Radiation Dose Index Monitoring

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AAPM TG 257 (MPPG #6) charge:
“Create a practice guideline on the minimum requirements of patient dose tracking systems based on core patient safety objectives.”

Status: Draft completed and out for review

Minimum requirements described here are included in draft document

Best practices for using dose index monitoring software also addressed

Topics

• Informatics Requirements for RDIM
• Practical Advice on Configuration
• CT Requirements for RDIM
• CT QA Use Scenarios
• Nuclear Medicine Requirements for RDIM
• NM QA Use Scenarios
• Conclusion

Informatics

*Image from SIIM
Informatics

• An RDIM system is nexus linked to nearly all radiology hardware and software
  – PACS
  – RIS
  – EMR
  – Modalities
  – Dictation VR
  – Provider/Physician/Technologist database

Informatics

• An RDIM system that does not meet the Informatics Requirements will likely not meet most other requirements
• Participation from team members is key for configuration
  – QMP
  – Technologist
  – PACS/IT
  – Clinical Engineering
  – OEM service rep

Informatics: Dose Metric Acquisition

• Primary Consideration:
  – How will RDIM receive dose metrics?
• Options
  – Directly from modality
  – Pulled from PACS
    • DICOM metadata
    • OCR of dose pages

RDIM Informatics Requirements

• Communicate using DICOM, IHE and HL7 standards
• Vendor-neutral data portability (database of dose indices is purchaser’s if contract terminated)
• Patient PHI protected according to HIPPA and HITECH requirements
• Vendor-neutral dose index input and collection
Informatics: Dose Index Acquisition

- Receipt of DICOM Radiation Dose Structured Report (RDSR)
- Dose index data per IHE Radiation Exposure Monitoring (REM) profile
- Acceptance of DICOM Modality Perform Procedure Step (MPPS) message
- Optical Character Recognition (OCR) of secondary capture dose page images
- Dose index capture from DICOM metadata
- Manual entry

Informatics Configuration Considerations

- Workstation or server configuration
  - Virtual, dedicated or cloud
  - User or vendor supplied
- Modality configuration
  - DICOM Node configuration
  - Global or protocol specific configuration
  - Automated transmission or operator intervention

Practical Advice on Configuration

- Key consideration: Dose indices from modalities or PACS
  - Fewer setup steps if PACS queried
  - Real time updating of database requires modality configuration
  - Some modalities may not be able to send DICOM RDSR (preferred method)
  - CMS requirement of NEMA XR-29 for full CT reimbursement in 2016 (includes RDSRs)

Practical Advice on Configuration

- Modality ability to generate RDSRs not a magic bullet
- Some PACS systems/versions do not play nicely with RDSRS
- Generation of RDSR along with dose page image and transmission to PACS may cause issues
Computed Tomography

• Dose index monitoring for CT
  – Largest contribution of radiation dose from medical imaging to population
  – Profile raised due to several highly publicized cases of patient over irradiation
• Say it with me:
  – CTDIvol is not patient dose

CT-Specific Requirements

• Automatic monitoring of essential dose indices
• The following indices must be recorded on a per-series (irradiation event) basis
  – CTDIvol
  – CTDI phantom
  – DLP

CT-Specific Requirements

• CT dose indices may be collected via:
  • DICOM RDSR (complies with NEMA XR-29)
  • OCR of dose page with series level dose index information
    – Most common option for systems not NEMA XR-29 compliant
  • DICOM metadata

CT-Specific Requirements

• Notification of dose indices outside defined range
• RDIM software must be able to generate notifications to end user if dose indices fall outside of defined range
  – Global or protocol specific ranges
CT-Specific Requirements

- Dose indices outside of defined range
  - Key requirement for quality assurance and detection of outliers
  - Configuration of acceptable dose index ranges and active monitoring of exams outside acceptable ranges to comply with new Joint Commission requirements

CT-Specific Requirements

- Transmission of anonymized data to data repositories or registries
  - Joint Commission requires comparison to external benchmarks and CMS requires transmission to registry for lung cancer screening
  - Software must be able to transmit anonymized CT dose indices to external repositories or registries

CT-Specific Requirements

- Size Specific Dose Estimate (SSDE)
- RDIM software should be capable of calculating series-level SSDE for CT
- Methodology for calculation of SSDE should be defined in user manual

CT-Specific Requirements

- Utilization of SSDE or CTDIvol and Water Equivalent Diameter (WED)
  - Essential for quality assurance
  - Protocol or body-region specific analysis of SSDE or CTDIvol and WED:
    - Outlier analysis taking into account body habitus
    - Expected range of scanner output taking into account body habitus
Nuclear Medicine Requirements

• Second largest contribution to average population dose from medical imaging
• Significant increase since 1980
  – Extensive use of Myocardial Perfusion Imaging (MPI) for coronary artery disease
  – FDG PET imaging for oncology applications
• Increases in pediatric PET imaging
• Radiation exposure monitoring important for QA

NM-Specific Requirements

• Automatic monitoring of dose indices for diagnostic radiopharmaceutical administrations
  – Software must be able to import DICOM radiopharmaceutical radiation dose reporting (RDRR) structured reports defined in DICOM supplement 159

NM-Specific Requirements

• Manual entry of diagnostic radiopharmaceutical administration dose indices
  – Software must support manual entry of procedure and patient related parameters
    – Procedure Name
    – Radionuclide
    – Pharmaceutical
    – Pre-Administration Activity
    – Post-Administration Residual Activity
    – Date/Times of Activity Assays
    – Activity Administration Date/Time
    – Route of Administration
    – Patient age at time of exam
    – Patient height and weight

NM-Specific Requirements

• Multiple radiopharmaceutical administrations
  – Software must support importing dose indices for procedures that involve multiple radio
  – For example: Stress-rest myocardial perfusion imaging or simultaneous solid-liquid gastric emptying
NM-Specific Requirements

- Organ and effective dose estimates
  - Software should support calculation of organ and effective dose estimates for diagnostic procedures
    - Account for patient age and gender
    - Based on appropriate and published reference tables
    - References should be clearly cited in report
    - User entry of dose tables should be supported and include field for citation
  - Dose estimates are for QA purposes and shall not be used for treatment planning or medical event dose calculations

NM Use Scenarios

- RDIMs may be employed to confirm imaging protocols are being followed when combined with information from EMR
  - Example case
    - Pediatric specific PET protocol calls for lower activity to be administered than is used for adults
    - Monitoring pre-administration activity and patient age can confirm imaging protocol is followed

NM Use Scenarios

- A number of vendors and institutions were contacted to offer examples of how RDIM software is used in clinical practice in Nuclear Medicine
- These examples are not exhaustive – nor do they include examples from all vendors but are presented to offer guidance on current best practices

Conclusion

- Many platforms calculate exam specific effective dose estimates and may provide a patient-specific cumulative effective dose estimate
- Effective dose estimates have large error bars
  - Phantom used for calculation
  - Study specific technique factors
- Effective dose is not an indicator of an individual patient’s risk
  - Risk estimate valid only for populations
  - Weighting factors derived from much higher exposure levels than diagnostic imaging provides
Conclusion

- Numerous vendors have developed RDIMs and several health systems have built their own in house RDIMs
- Use of RDIM can confirm exposure to ionizing radiation is kept as low as diagnostically reasonable
- RDIMs can help meet regulatory requirements
- RDIMs can be used in QA to identify and investigate outlier cases

Conclusion

- Aggregation and storage of data by RDIMs must be transparent
- QMP and facility have responsibility to monitor and use the data in reasonable manner
- RDIM software landscape is changing rapidly, keep up to date on new developments