Quantifying Quality: ‘If you cannot measure it you cannot improve it’

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**IOMP – International Organization for Medical Physics**

- Federative body of all medical physics societies in the world
- Created in 1963 by UK, USA, Canada, Sweden (6000 members)
- In 2016 IOMP has c.25,000 members in 86 National Societies
- 6 Regional Organisations (Federations)
- NGO to IAEA and WHO

**MISSION**

- To disseminate scientific and technical information
- To foster the educational and professional development
- To promote the highest quality medical services for patients
• X-ray examinations are about 3/4 of all Diagnostic Imaging
• X-ray DR delivers the highest patient dose in Imaging

Ref. 1
Variation of DR Patient Doses

Entrance Surface Dose from Computed Radiography X-ray examinations in a LMIC country, 2014

Variations of the order of 10 to 50 times

Entrance Surface Dose from Film-Screen Radiography X-ray examinations in UK, 1990

Variations boosted QC activities

Ref. 2

Ref. 3
Quality Control activities over the years

- Dose Measurements
- Image Quality Assessment
- Test Objects
- Quality Factors
- Quality Assurance Systems
- Myriads of papers, many books
- The e-learning in the profession
- Dissemination
- Quick results

Dose Output Consistency after 3 years QC measures

Ref. 4
**Imaging Achievements and Challenges**

**Technical Achievements:**
- Stable source of radiation
- High sensitivity detectors
- Image improvement software
- Precise quantitative measurements
- New imaging methods

**Various Challenges:**
- Dynamics of Innovations
- Huge massive of data
- Lack of Information/Understanding
- Need of constant specialist re-training
- Training for medical staff
- Increased Patient Dose
Precision and Optimisation

Precision of QC measurements:
- Quantification of performance quality
- Objective Quality indicators
- Precise Dose measurements
- Comparative Analysis
- Optimisation strategy research/plans

Optimisation:
- Quality benchmarks
- Dose reduction programme
- Training staff
- Tracing Optimisation results
- Disseminate Good practice

Effective Dose > Image Quality Factor
IQF > Visual Grading Criteria

Ref. 5
Quantification of Quality

Correct Quantification:
- Precision of tools
- Quality Procedures
- Plan for Optimisation
- Practical implementation
- Trained specialists

Entering Quality in the Education:
- Specifying the problem/parameter
- Parameter description
- Method of measurement
- Understanding the result
- Analysis of the outcome
- Improvement of the parameter

CTDI = \frac{1}{n \cdot T} \left[ \int_{z_1}^{z_2} D(z) \, dz \right] \text{ mGy}

DQE = \frac{(SNR^2)_{out}}{(SNR^2)_{in}} = \frac{NEQ}{N}
Optimisation: Ways Forward

Wrong:
- Relying on automatic QC only
- High number less-qualified QC assessors
- Privatisation of QC activities alone

Right:
- Increased links with the industry
- Forcing industry to intra-harmonization
- Standard measurements
- Increasing the volume of curricula
- New types of re-training (e-learning)
- Increasing the number of medical physicists

www.mpijournal.org
Number of medical physicists worldwide since the establishment of IOMP

UNSCEAR 2008:
- 3,600 millions X-ray examinations
- 37 million Nucl. Medicine procedures
- 7.5 million Rad. Oncology treatments

**Work force necessary for Radiotherapy:**
2035 Report of the Global Task Force on Radiotherapy for Cancer Control (GTFRCC)  [Ref.6]

Needs to achieve adequate healthcare in the field of oncology until 2035:
- In countries with low and middle income – needed 13,000 Megavoltage machines and about 22,000 medical physicists.
- In countries with high income needed 9,000 Megavoltage machines and about 17,000 medical physicists.

?? Need of Medical Physicists in Imaging – work in progress ...
IOMP : Global Organization with 6 Federations + 86 National societies

USA+Canada 8400
ALFIM 900
EFOMP 8400
FAMPO 400
MEFOMP 600
SEAFOMP 500
AFOMP 4700

IOMP : 86 countries
~24,000 members (2015)

IOMP is NGO member of IAEA and WHO

Ref. 7
Medical Physics Dictionary and Encyclopaedia WWW.EMITEL2.EU:

- Translated in 29 languages (8 alphabets): English, French, German, Italian, Swedish, Spanish, Portuguese, Bulgarian, Czech, Greek, Hungarian, Lithuanian, Polish; Estonian, Romanian, Turkish, Latvian, Russian, Thai, Arabic, Iranian, Bengali, Slovenian, Malay, Chinese, Croatian, Japanese, Finnish, Korean

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**Anode heel effect**

**Diagnostic Radiology**

The X-ray anode generates radiation in all directions (only a fraction of it is at the direction of the patient). At diagnostic energy, this fraction is mainly at direction 90° from the direction of the incident electron beam (anode current) in the X-ray tube. The intensity of the radiation beam towards the patient has significant spatial variation. Figure 1 (curve 1) presents an example where the maximal intensity of a new X-ray beam (marked with 100%) is at direction 15° measured from the anode surface (this depends on the type of the X-ray tube). There is a notable loss of X-ray beam intensity (up to 50%) at the anode side of the beam. This is due to lesser production of X-ray photons at this direction (mainly due to absorption of the X-rays in the anode itself at the lower end of the target surface). This decreased intensity of radiation at the Anode site of the beam (if one looks it from the place of the patient) is known as "Heel effect".

X-ray beam span (degrees)
CONCLUSION:

- High Quality could be maintained only by Qualified Specialists
- Medical Physicists are at the forefront of Safety and Quality Assurance in Radiation Medicine

References:

2. Sharma R et al, Radiation dose to patients from X-ray radiographic examinations using computed radiography imaging system, J. of Medical Physics, 2015
3. Patient Dose Reduction in Diagnostic Radiology, NRPB, 1990, 1(3), UK
THANK YOU