Conflicts of Interest

• Not related to this topic
  • Co-founder of Infondrian, LLC
    • Gap fund and Iowa based Grant to Infondrian
    • STTR phase I grant
  • Various TG, committees, leadership positions in AAPM, ASTRO, RO-SSI, Penn-Ohio Chapter of the AAPM

• Related to topic
  • NONE
Outline

• Introduction
• Overview of IT areas
• The medical physicist’s responsibilities
• Education and Training
• Determining and Procuring IT resources and services
Radiation Oncology is Data Intensive

• IMRT plan:
  • over 100,000 parameters

• IMRT Tx record
  • 2,000,000 parameters for the course

• IGRT: daily imaging
  • average of 20 per patient per course, many are CBCTs

• Imaging
  • 4DCT
  • Multimodality – fusion – PET CT, MRI
Radiation Oncology: Many Moving Parts

- Several work flows
- A lot of data flow from one workflow to another

Fig. 1. Schematic of a typical radiation therapy process flow.

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Overview of IT areas

- Desktops
- Servers
- System administration
- Networks
- Electronic Medical Record
- PACS
- Archives
- Custom software
Overview of IT areas

• Desktops
• Servers
• System administration
• Networks – internal and external
• Databases
• Electronic Medical Records
• PACS
• Archives
• Custom Software (web apps, db reports, utilities, spreadsheets)
Classification of systems

• Three tiers:
  • Medical Device
    • Imaging (CT, MR, PET, U/S, ...)
    • Treatment (Linacs, HDR units)
    • On board imaging (kV, MV ports, CBCT)
    • Sim, V-Sim
    • Treatment Planning System
    • Offline review, contouring
  • Multi-purpose
    • Adjunct to medical device
    • Could have other software on it
    • Servers, IT storage
    • Research, QA equipment and software
  • Office
    • Desktops (word, excel, etc.)
Desktops

• Access to servers, local files, network files, databases
• Who has the right to install software?
  • Radcalc
  • Aria, Mosaiq
  • Eclipse
  • Epic
• Different needs, some crossing over into multi-purpose
  • Medical Physicist desktop
  • QA laptop/desktop to drive QA equipment
  • Front desk desktop
  • Secretary desktop
• Configurations by role (physicist, physician, secretary,...)
Servers - store and provide data

• Type: - Generic knowledge
  • Files
  • Databases
• Content: - Domain knowledge
  • Oncology Information System (e.g. Aria, Mosaiq)
  • PACS
  • Archives
Databases

- The data store for several information systems
  - Oncology Information system
  - Hospital Information system
- Applications write information (Mosaicq, Aria, Eclipse)
- Queried by applications to retrieve information
- In addition to applications that write information, there is custom software
  - Dashboards, in-house queries
Networks

• Connections to provide data flow
  • Citrix farms for apps (Aria, Mosaiq, etc).
  • Servers with Applications, DBs
  • Exchange with clinical trials
  • Transfer of care
• Should mimic/support the work flow in the department
• Communication protocols
  • TCP/IP
  • DICOM
  • HL7
System Administration

• NEED KNOWLEDGE + ACCESS
• Watching over all systems on the network
  • Coordinate with networking team
• OISs – Aria, Mosaiq
  • IT systems analyst with previous RT knowledge
  • Interfaces (OIS to HIS, eg Epic)
  • Add new users, documents, etc – needs physics/clinic input
• Setting up new staff
  • Rights to configure staff desktop
  • Other software: MU check, Radcalc
  • Citrix access
Electronic Medical Records

- Hospital Information System (HIS)
  - Demographics
  - Appointments
  - Various notes from all doctors around the hospital
  - Orders
  - Links to imaging studies (on PACS)

- Oncology Information System (OIS)
  - Medical Oncology
  - Radiation Oncology
    - NOT JUST AN EMR, BUT ALSO A MEDICAL DEVICE
    - Contains treatment machine parameters – can’t be in an HIS.

- Interface between HIS and OIS
  - HL7 transfers of demographics, notes, appointments
PACS

- Picture Archiving and Communications System
- Access to PET, CT, MR, U/S
- Export to treatment planning system
- Store CT-Sim data
- What about IGRT data? Depends on your department...
- RT-PACS: not just pictures.
  - Treatment plans
  - Dose distributions
  - Any other Dicom-RT object
Archives

• Items not needing immediate retrieval
• Usually off site, separate system, slower access
• NOT A BACKUP!
  • A Backup is a copy of an active, production data set
  • Must be current
  • Fast retrieval
  • To be used when something goes wrong with the production system
  • Examples – RAIDs, Mirrors, immediate fail over
Business Continuity

• Keep the clinic running
• Production server dies, malfunctions, etc –
  • fail over to a backup server
• Disaster Recovery is part of business continuity
  • Redundant system(s) at a different site
  • Floods, fire, earthquakes at original site – fail over to remote site
Custom software

• In-house spreadsheets, utilities, applications
• Queries for Reports
• Sometimes – freeware / shareware only used in radiation oncology
• Anything your IT staff hasn’t seen before or that needs to be created to solve a specific problem
Caveats

• This is not an exhaustive list of IT areas
• Maybe this is more than what you have
• Maybe this is less than what you have

------

Responsibilities ...

• You need to map out your work flows, data flows, the systems that support them, and the networks that connect them.
• Classify your computer systems (which tiers do they belong to)
• Establish requirements for computing systems and networks
Medical Physicist’s responsibilities

• Most IT staff don’t know anything about radiation oncology
  • They know the generic IT: servers, networks, desktops
  • They don’t know the domain knowledge (the content that moves over the generic IT infrastructure)

• We have the domain knowledge
  • Collaborate with IT
  • Educate IT
  • Emphasize the clinical implications of the IT infrastructure
  • (what happens to the clinic when systems fail?)

• First line of defense
  • Patient’s on the table, what should we do when there’s an issue?
Roles by Tiers

- Medical Physics:
  - QA
  - ATP
  - Policies/procedures for use of systems
  - Provide a list of systems requirements

<table>
<thead>
<tr>
<th>Tier</th>
<th>Staff</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Device</td>
<td>Medical Physicist (P)</td>
<td>Initial system tests to verify system is safe and functioning according to specifications. Periodic QA tests to verify system is still in specifications. Internal policies and procedures regarding system use.</td>
</tr>
<tr>
<td></td>
<td>IT (S)</td>
<td>Power and environment for hardware. Network connectivity to meet requirements specified by vendor and to meet needs determined by medical physicist. System security in accordance with specifications provided by vendor and medical physicist. Patient data backup and archiving.</td>
</tr>
<tr>
<td></td>
<td>Vendor (S)</td>
<td>Specifies system configuration; provides software and upgrades, provides technical support.</td>
</tr>
<tr>
<td>Office</td>
<td>IT (P)</td>
<td>Power and environment for hardware. Software and support. Network connectivity to clinical needs. System security in accordance with hospital and/or clinic policies.</td>
</tr>
<tr>
<td></td>
<td>Medical Physicist (S)</td>
<td>Provides IT with a list of system requirements to meet clinical needs.</td>
</tr>
<tr>
<td></td>
<td>Vendor (S)</td>
<td>Provides initial system with configuration as specified by IT. Provides software, upgrades, and technical support as requested by IT.</td>
</tr>
<tr>
<td>Multipurpose</td>
<td>Medical Physicist (P)</td>
<td>See the description for the medical device tier.</td>
</tr>
<tr>
<td></td>
<td>IT (S)</td>
<td>In addition to the items described in the medical device tier: Additional software and support as required by medical physics.</td>
</tr>
<tr>
<td></td>
<td>Vendor (S)</td>
<td>See the description for the medical device tier.</td>
</tr>
</tbody>
</table>

P = Primary and S = Secondary responsibility.
Responsibility

- **Medical Physics:**
  - Systems with patient interaction
  - Systems needing vendor support
- **IT**
  - Office systems
  - Rarely needing vendor support
- **NOTE** – there are exceptions – depends on the local talent (e.g. experienced IT staff with extensive RT knowledge)

<table>
<thead>
<tr>
<th>Category \ Tier</th>
<th>Medical Device</th>
<th>Office</th>
<th>Multipurpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Interaction</td>
<td>Direct</td>
<td>None</td>
<td>Indirect</td>
</tr>
<tr>
<td>Primary Responsibility</td>
<td>Medical physicist</td>
<td>IT</td>
<td>Medical physicist</td>
</tr>
<tr>
<td>Vendor Support</td>
<td>Often</td>
<td>Rare</td>
<td>Often</td>
</tr>
<tr>
<td>IT Support</td>
<td>Must go through medical physicist</td>
<td>Per IT Policy</td>
<td>As requested by physicist</td>
</tr>
<tr>
<td>Connectivity (clinic)</td>
<td>Isolated from other network traffic, high bandwidth</td>
<td>Limited to non-clinical tier systems</td>
<td>Full</td>
</tr>
<tr>
<td>Connectivity (outside)</td>
<td>Virtually no direct internet access (exception: remote vendor support)</td>
<td>Full</td>
<td>Full</td>
</tr>
</tbody>
</table>
Variability and evolution of IT staff...

• Support desktops
  • experts with windows and macs, maybe linux!
• Understand the IT systems
  • hardware, networks, storage, servers,…
• Understand Hospital IT
• Familiarity with radiation oncology information systems
• Troubleshoot imaging devices on the network
• Troubleshoot linac connectivity
• Informatics training
• BUT: They rarely understand how clinical data affects the delivered dose.
THIS BEARS REPEATING:

IT staff will rarely understand how clinical data affects the delivered dose
Physicists should:

• Understand how data propagate through our clinical workflow
• Know how data transform
  • Changes based on different conventions
    • coordinate systems
    • labels on parts
    • Links to other data
• Know how data become information or instructions
  • E.g. couch coordinates are useless without knowing the coordinate system
  • What does a table shift actually mean?
• Know how data and their associated processes impact dosimetric and positioning accuracy
• PERFORM END TO END TESTS INVOLVING IT SYSTEMS
Collaborate with IT - 1

• Even if you have the IT knowledge, you may not have the time
• IT has access to systems; you might need some, request it!
• Discuss needs with IT and find out how your organizational structure can support it
  • Dedicated IT to rad onc?
  • Project manager coordinating with several groups?
• Liaison between vendors and IT
• Educate IT staff and upper management
Collaborate with IT - 2

• Site planning
  • New linac, new bunker, ...
• Business Continuity
• Disaster Recovery
• Security Audits
• Compliance

NOTE: THIS IS THE RESPONSIBILITY OF THE MEDICAL PHYSICIST, BUT YOU NEED IT’s HELP.
### Table 3. A partial list of generic computer skills, which could be acquired through traditional IT training.

<table>
<thead>
<tr>
<th>Category</th>
<th>Concept</th>
<th>Example Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>Computer hardware components, architecture, type, design</td>
<td>Trouble shoot and replace broken parts, upgrade, install and configure UPS, KVM switch, tape libraries or MO/DVD jukeboxes, S-ATA, SCSI (ID, connector, cable, terminator), RAID</td>
</tr>
<tr>
<td>Desktop</td>
<td>Operating system (including Windows, Linux, Mac OSX, Solaris, Irix, HP-UX), firewall, antivirus, spyware, performance monitor, office software support</td>
<td>Operating system setup, driver configuration, firewall rules</td>
</tr>
<tr>
<td>Database</td>
<td>Relational model and object-oriented, Architecture, Indexing, Transactions, concurrency control and database recovery, data mining</td>
<td>Track database growth, performance tune-up, backup/restore, manual dump, user add/remove, privilege assignment</td>
</tr>
<tr>
<td>Productivity</td>
<td>Citrix configuration and setup, create custom crystal report, dedicated backup/restore software, VMWare, Ghost</td>
<td>Manual/automatic backup/restore with Veritas BackupExec</td>
</tr>
<tr>
<td>Network</td>
<td>Network topology, protocol, TCP/IP (address, DNS, WINS, GW, mask), client/server, devices, bandwidth, Autonegotiation / Autosense, half duplex and full duplex, VPN, SSH/SFTP, X11 forwarding, X Windows client and server, XDMCP, FileServer/NAS (NFS, SMB/CIFS), VNC, Iogmein</td>
<td>Network setup workstation/servers for TPS/R&amp;V/Linux, router/bridge setup, DHCP binding, network connections troubleshooting</td>
</tr>
<tr>
<td>Web</td>
<td>Intranet/Internet web server</td>
<td>Setup and update the website, web design and content update</td>
</tr>
<tr>
<td>Research</td>
<td>Research programming</td>
<td>SQL programming, batch/script programming, C/C++ programming with GUI</td>
</tr>
</tbody>
</table>
**Education and Training of IT staff - RO specific skill set**

Table 4: A partial list of RO specific skills (most are vendor specific).

<table>
<thead>
<tr>
<th>Category</th>
<th>Concept</th>
<th>Example Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS</td>
<td>TPS specific, data format, coordinate definition, remote access, MU second check software, segmentation and contour software</td>
<td>Data format conversion and transfer between beam scanning software and TPS, model backup, modeled data export, regular cleanup of non-used data file, backup and restore customer configuration, script creation and modification</td>
</tr>
<tr>
<td>R&amp;V</td>
<td>HL7, interface, different format conversion</td>
<td>Integration with HIS, emergency file transfer with faulty network, troubleshooting mismatching</td>
</tr>
<tr>
<td>Linac</td>
<td>Console</td>
<td>Connection with R&amp;V, cooperation with localization and couch, backup data</td>
</tr>
<tr>
<td>Simulation</td>
<td>CT Sim/MRI/PET, external laser, coordinate translation</td>
<td>Connection configuration, coordinate and structure set matching</td>
</tr>
<tr>
<td>Localization</td>
<td>Daily MVCT or KVCT, ultrasound, radiofrequency, optical camera, radiocam, gold seed</td>
<td>Image transferring and archiving</td>
</tr>
<tr>
<td>Verification</td>
<td>EPID</td>
<td>Manage image database</td>
</tr>
<tr>
<td>Dosimetry</td>
<td>Film scanner, TLD/OSL reader, diode, MOSFET</td>
<td>Upgrade and clean the space</td>
</tr>
<tr>
<td>QA</td>
<td>Daily/monthly/annual QA software like Argus</td>
<td>Trend analysis</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Patient scheduling and tracking</td>
<td>Real-time tracking of patient location</td>
</tr>
<tr>
<td>DICOM</td>
<td>DICOM/DICOM-RT, SCU/SCP roles, information object definitions, attributes, data dictionary, service classes, service object pair, association handling, AE title, UID, conformance statement</td>
<td>Setup DICOM node by ip:port AE title, troubleshoot association handling mismatches, (commit, compression, endianness)</td>
</tr>
<tr>
<td>PACS</td>
<td>PACS, HIPAA privacy and security regulations, archive, backup, monitor QA, film camera QA</td>
<td>User creation and privilege assignment, query/retrieve, auto-send, customize LUT</td>
</tr>
</tbody>
</table>
Determining and procuring IT resources and services

• Task Lists
• Support Models
  • Dedicated IT
  • Team based by function
  • Hybrid
• Local and Institutional politics
Task Lists - Brainstorming

- Recurring Tasks
  - System maintenance, troubleshooting, connectivity
- Infrequent tasks
  - Inventory, Audits
- Equipment based tasks
- Clinic
- Research – e.g. custom databases
- Communication tools – websites, document servers, etc
- What is currently being done
- What should be done but is not
- Wish list
Task List – Example

General Areas of Dedicated IT Support

1. Departmental computers
   a. Inventory/asset tracking—update for all team
   b. Replace hardware every 3 years
   c. Update operating systems (currently Windows 7)
   d. Update applications (office, web browsers, etc.)
   e. Install new applications
   f. Maintain connectivity (network switches, routers, etc.)
   g. Connectively audits (data flow, effective transfer rates between nodes)
   h. Ensure adequate backup
   i. Software make sure all computers, servers, etc. are running

2. Radiation Therapy Device Computers
   a. Coordinate with Viera and Corvus Field Service Engineers
   b. Schedule and deploy patches/coordinates with vendors
   c. Maintain SAP, server, other servers for device
   d. Maintain connectivity (figural)
   e. Network architecture/audits/ maintenance/appropriate isolation or limited connections of systems

3. Network access for all staff for their systems (email accounts, access control lists, etc.)

4. General IT/Support for the entire department
   a. General IT/Support for the entire department

5. First Line Response Team for Treatment Device support
   a. Identify devices

6. Security: analyze systems in department to ensure we meet standards (open need – audit)

7. Business Continuity for all departmental data and therapy (device) (open need – audit)

8. Disaster Recovery for all data and systems (open need – audit)

9. SQL Query and Reporting
   a. Develop SQL reports

10. Business Intelligence Systems—workflow routing applications (leviages, Aria, EHR, and display systems)

11. Device trauma (inpatient reports from Lumea)

12. Trending/Waterfall

13. Mainframe

   a. Demographics
   b. Notes
   c. Billing
   d. Scheduling

14. Providers are needed to maintain devices, participation from IT for dedicated IT support

15. Maintain departmental websites/sites

16. API Adapters

   a. New features (change request; e.g., for example automating storage of field service reports from emails)

17. Device and maintain departmental databases

   a. Outlines database
   b. SQL databases

18. Converting all paper in department to databases

19. Error reporting

20. SEO & Social Media

21. Coordinate with Physics and Device manufacturers for new equipment installs (e.g. Abin

22. Design, Deploy, and Maintain Connectivity solutions for remote sites

23. IT/Information and ICP Support

24. Applications support: training new application deployment, new employees — currently being done by IT staff

25. Network upgrades

   a. Connectivity (open need – audit)

Specific Systems requiring support

1. All personal computers

2. Aria EMR SQL server

3. Aria/ML SQL support

4. Follow Computer servers

5. ITIL (open: specific AUC’s)

6. CT scanner-related systems

7. Synergy/Catch-related systems

8. VRSUB: related systems

9. Link (IP Print, Transducer) related systems

10. Instrument-related systems

11. IT/ICOM servers

12. VENTRA: related systems

13. Project-related systems that were deployed

14. Follow through on SQL server setup in Data Center

15. S/MIMAB: related systems

16. CT scanner-related systems

17. MRI-related systems

18. MRI-related systems

19. MRI-related systems

20. MRI-related systems

21. MRI-related systems

22. MRI-related systems

23. MRI-related systems

24. MRI-related systems

25. MRI-related systems

Many of the ongoing support items are being handled by a combination of IT help desk, John Cruz and Medical Physics Staff.
Support Models

• Dedicated IT staff
  • Reports to Medical Physicist
  • The number depends on the activities in the department

• Team Based by Function
  • Reports to Hospital IT
  • Use different teams from Hospital IT for different tasks
    • Reports: Business Intelligence Team
    • Desktop/Applications: Help Desk
    • Web Apps: Applications Development Group
    • Still need Rad Onc trained individuals (e.g. from the Ambulatory Services Group) for Rad Onc IT administrative tasks

• Project Manager assigned to coordinate all tasks

• Hybrid model
  • One dedicated RO IT person coordinates with the Hospital IT teams
Politics...

• The help you get depends on who you talk to
• Find a responsive person
• Get to know IT upper management
• Understand your organizational structure
• Know the people and the relationships
• Sometimes this can take a couple of years...
Conclusion

• Overview of IT issues
• Understand all the IT areas that affect Rad Onc
• Know your responsibilities
• Assess the education and training of IT staff and remedy as needed
• Meeting the IT needs takes a lot of work and people skills!
References


• Siochi RA, Brack CD, Orton C. Point/Counterpoint: The chief Information Technology officer in a Radiation Oncology department should be a medical physicist. Med. Phys. 2009;36:3863-3865. PMID: 19810457