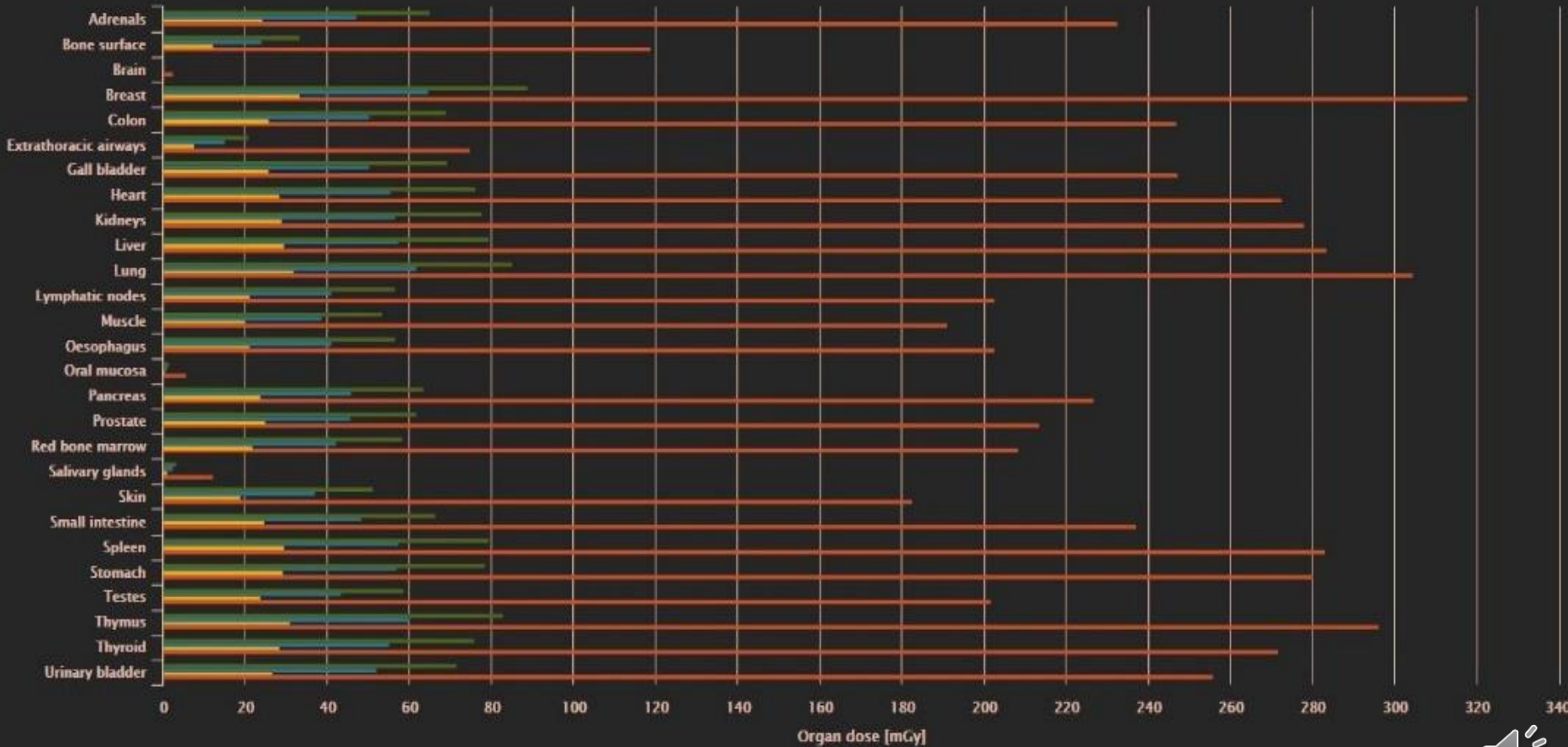
Facilitates easy, quick, and immediate estimation, calculation and analysis of

- Diagnostic reference levels
- Dose alerts
- Compares with national and international standards



Country	ICRP 103	ICRP 60	FORSHOFT	THRESHOLD
01_CHEST
01_CHEST
01_CHEST
01_CHEST

Organ dose comparison



Current study 25 perc Median 75 perc



Data validation

- After data are collected, they must be validated. Guidelines are lacking on how this can be done
- Parameters are occasionally mentioned in the wrong DICOM field
- Parameters may be mentioned in vendor specific fields

Neuroradiology. 2016 Oct;58(10):955-959. Epub 2016 Jul 20.

Clinical evaluation of a dose monitoring software tool based on Monte Carlo Simulation in assessment of eye lens doses for cranial CT scans.

Guberina N¹, Suntharalingam S², Naßenstein K², Forsting M², Theysohn J², Wetter A², Ringelstein A².

Acta Radiol. 2017 Jan 1:284185117716199. doi: 10.1177/0284185117716199. [Epub ahead of print]

Verification of organ doses calculated by a dose monitoring software tool based on Monte Carlo Simulation in thoracic CT protocols.

Guberina N¹, Suntharalingam S¹, Naßenstein K¹, Forsting M¹, Theysohn J¹, Wetter A¹, Ringelstein A¹.



European experience



Medical Physics and Informatics - Original Research



How Tracking Radiologic Procedures and Dose Helps: Experience From Finland

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Mads M. Fatemi²
Mika Korttinen³

OBJECTIVE. The purpose of our study was to assess the effectiveness of tracking radiologic procedures and estimate dose for individual patients in terms of impact on justification and optimization.

MATERIALS AND METHODS. Data were collected in the hospital for Children and Adolescents in Helsinki, Finland, through a PACS system that covers 33 institutions in the Helsinki-Uusimaa Hospital District in which monitoring previous radiologic procedures or additional doses helped to reduce duplicate tests, procedures or provided insight that helped to streamline dose optimization for CT.

RESULTS. With the help of dose reports, our results show that availability of previous imaging studies and estimates dose figures helped to avoid additional non-CT examinations by providing required information from previously performed CT examinations, indicate the need for ongoing justification optimization in our facility as well as future studies identified in another facility, observe the need for further optimization. With a specific CT unit and estimate the outcome of successful optimization, and other 3 sites performed 3 studies in which it played the leading role and 2 studies of CT examinations had 2 additional studies could be avoided. Our patient-specific optimization provides a more reliable and effective method than that of comparing single patient group studies. Collection dose for 3 patients was not used in any studies in decision making.

CONCLUSION. Patient-specific justification and optimization becomes possible using the tracking of radiologic procedures and estimates dose of individual patients.

Advances in CT technology in the past decade have resulted in an ever-increasing use of CT scans. It is well established that patient dose is a major concern in radiologic procedures, and the use of CT scans has led to a significant increase in patient dose. The International Atomic Energy Agency, which proposed, through its Inter-Departmental Group, tracking patient exposure over 3 decades (1, 2). The United States National Academies have also published a report on the use of CT scans (3). Tracking radiologic procedures and estimates dose for individual patients has been shown to be a valuable tool in the optimization of radiologic procedures (4). There are no studies that estimate the number of CT scans will double. On the contrary, CT only represents about 1% of the total radiologic procedures (5).

Although initial concerns on tracking a facility in reducing the number of radiologic procedures and estimates dose have been lowered. With developments in PACS and optimization of dose profiles, concerns remain about the ability of monitoring and tracking. This article describes the effectiveness of tracking radiologic procedures and dose, and shows the ability of such tracking in strengthening the process of justification and optimization in radiology.

Materials and Methods

The Hospital for Children and Adolescents in Helsinki, Finland, is a PACS system covering 33 institutions in the Helsinki-Uusimaa Hospital District. The PACS system was installed during 1998. The PACS system had included only the necessary images in the beginning, but during the digital migration process in Helsinki, the entire hospital had the complete patient data, and the data were stored in PACS system by 2004. Currently, hospital receives 0.1 (1/10)

- Hospital for Children and Adolescents
- PACS system that covers 33 institutions in the Helsinki-Uusimaa Hospital District
- 900.000 radiologic procedures a year
- **Conclusion:** Radiation exposure tracking will enable institutions to formulate prospective dose reduction strategies, allowing a more individual patient-based or patient-centered approach to dose optimization than is currently possible.

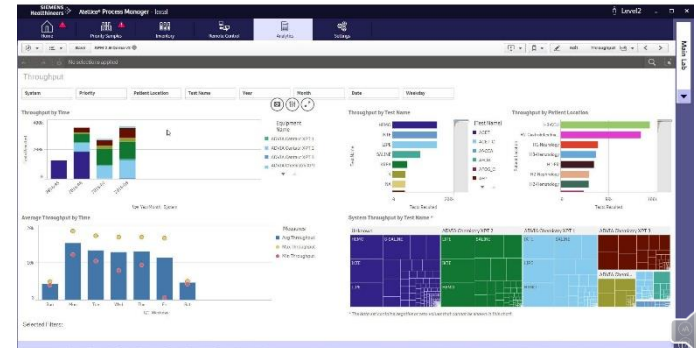
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clinical reality



What are the challenges in clinical environment?



DATA PROTECTION



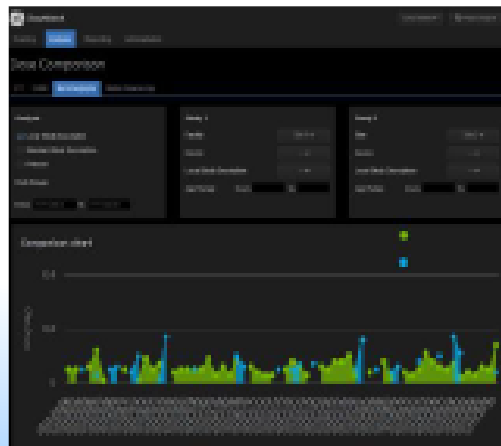
Guidelines on data protection are also needed to summarise the key points for those establishing DRLs, answer frequently asked questions, and contain practical checklists to help them comply with regulations.



Enormous amount of information

- The clinicians are bombarded with tons of graphs, figures, statistics and other info
- This tons of data do not necessarily lead to knowledge, innovation, insights

One has to scrutinize this data and be able to dig out meaningful information for the user

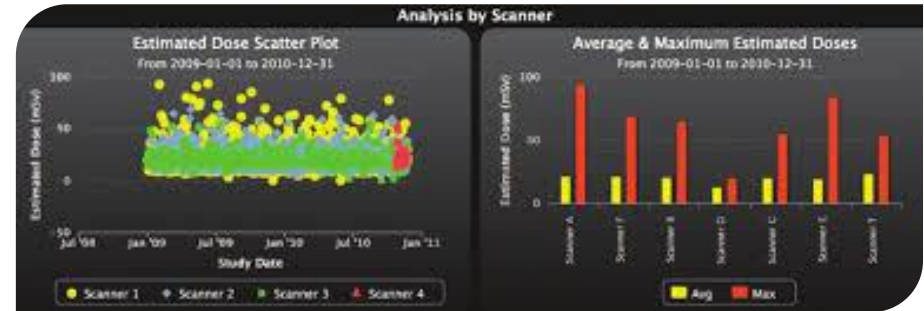


Enormous amount of protocols



- In one hospital it can be thousands of exams
- In many hospitals it can be millions of exams

- Hundreds of protocols for CT
- Mixture of old and new exams (data)



Every time you change something in the protocol or you change the protocol name there will be a permanent trace in the history of the record. This is another important reason why we have so many data



Enormous variety in machines (possible connectivity issues)

- So many different modalities (CT, mammo, radiography, fluoroscopy, interventional, nuclear medicine, MRI, etc)
- So many vendors in each modality
- So many models per vendor
- All of them will have different way of implementation
- Older machines may not provide dose reports
- Older machines do not even report dose



Institution must be certain that the X-ray machines CAN be connected to the software.

Numerous dosimetric quantities for all modalities

CTDI

AGD

CTDI_{vol}

DLP

CTDI_w

MGD

KAP

SSDE

P_{KA}

DAP

Kar

ESAK



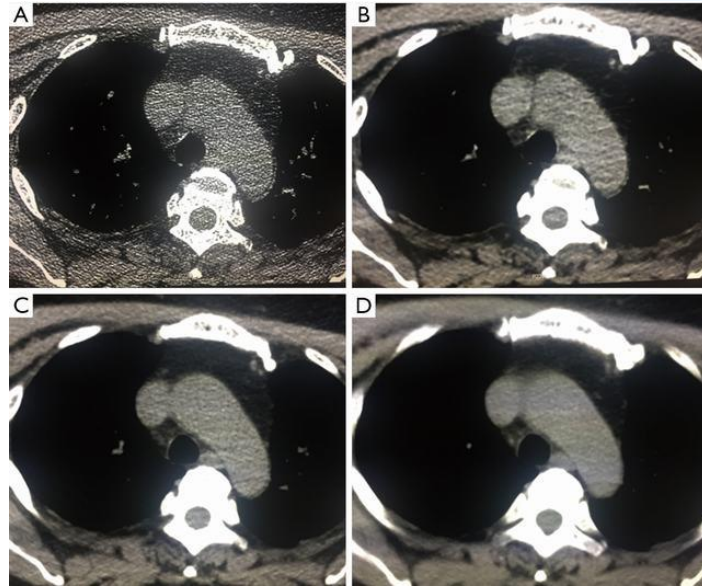


Enormous variety in
protocol
nomenclature

Use RadLex Playbook:
<http://playbook.radlex.org/playbook/SearchRadlexAction>

This is the biggest challenge after procurement and mapping better be done at a machine level.

Image quality evaluation



- The grading of image quality is not standardized
- Guidance on how to evaluate image quality is needed.



Notification values are fixed and independent of patient size.

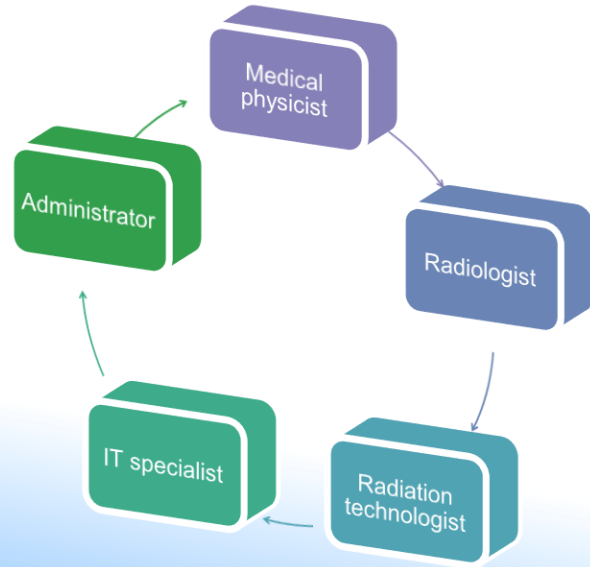
- Appropriate doses for bariatric patients may inappropriately trigger notification events.
- This can lead today to unnecessary incident reviews required by authorities.
- Even worse, when the alert value is exceeded, the workflow may stop on the scanner until a user with the proper credentials authorizes scan continuation.



Define your strategy for best use of these repositories

Define the team: medical physicist, a lead radiologist, a lead technologist and an IT expert.

Depending on local requirements, administration member or other specialists could be in the team.



TEAM EFFORT



Deciding your DMS to create the repository

- PACS is preferable for easier, quicker and more efficient installation.
- Radiation dose structured report (RDSR) is preferred.
- If there are various types of X-ray machines better state each model to be connected to avoid connectivity problems.



Before any installation of DMS, setting up correctly exam protocol is crucial to be able to use these large repositories in a meaningful way

Commitment from DMS vendors

Commitment to contact the different X-ray equipment manufacturers for modalities integration and for RIS/PACS communication to avoid connectivity problems

The vendor should define clearly actions before during and after installation on:

- Connectivity
- Installation steps
- Training (number of days number of personnel follow up training, for additional configuration as well as troubleshooting, etc)
- Assessment
- Support
- Personnel to be engaged



Conclusions

Large repositories have proven to be very useful specially in the case of DRL establishment and dose optimization purposes.

Dose management software can facilitate data collection and help in establishing, updating, and using DRLs and, hopefully, will become widely available in all countries around the world.

Work for the future:

- Collaboration with vendors on standardisation of automatic transmission of dose-related data
- standardisation of protocols
- establishment of national or regional dose repositories
- harmonisation of the terminology used to define the protocols





THANK YOU FOR YOUR ATTENTION

