Overview of Dose and Procedure Tracking: What, Why and How?

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Good, Bad & Ugly of Patient Exposure & Dose Tracking

Understanding tracking

1. Tracking of Individual patient’s exposures or doses
2. Tracking doses of Group of patients

Terminology

• Patient exposures implies imparting of radiation
• Patient exposure tracking: Gives a sense of tracking of exposures (dose gets implied but in qualitative sense)
• Dose tracking: Specific focus on dose

Understanding Individual patient tracking

1. Individual patient exposures or doses
   A. Only procedure tracking (number & type of imaging studies)- Procedure or exposure tracking
   B. Doses involved in these studies- Dose tracking
   C. It does NOT automatically imply cumulative dose of an individual patient

Misconception & Myth

- Radiation doses on a card with the patient
- Card like ATM card - No cash on card
- Credit Card - No credit on card
- Card acts as digital signature to access information on the server

Understanding tracking

**Doses from group of patients**

- Has been done for decades (dose monitoring)
- Effective doses or other dose indices
- Collective dose
- DRLs
- dose registries
- Dose records
- Dose optimization

Tracking of dose to **Group of Patients**

- Has been quite prevalent (less barriers of confidentiality of patient identification)
- Comparing doses within an institution
- Comparing doses with others
- Accreditation

**USA (NCRP)**

- Interventional radiology 0.4
- Nuclear medicine 0.8
- CT scans 1.5
- All other 0.14
- Natural background 3.3

mSv contribution to population dose

**Tracking of Individual patient doses**

Relatively New
WHY new focus on individual?
- DRLs not applicable to individual
- Risk estimates not applicable to individual
- We want to protect individual
- Day-to-day situations
- Regulatory requirements (California law)
- Individual patient doses are increasing

**Number of CT Examinations**
- 31,500 patients
- 190,712 CT examinations
- 22 year period
  - 33%: ≥ 5 CT exams
  - 5%: 22-132 exams

**Estimated Cumulative Dose**
- 15%, ED > 100 mSv
- 4%, 250 - 1375 mSv
- 1%, > 399 mSv

**Tracking of exposures & doses of an individual patient**

**Down the memory lane**

**Situation 2003-2008: Critics**
August 2009

IAEA MOUNTS EFFORT TO RECORD PATIENT DOSE

In April of this year, the International Atomic Energy Agency announced a new project to record medical radiation exposure to patients over a lifetime. Besides calling attention to the increased exposure from the growing volume of CT scans and other procedures, the IAEA also notes that patient dose from CT scans is distinctly from traditional x-ray examinations, said Madan Rehani, an IAEA radiation safety specialist.

The IAEA has invited the ISRO and other international organizations to participate in the design of a "smart card" which people might carry to record their radiation exposure over a lifetime. How such a system might function has not been determined, he said.
AAPM 2010

The public is largely unaware of the radiation doses delivered by CT, positron emission tomography (PET) and other examinations that involve using ionizing radiation to create medical images of the body and to detect cancers. The use of CT and PET scan imaging for cancer patients may be higher than expected. While the cost of these techniques has increased, they may not be the most cost-effective. The cost of PET scans may be as high as $3000 per scan, while a PET scan may cost as much as $5000 per scan. The cost of cancer treatment is also increasing. The cost of cancer treatment is increasing at a rate of 10% per year.

In order to improve the quality and cost-effectiveness of medical imaging, the American College of Radiology (ACR) has developed a set of guidelines for the use of medical imaging. These guidelines recommend the use of low-dose CT scans for the evaluation of patients with cancer. The ACR guidelines recommend that patients receive a CT scan only if it is necessary to determine the extent of the cancer. The guidelines also recommend that patients receive only one CT scan in the course of their treatment. The ACR guidelines also recommend that patients receive a CT scan only if it is necessary to determine the extent of the cancer. The guidelines also recommend that patients receive only one CT scan in the course of their treatment. The ACR guidelines also recommend that patients receive only one CT scan in the course of their treatment.

UN News Centre

"Smart Card" project aims to better protect patients from radiation, says UN experts

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Outcomes

- Implementation by industry in few years
- Difficult to find another example
- Call for action
- Some countries already having experience
- Enthusiasm in others to establish

How?

6 mo boy, neuroblastoma of the posterior mediastinum

AJR April 2013, 771-775

How Tracking Radiologic Procedures and Dose Helps: Experience From Finland

Objective. The purpose of our study was to assess the experience of tracking radiologic procedures and radiation dose for soft tissue patients in terms of impact on justification and optimization.

Materials and Methods. Examples were collected at the Hospital for Children.

Conclusion. Patient-specific justification and optimization becomes possible using the tracking of radiologic procedures and radiation dose of individual patients.
Case Report: 1 (Justification)

- 6 month old boy diagnosed with neuroblastoma of the posterior mediastinum.
- The initial imaging included CT of the thorax as well as abdominal MRI.
- Bone scan performed two weeks later showed increased uptake in the posterior upper ribs on the right.
- Alarmed the oncologist to think of metastases in the ribs and thus a request for new CT scan.

Case Report: 2

Boy 16 y, osteosarcoma of the femur, CT chest for metastasis survey

Dec 2008, DLP 475 mGy•cm

Boy 16 y, osteosarcoma of the femur

Oct 2009 CTDI 5.27mGy, DLP 221mGycm

May 2010 CTDI 3.44 mGy, DLP 135 mGycm
Case Report 2 (Optimization)
- Boy 16 y, osteosarcoma of the femur.
- Initial imaging: CT of the chest (old scanner in 2008). DLP 475 mGy.cm.
- Follow-up examination in 2009, in another hospital but connected by PACS.
- DLP 221 mGy.cm.
- New scanner DLP 135 mGy.cm. Good image quality despite such low dose values

Case Report 2 (Optimization)
- Feedback was provided to facilities that provided higher doses for the same study for the same patient.
- It helped them to optimize.
- Thus tracking provided opportunities to strengthen optimization of patient protection.
- Patient acting as a self control for comparison (not comparison to DRL).
- Fundamental issue of Individual optimization

Case Report 3 (Justification & Optimization)
- A 7-year-old boy had been operated for omphalocele at another hospital soon after birth.
- He had been doing quite well but had lately developed elevation of liver transaminase levels during infections.
- A pediatric gastrointestinal surgeon in the Hospital for Children and Adolescents in Helsinki, Finland, was consulted, who suggested CT angiography because of the anomalous anatomy.
- CT of the abdomen had been performed for the same reason in the local hospital, although only in one vascular phase.
- The study was sent electronically to the PACS at the Hospital for Children and Adolescents and was found to be sufficient for vascular analysis.
- Thus, CT angiography could be avoided.

Case Report 3 (Optimization part)
- The scanning metadata also included radiation parameters, such as kVp, tube current, and exposure indices (DLP and CTDIvol).
- The analysis of radiation dose data, together with the image quality, revealed lower exposure than in normal practice, 0.79 mGy compared with 3.7–2.0 mGy (32-cm phantom) with a child about the same size.
- This provided the need for further optimization with specific CT unit and validate the outcome of successful optimization.
- The common denominator in all such examples is the specific patient who acts as a control for comparison.
- This perspective is markedly different from merely comparing average values with variable sample populations between facilities, which is the approach used traditionally.
Experience of patient exposure tracking indicates that it leads to

• Strengthening the process of justification by avoiding another examination
• Strengthening the process of optimization
• Information for audit of patient doses for quality assurance purpose

Future of optimization

• Based on
  – the individual patient
  – Doses for indication based examination
  – Suggested settings
• Whole new area of optimization, departure from DRLs

2008

• What tracking means?
• Why track?
• What to track?
• How to track?
• Usefulness of tracking?

2017

• What to do with dose information from tracking?
• Should dose be used for justifying next examination?
• How to deal with cumulative dose information?

Tracking of individual patient

How to make it happen?

Foremost necessity

Use of permanent ID of patient
Countries who responded to IAEA survey

Algeria, Argentina, Armenia, Bosnia and Herzegovina, Bulgaria, Colombia, Costa Rica, Czech Republic, Egypt, Estonia, Finland, Greece, Honduras, Hong Kong (China), Ireland, Ireland, Kenya, Lithuania, Malaysia, Macedonia, Malta, Mexico, Moldova, Montenegro, Portugal, Nicaragua, Romania, Russian Federation, Serbia, Singapore, Slovakia, Slovenia, Spain, Sri Lanka, Sudan, Tajikistan, Tanzania, Uruguay

Is there a unique permanent identification number for every person in the country valid for life?

- YES: 81%
- NO: 19%

Total: 36

Is this permanent number used for X-ray examinations whenever a person visits a hospital?

- YES: 44%
- NO: 56%

Total: 36

If this number is NOT used, it is because of:

- Lack of technology: 92%
- Confidentiality issue of patient: 8%

Percentages out of 20 answers!!

**Table 1. Potential benefits of patient radiation exposure tracking.**

- Reduced risk of radiation exposure.
- Improved patient safety and protection.
- Enhanced efficiency and accuracy in radiation therapy.
- Facilitates regulatory compliance.
- Promotes transparency and accountability in healthcare.

**Joint Position Statement**

- World Health Organization (WHO),
- U.S. Food and Drug Administration (FDA),
- European Society of Radiology (ESR),
- International Organization for Medical Physics (IOMP),
- International Society of Radiographers and Radiological Technologists (ISRRRT), and
- Conference of Radiation Control Program Directors (CRCPD) of USA.

**Looking back**

- It was good that I did not pursue it aggressively in 2003-2007
- Ahead of time
- Radiation units were not as matured (IAEA TRS -2007, ICRU 74-2006)
- PACS not talking to each other
- e-Health was in infancy
- Reports of few tens of or of ≥100 mSv doses to an individual were not there, but we predicted it to come
How to use information?

Tentative

- The decision for the examination at hand should primarily be based on benefit versus risk of current examination but there should also be an awareness of risk from patient’s prior radiation history.
- Holistic reflection of the quality and safety of patient’s care

Cumulative dose (Ugly?)

- An area which is yet to mature
- Like in case of occupation exposure, despite availability of lifetime record, what really matters is the 5 year slot.
- Likewise, from clinical standpoint what may be of use is the examination done in past 2 years

Future

- Future: ? Dose constraints for patients
- If the concept of dose constraints is accepted, there may a value of cumulative dose e.g. in research subjects currently
- Yellow light, rather than red
- Cultural shift from ALWAYS green
- Utility in epidemiological studies

Recap

- What? Understanding tracking: Individual patient’s versus group of patients, exposure tracking vs dose tracking
- Why tracking
- How did it start and initial years, momentum through Call for action
- Patient ID (Crucial for individual tracking)
- Case reports from published paper
- Patient acting as his/her control (optimization)
- Future

Some publications


Some publications

Some publications


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