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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

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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

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Informatics

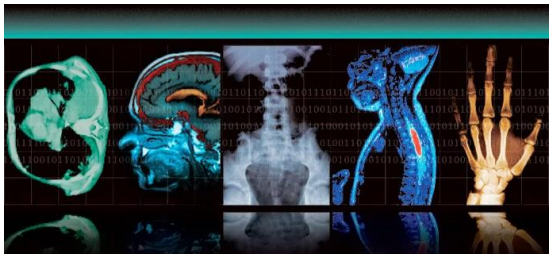

*image from SIIM

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 no 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

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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

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CT-Specific Requirements

- Transmission of anonymized data to data repositories or registries
  - Joint Commission requires comparison to external bench marks 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

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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

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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
    - Dates/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