2020 Joint AAPM/COMP Virtual Meeting

Anatomical and clinical Diagnostic Reference levels; an update

Large repositories: Opportunities and challenges

V.Tsapaki
Medical Physicist (Diagnostic Radiology)
Dosimetry and Medical Radiation Physics Section
Division of Human Health, IAEA

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

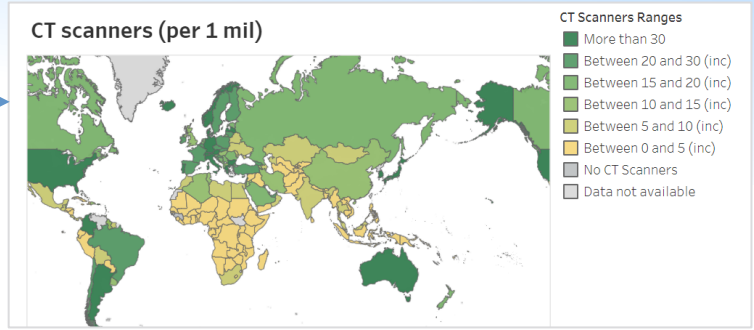
IMAGINE

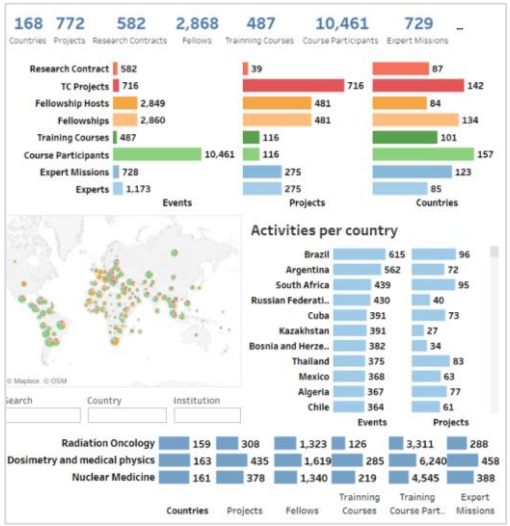
DOLNET

GLOBAL DATABASE

NUMBAD

DAN



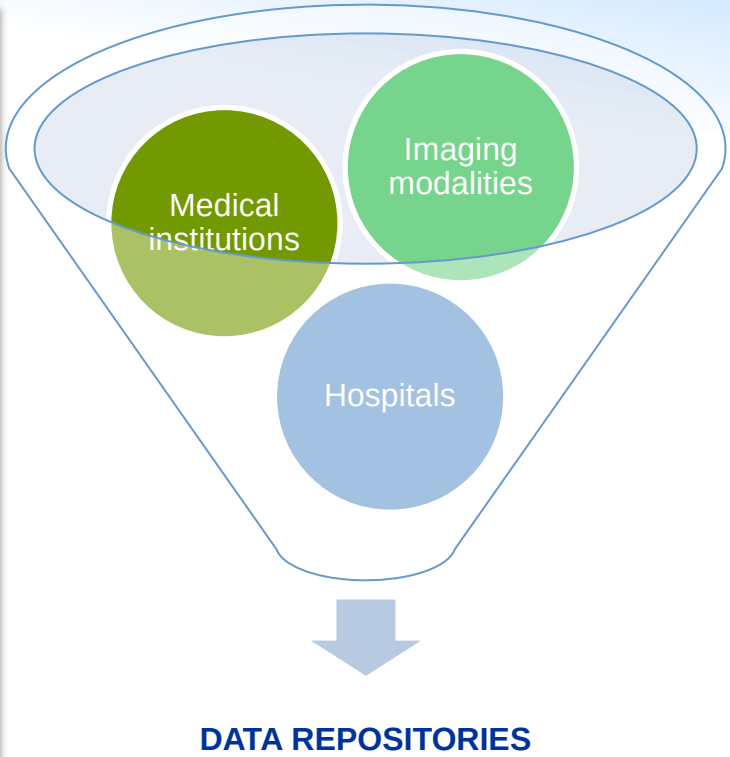


Clinical Data Repository

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



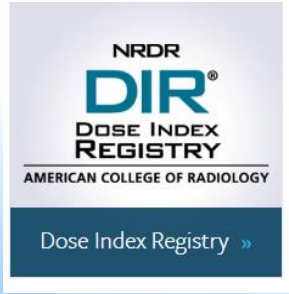
Patient data repositories

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

Dose repository



April 2018

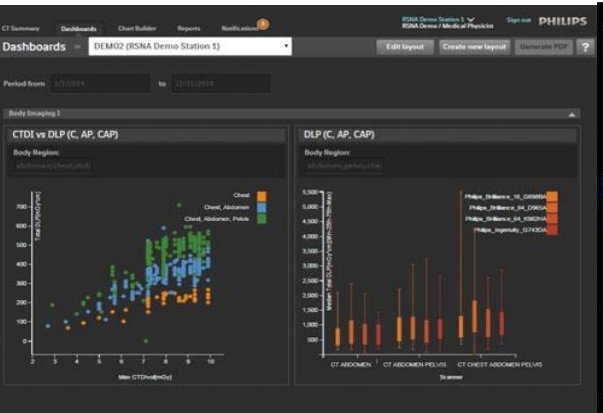
50 million exams from more than 2100 facilities

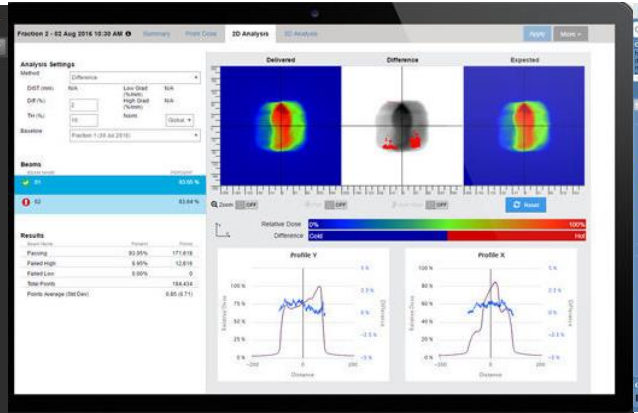
Examples of such data repositories are dose management software

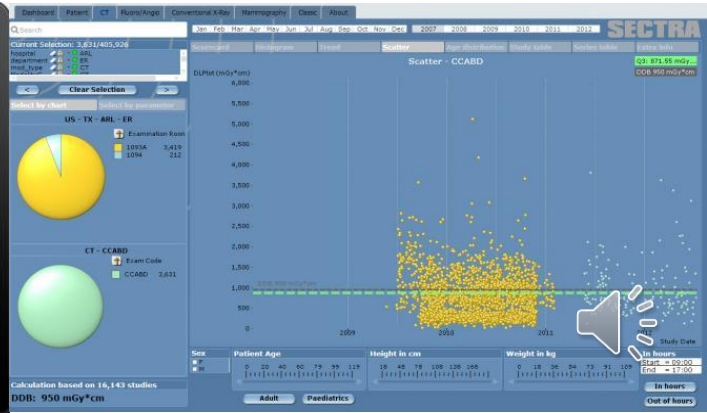
It is a software tool that can be connected with different medical ionizing and non-ionizing radiation machines to consolidate all available data into a single configuration where every examination is analyzed and archived.

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.







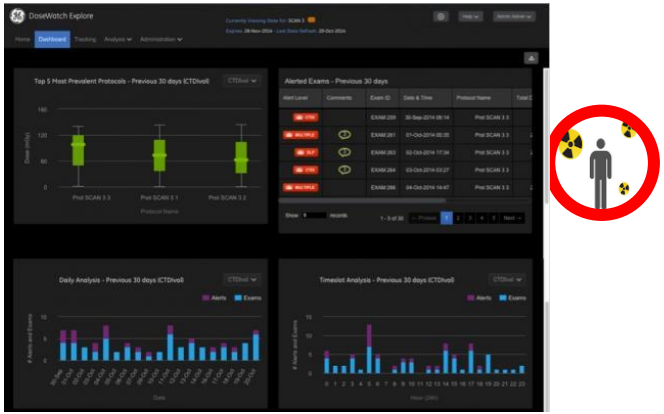
Every imaging equipment can be connected to the DMS

RIS

WEB

MAIL

Dose management software



Dose management software

CT

Radiogr

Angio

Mobile

NM

MRI

Mammo

US

DEXA

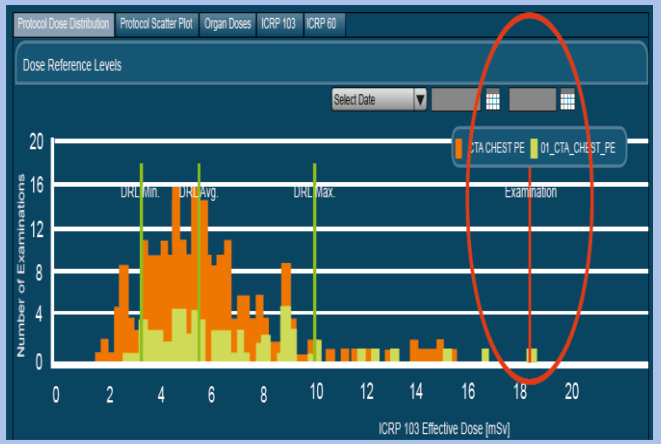
CBCT

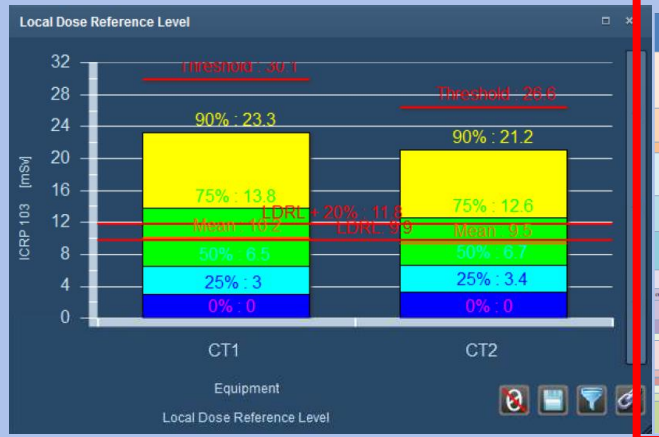
PACS

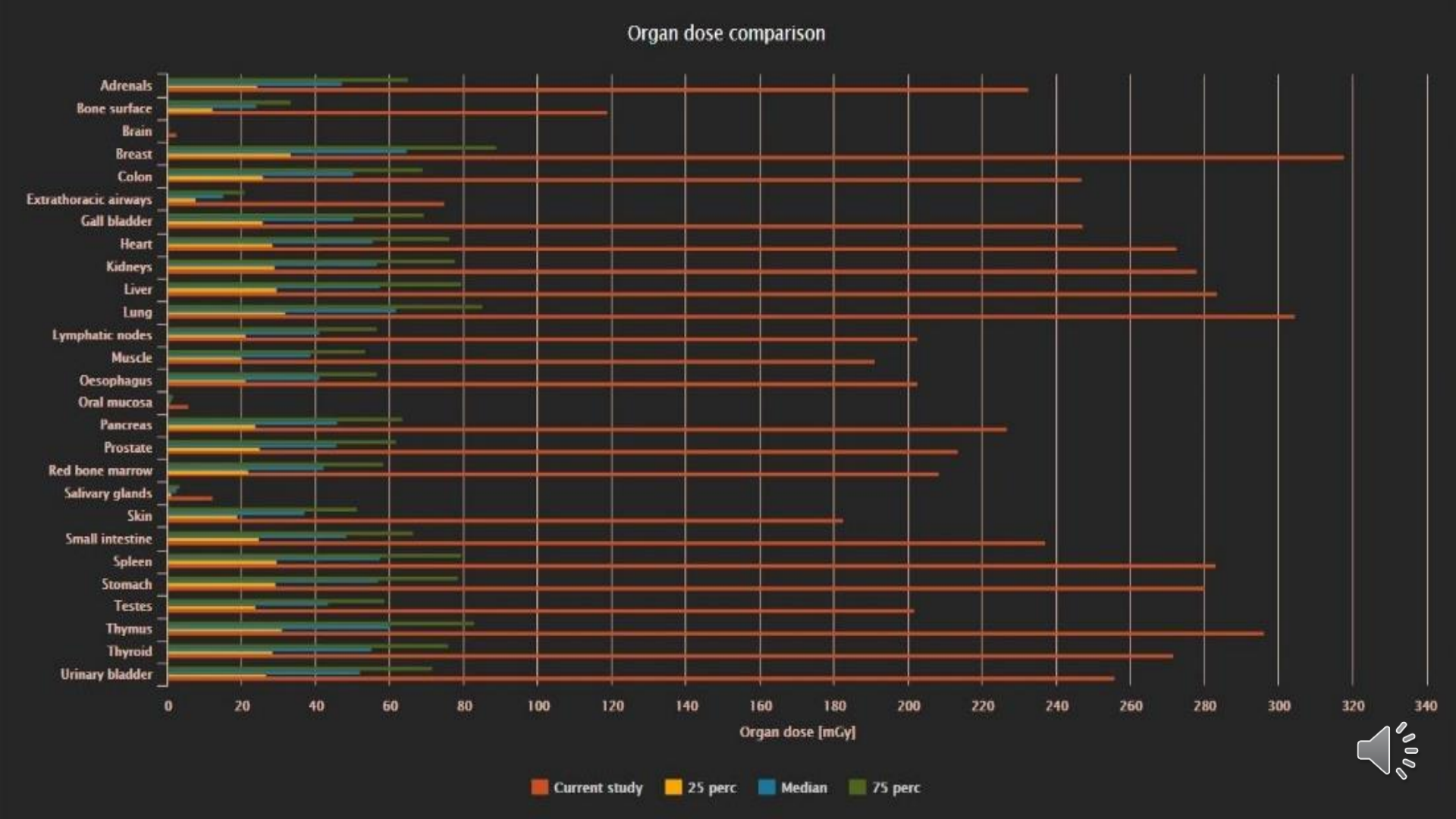
DMS and DRLs

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

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






Organ dose comparison
Adrenals
Bone surface
Brain
Breast
Colon
Extrathoracic airways
Gall bladder
Heart
Kidneys
Liver
Lung
Lymphatic nodes
Muscle
Oesophagus
Oral mucosa
Pancreas
Prostate
Red bone marrow
Salivary glands
Skin
Small intestine
Spleen
Stomach
Testes
Thymus
Thyroid
Urinary bladder
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
Organ dose [mGy]
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.

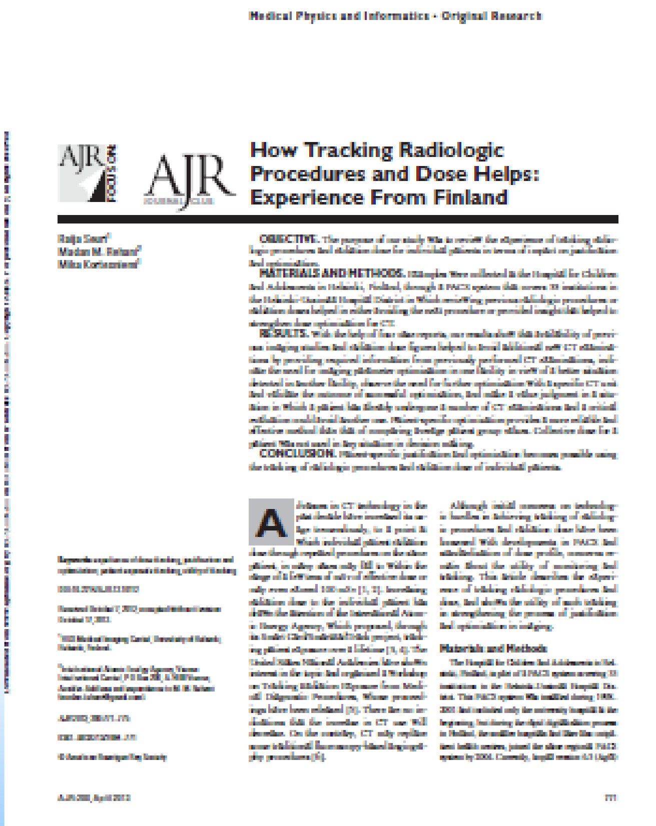
Guberina N[1], Suntharalingam S[2], Naßenstein K[2], Forsting M[2], Theysohn J[2], Wetter A[2], Ringelstein A[2].

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 N[1], Suntharalingam S[1], Naßenstein K[1], Forsting M[1], Theysohn J[1], Wetter A[1], Ringelstein A[1].

European experience


Medical Physics and Informatics • Original Research

How Tracking Radiologic Procedures and Dose Helps: Experience From Finland

Raija Seuri
Madan M. Rehani
Mika Kortesniemi

OBJECTIVE.

MATERIALS AND METHODS.

RESULTS.

CONCLUSION.

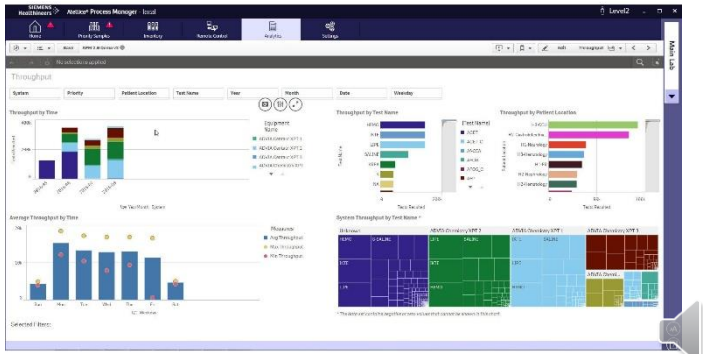
Materials and Methods

- 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.

clinical reality

What are the challenges in clinical environment?



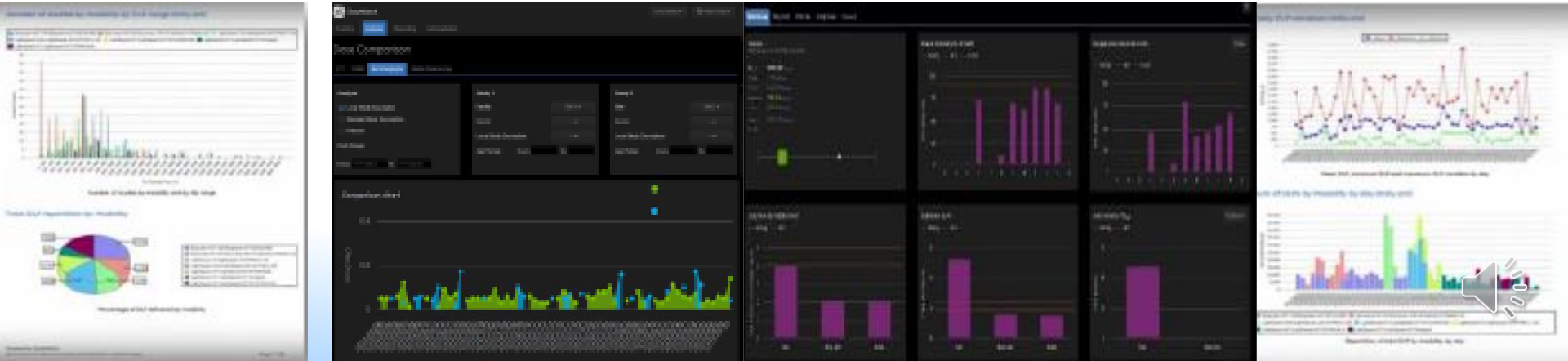
DATA PROTECTION

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

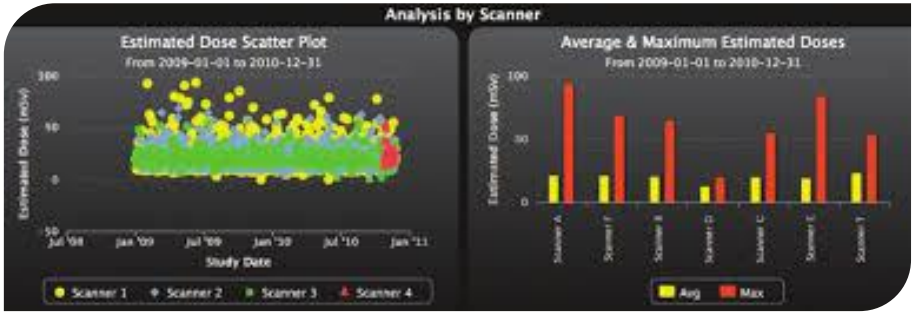
One has to scrutinize this data and be able to dig out meaningful information for the user



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

K_{ar}

P_{KA}

DAP

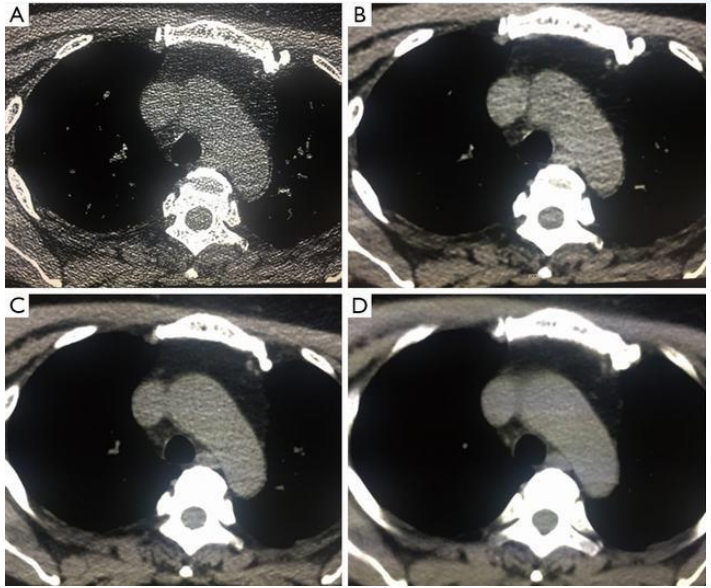
ESAK

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



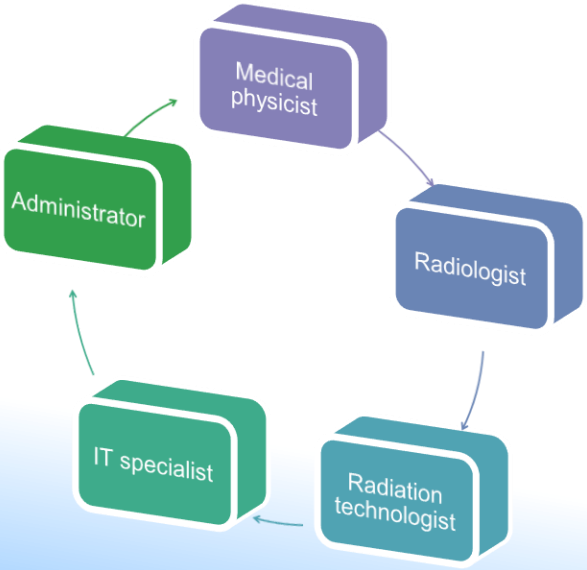
- The grading of image quality is not standardized
- Guidance on how to evaluate image quality is needed.

Notification values are fixed and independent of patient size.

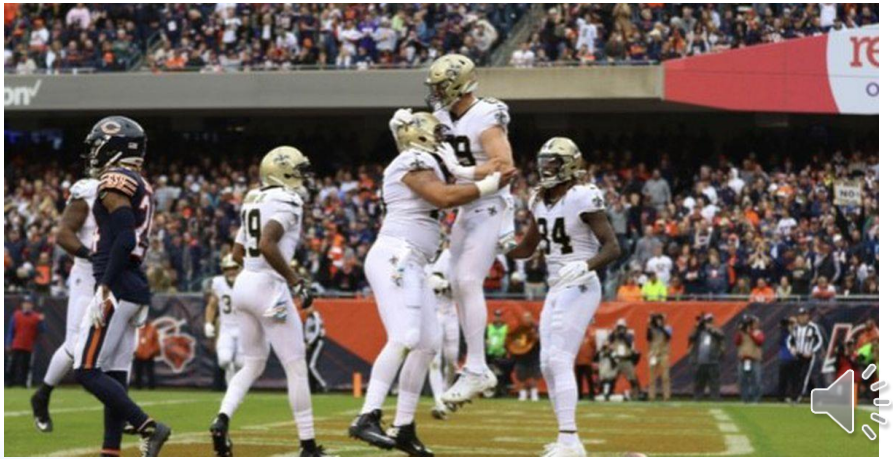
- Appropriate doses for bariatric patients may inappropriately trigger notification events.
- This can lead today to unnecessary incident reviews required by authorities.
- Even worse, when the alert value is exceeded, the workflow may stop on the scanner until a user with the proper credentials authorizes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