

Overview of IT issues in Radiation Oncology

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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

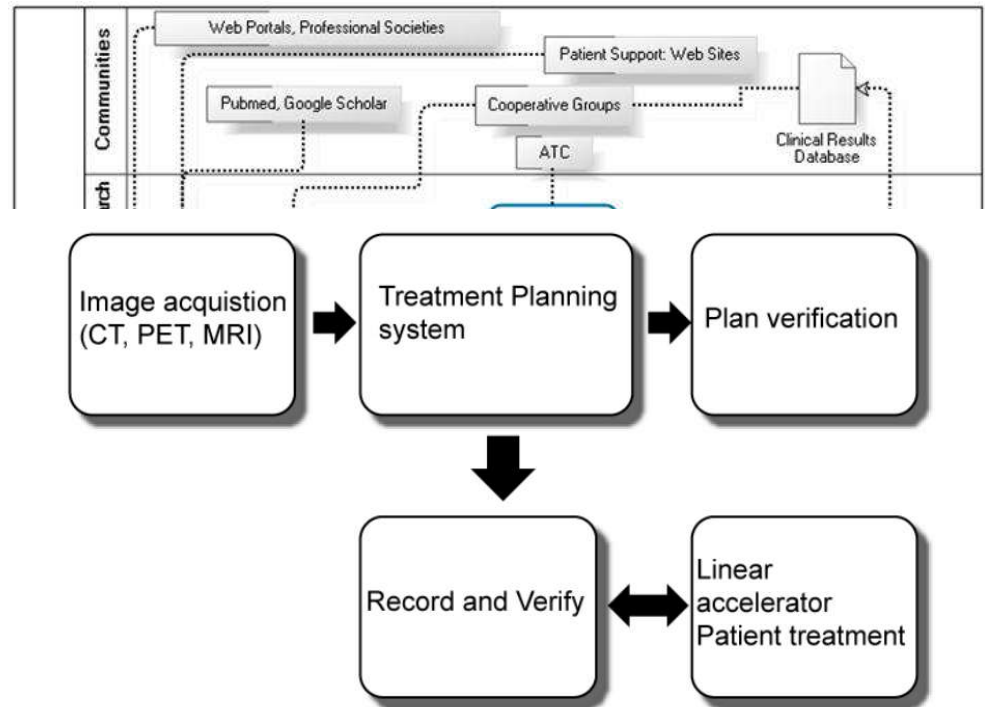


FIG. 1. Schematic of a typical radiation therapy process flow.

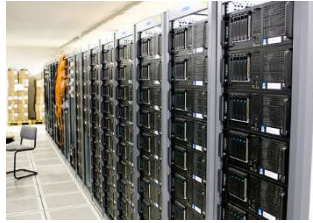
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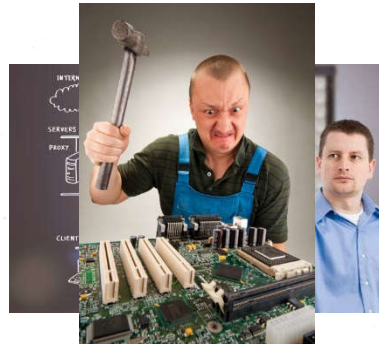
Overview of IT areas



Desktops



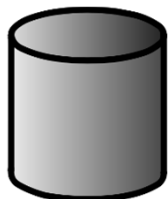
Servers



System administration



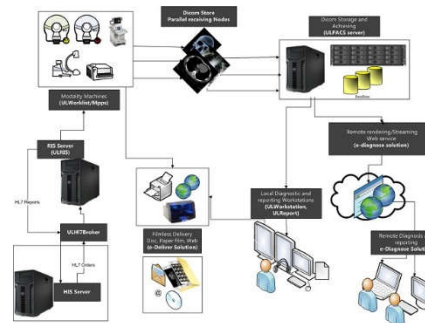
Networks



Database



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.)

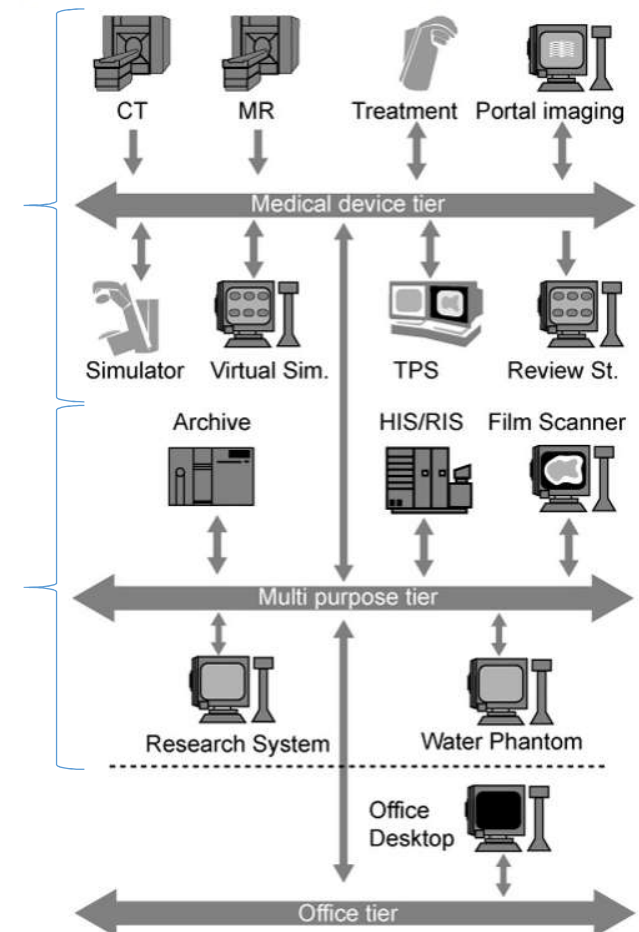
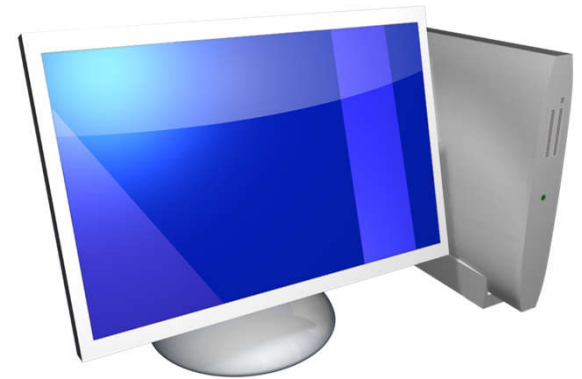


FIG. 2. The three tiers of computing resources and their connections.

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 (Mosaik, Aria, Eclipse)
- Queried by applications to retrieve information
 - In addition to applications that write information, there is custom software
 - Dashboards, in-house queries



PersonID	Address	Address	City	City	FirstName	FirstName	Last
1	1040 East Street	1040 East Street	Plateau City	Plateau City	Loretta	Loretta	Bov
2	154 Baltic Walk	154 Baltic Walk	Excelsior	Excelsior	Evelyn	Evelyn	Elko
3	952 Tennessee Avenue	952 Tennessee Avenue	Embarcadero	Embarcadero	Harold	Harold	Mco
4	700 Fourth Lane	700 Fourth Lane	Tenderloin	Tenderloin	Chad	Chad	Han
5	1079 Beach Way	1079 Beach Way	Cow Hollow	Cow Hollow	Sandra	Sandra	San
6	758 North Lane	758 North Lane	North Beach	North Beach	Kathleen	Kathleen	Rho
7	978 Eighth Walk	722 Arrow Lane	Milama Park	Colandus	Parrella	Parrella	Nea
8	247 Fifth Place	247 Fifth Place	Western Addition	Western Addition	Emily	Emily	Dar
9	843 States Street	843 States Street	Nice Valley	Nice Valley	Vernon	Vernon	Carl
10	749 Washington Street	749 Washington Street	Civic Center	Civic Center	William	William	Cor
11	360 Tennessee Place	360 Tennessee Place	Fisherman's Wharf	Fisherman's Wharf	Oladyc	Oladyc	Lav
12	14 Oriental Place	14 Oriental Place	Buena Vista	Buena Vista	Margaret	Margaret	Colt
13	688 Lower Avenue	688 Lower Avenue	Diamond Heights	Diamond Heights	Kathleen	Kathleen	Guz
14	886 Third Street	886 Third Street	Civic Center	Civic Center	Bertha	Bertha	Pov
15	229 Kentucky Place	229 Kentucky Place	Ocean View	Ocean View	Kim	Kim	Gra
16	1019 Marvin Gardens Place	1019 Marvin Gardens Place	Potrero Hill	Potrero Hill	Steve	Steve	Cun

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, Mosaic
 - 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



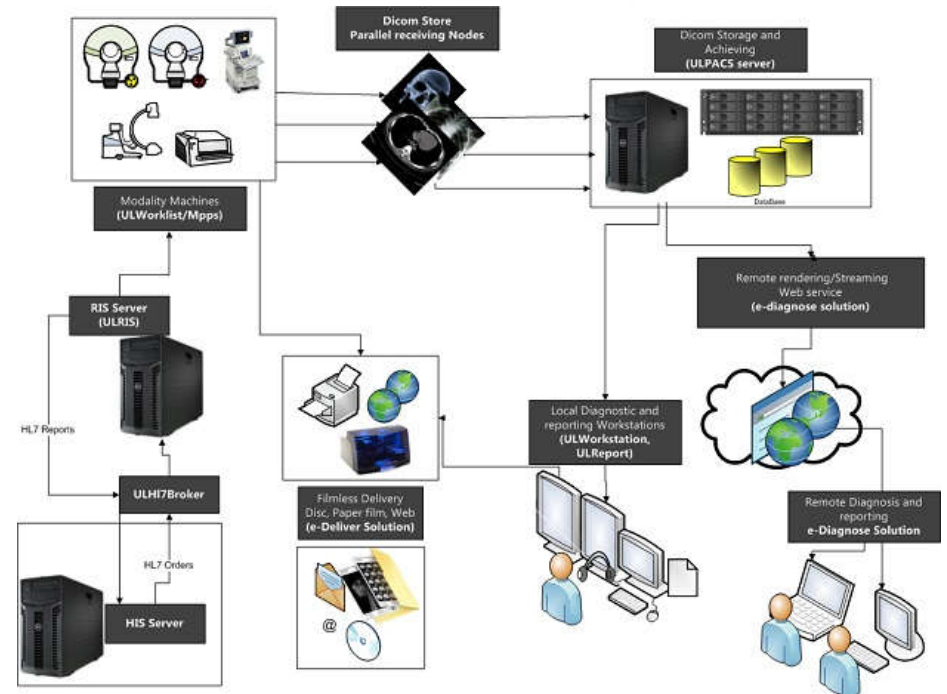
Electronic Medical Records

- 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 1. Roles classified by tiers.

<i>Tier</i>	<i>Staff</i>	<i>Roles</i>
Medical Device	Medical Physicist (P)	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.
	IT (S)	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.
	Vendor (S)	Specifies system configuration; provides software and upgrades, provides technical support.
Office	IT (P)	Power and environment for hardware. Software and support. Network connectivity to clinical needs. System security in accordance with hospital and / or clinic policies.
	Medical Physicist (S)	Provides IT with a list of system requirements to meet clinical needs.
	Vendor (S)	Provides initial system with configuration as specified by IT. Provides software, upgrades, and technical support as requested by IT.
Multipurpose	Medical Physicist (P)	See the description for the medical device tier.
	IT (S)	In addition to the items described in the medical device tier: Additional software and support as required by medical physics.
	Vendor (S)	See the description for the medical device tier.

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 2. Characteristics of the three IT system tiers.

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

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.

Education and Training of IT staff - generic skill set

TABLE 3. A partial list of generic computer skills, which could be acquired through traditional IT training.

<i>Category</i>	<i>Concept</i>	<i>Example Tasks</i>
Hardware	Computer hardware components, architecture, type, design	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
Desktop Software	Operating system (including Windows, Linux, Mac OSX, Solaris, Irix, HP-UX), firewall, antivirus, spyware, performance monitor, office software support	Operating system setup, driver configuration, firewall rules
Database	Relational model and object-oriented, Architecture, Indexing, Transactions, concurrency control and database recovery, data mining	Track database growth, performance tune-up, backup/restore, manual dump, user add/remove, privilege assignment
Productivity Software	Citrix configuration and setup, create custom crystal report, dedicated backup/restore software, VMWare, Ghost	Manual/automatic backup/restore with Veritas BackupExec
Network	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, logmein	Network setup workstation/servers for TPS/R&V/Linac, router/bridge setup, DHCP binding, network connections troubleshooting
Web	Intranet/Internet web server	Setup and update the website, web design and content update
Research	Research programming	SQL programming, batch/script programming, C/C++ programming with GUI

Education and Training of IT staff - RO specific skill set

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

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

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 – audit for rad onc (open need)
 - b. Replace Hardware every 3 years (open – open need)
 - c. Update operating systems (currently Windows 7) (pending need)
 - d. Update applications (office, web browsers) (John Gruz, IT help desk)
 - e. Install new applications (John Gruz, IT help desk, Alf Siochi)
 - f. Maintain connectivity (network drives, printers, citrix, Dicom) (John Gruz, IT help desk, some troubleshooting by Alf Siochi)
 - g. Connectivity audits (trace routes, effective transfer rates between nodes) (open need)
 - h. Uptime – make sure all computers, servers, etc. are running (open need – have to implement a process)
2. Radiation Therapy Device Computers
 - a. Coordinate with Varian and Elekta Field Service Engineers (Medical Physics)
 - b. Schedule and Deploy patches / coordinate with physics (Medical Physics, John Gruz)
 - c. Maintain SQL server, other servers for devices (Medical Physics, John Gruz)
 - d. Maintain Connectivity (Dicom) (John Gruz, Troubleshooting by Medical Physics)
 - e. Network architecture/ audits/ maintenance/ appropriate isolation or limited connections of systems (open need)
3. Network access for all staff for their systems (adding accounts, access control lists, etc.) (John Gruz, IT help desk)
4. General Desktop support for the entire department (currently a combination of physics and John Gruz) – would like to get an On Call Rad Onc IT paper just for this purpose
5. First Line Response Team for Treatment Device support (currently done by medical physics, occasionally with help from John Gruz)
6. Security – analyze systems in department to ensure we meet standards (open need – audit)
7. Business Continuity (for all departmental data and therapy device data) (open need – audit)
8. Disaster Recovery (for all data and systems) (open need – audit)
9. SQL Query and Reporting (currently done by Alf Siochi)
 - a. Coordinate with various functional groups (ongoing need)
 - i. Scheduling
 - ii. Billing
 - iii. Nursing
 - iv. Physicians
 - v. Physicists
 - vi. Dosimetrists
 - vii. Therapists
 - b. Design reports – from Aria / Eclipse Patient Statistics (open need)
 - i. Treatment Numbers
 - ii. Billing Audits
 - iii. Device QA trending
 - iv. Etc....(we could generate a list of 50 reports and still find more)
10. Business Intelligence Systems – workflow routing applications – leverage Aria, design and deploy in-house systems (open need)

11. Design/request/coordinate reports from Epic (open need)
12. Design, implement and maintain HL7 connectivity between Aria and Epic (currently being checked by Alf Siochi, tracking down someone in IT or in Varian until it is resolved)
 - a. Demographics (in)
 - b. Notes (out)
 - c. Billing (out)
 - d. Scheduling (in)
13. Maintain departmental websites/docs – currently done by Alf Siochi
 - a. Sys Admin
 - b. New features (JavaScript widgets, etc., for example automating storage of field service reports from emails.)
14. Deploy and Maintain departmental databases
 - a. Outcomes databases (to be developed)
 - b. QA databases (to be developed)
 - c. Converting all paper in department to databases – e.g. machine service logs (to be developed)
 - d. Error reporting (SPEAK – developed 6/2015 – Alf Siochi)
15. Coordinate with Physics and Device Manufacturers for new equipment installs (e.g. Mon General) – currently Medical Physics handles this
16. Design, Deploy, and Maintain Connectivity solutions for remote sites
 - a. Fairmont – John Gruz and IT help desk
 - b. Mon General – pending/potential need
 - c. Parkersburg – mainly driven by Kevin Yarnoy at Camden Clark. He touched base with Alf Siochi at WVU (Farhan Ahmed, Brian Matlick) to resolve connectivity issue.
17. AV/Conference room support (IT help desk, John Gruz)
18. Applications support and training (new application deployment, new employees – currently being done by Alf Siochi, Josh Hack, Nikkie Banda for a variety of applications in the department)
19. IT infrastructure maintenance, growth, research, and development (open need – example project in the planning/purchase consideration stage is called Full Scale from Varian)

Specific Systems requiring support:

1. All personal computers
2. Aria DB SQL server
3. Aria/Eclipse Citrix support
4. Eclipse Compute servers
5. Rad Onc Specific PACS
6. CT scanner related systems
7. Gamma Knife related systems

8. Varisource related systems
9. Linac (Trilogy, TrueBeam) related systems
10. IntraBeam related systems
11. All DICOM servers
12. WVURO.net (maintained, developed by Alf Siochi)
13. Recent Projects, new systems that were deployed in 2015:
 - a. In-house DBs on SQL server set up in Data Center –deployed by IT group – vm-radoncapps – 6/2015
 - b. Departmental HIS servers – deployed by IT group – vm-radoncapps – 6/2015
 - c. Velocity – IT group (John Gruz, Mark Knowlton – 11/2015)
 - d. Mobius 3D – John Gruz – 12/2015

Many of the ongoing support items are being handled by a combination of IT help desk, John Gruz 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!

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