Patient Dose Measurements and Audits
Employing Electronic Examination Records –
Part 1; Data Collection - System Architectures and Methods
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Introduction

• History & Background
• Current dose audit system
• Future Considerations
History

• 1956 ICRP and ICRU requested by UNSCEAR to consider mechanisms for collecting patient dose data
• ICRP/ICRU Report published
• UK implemented the agreed methodology as part of the “Adrian Survey”
History

- Section 6 of the ICRP/ICRU report gave reasons for not implementing universal recording of patient doses.
  - The excessive costs that would be involved
  - Difficulty in obtaining the dose values
  - Problems associated with centralised data management
Dose Audits in the UK

• Methods employed in the UK for national and local patient dose studies (embodied in National Patient Dose Protocol) support the conclusions

• TLD and DAP measurements are costly and labour intensive for large scale audits

• No centralised management system in place to store records and allow analysis
Dose Audits in the UK

How do we solve these problems?
Dose Values

• The approaches used in UK NPDP ignore the universal calibration of the tube and generator under its full operating range logged by routine QA

• This data can be used to calculate dose received as ESD when used with exposure factors kV, mAS & FSD
Dose Values

\[ SEAK = OP_{kV} \times mAs \times \left( \frac{1}{FSD^2} \right) \]

\[ ESD = SEAK \times 1.3 \]
Dose Values

• In 1990 IRS began development of a software tool that would allow users to enter exposure factors for an examination and have their dose calculated based on their tube and generator calibration and have a record of this saved

• It was integrated with a similar package for storing QA data and named QADDS (Quality Assurance Dose Data System)
Dose Values

• QADDS was developed using a Visual Basic front-end and an MS Access 4 back-end
• Installed on a department workstation for IRS customers
• Limited to being accessed from a single workstation
• Upgraded to allow access over a network (as well as Y2K compliance!)
Dose Values

- Date
- Modality
- Patient ID
- Gender
- Age
- Size
- Height
- Weight
- Examination
- Projection
- kV
- mAs
- DAP
- Focus
- FSD
- Tube Room
- Operator
Centralised Data

• Dose calculation and storage was now possible
• However, data was still dispersed around several hospital sites as Access files, not in one central location
Centralised Data

• Development started in 2004 on web-application QADDS v2 which used a Java Server Pages (JSP) front-end and a MySQL back-end

• Data was now held in one central database (using database server technology)

• Uploaded to www.qadds.co.uk

• Users able to access via any web browser
Centralised Data
2 Down 1 to Go

- System in place to make obtaining a dose easy
- System also deals with centralised management issues
- However, manual collection and entry of exposure parameters still labour intensive for large scale audits
RIS

- By 2007, there had been a major uptake of Radiology Information System (RIS)
- Exposure factors needed to calculate dose may be held within records in RIS
- Was it feasible to use RIS data to populate patient dose records in QADDS?
Feasibility

• Meetings set up with RIS managers
• Were the fields required by QADDS present in RIS?
• Could assumptions be made?
• Could data be exported and in what format?
QADDS Fields

- Date
- Modality
- Patient ID
- Gender
- Age
- Size
- Height
- Weight
- Examination
- Projection
- kV
- mAs
- DAP
- Focus
- FSD
- Tube Room
- Operator
QADDS Fields Not Present In RIS

- Date
- Modality
- Patient ID
- Gender
- Age
- Size
- Height
- Weight
- Examination
- Projection
- kV
- mAs
- DAP
- Focus
- FSD
- Tube Room
- Operator
Feasibility

• Most of the fields required by QADDS were present in RIS
• An assumption could be made for FSD
• Data could be exported as Excel, CSV or XML
Proof of Concept

- An application was developed during summer 2007 using Visual Basic 2005 and the .Net Framework 2.0 for Windows platform
- File format chosen for export was XML
Proof of Concept

<patient>
  <id>123456</id>
  <age>74</age>
  <sex>F</sex>
  <event>
    <date>01/07/2011</date>
    <exam>
      <examination>CHEST</examination>
      <room>ROOM 1</room>
      <operator_1>OPERATOR 1</operator_1>
      <postexam>
        <projection>PA</projection>
        <kvp>80</kvp>
        <mas>8</mas>
        <dose>20</dose>
      </postexam>
    </exam>
  </event>
</patient>
Proof of Concept
Proof of Concept

• Initial development centred around 2000 records for a single room and examination
• Data insertion took under a minute compared to 2 weeks to enter by hand
• The concept was proven
Refinements

• Method for transforming data into a common format was developed
• Now Excel and CSV data could be turned into XML
Refinements

• User input minimised
• Defaults given for FSD, focus, etc.
• Windows Service created to run constantly on server
Erroneous Data

• Some data entered incorrectly
• Problems with DAP
  – Users typing wrong value
  – Users typing wrong units
  – DAP meter not being reset
Erroneous Data

• Filters put in place
  – Removal of impossible data (outside an x-ray set’s range of operation)
  – Chauvenet’s Criterion

• More detail on these methods in Mike Moores talk tomorrow
Clinical Audit

- Clinical Audits initially based on erroneous data
- Expanded into workload analysis for radiographers and equipment
- Pregnancy and Patient ID checks
Local Dose Audit

- Initially developed using Statistica
- Now report generation is automated through Excel
What About DICOM?

- DICOM gets exposure factors and dose information automatically
- High level of accuracy (when all components are working!)
- Study undertaken to compare RIS and DICOM data
RIS & DICOM

- Application written to extract headers from DICOM and save as XML file
- Application installed on legacy machine at local site
- 2000 records recovered and compared against corresponding entries in RIS
RIS & DICOM

• If we assume that DICOM data is correct RIS data kV had a mean difference of 0.8%
• mAs had a mean difference of 2.2%
• DAP was obviously much better in DICOM data
• Not all DAP was recorded due to faulty meter
RIS & DICOM

- RIS data was much easier to access
- RIS data is now clustered so a whole region’s data can be exported together
- RIS has fields for clinical audit such as pregnancy
What about MPPS?

- Modality Performed Procedure Step (MPPS) could send accurate data to RIS
- Currently not a high uptake in the UK for MPPS due to perceived high cost
- Hopefully benefits will outweigh the costs in the future
Further Work

- Explore the DICOM approach further
- Expand does audits into other modalities
Thanks for listening

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