

Troubleshooting issues with linear accelerators

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Disclosures

- I have nothing to disclose.

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Objectives

- Understand why unscheduled linac downtime should be minimized
- Understand the competencies of linac troubleshooting
- Understand common approaches for using fault event reporting to minimize downtime

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Outline

- The downside of downtime and the first step to minimizing it
- How several institutions minimize downtime
- Take home points

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The Downside of Downtime and the First Step to Minimizing It



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Guidance on timely radiation therapy delivery (1)

	Daily	Weekly
Head and Neck	1.4%	10% – 12%
Lung		9%
Cervix	0.3% – 1.6%	

Loss of local control based on duration of treatment interruption.

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Bese et al. IJROBP 68(3): 654-61 (2007)

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Guidance on timely radiation therapy delivery (2)



Risk stratification of patients:

- *Category 1:* Rapidly growing tumors (e.g., squamous carcinomas) – don't exceed 2 days
- *Category 2:* Slower growing tumors (e.g., adenocarcinomas) – don't exceed 2 days*
- *Category 3:* Palliative treatment – 7 days

8/4/2016 The timely delivery of radical radiotherapy: standards and guidelines for the management of unscheduled treatment interruptions, Third edition, 2008. The Royal College of Radiologists. 7

Guidance on timely radiation therapy delivery (3)



- Ideal: transfer to a matched linear accelerator
- Be able to perhaps
 - treat over the weekend
 - twice daily
 - add extra treatment fractions
- Use biologically equivalent dose calculations to determine a modified number of treatment fractions

8/4/2016 The Royal College of Radiologists, 2008. 8

Step 1: Read the Manual



Example:

- Varian TrueBeam / Technical Reference Guide – Volume 1 Appendix B Safety Loops
- TrueBeam Administrators Guide, Chapter 7: Troubleshooting
- TrueBeam / Instructions for Use, Appendix J: Acknowledging Fault Interlock Messages

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How Several Institutions Minimize Downtime



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Capturing machine issues in a text document (Seattle VA)



VA Puget Sound Health Care System—Radiation Therapy
Procedure: Linac Problems and Fixes
Creation date: <2004 Revision Date: 9/6/2012
Prepared by Steven Sutlief Revised by Steven Sutlief

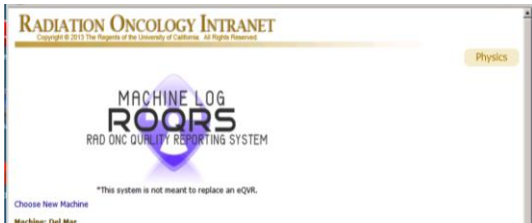
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UCSD Radiation Oncology Quality Reporting System-Machine Log



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UCSD Radiation Oncology UC San Diego Quality Reporting System-Machine Log

ML ID	Status	MessageDate	Message	Name	Username	Downtime
Select 5037	Open	1/11/2016 6:37:01 AM	Alight unable to perform daily QA this morning. Received error: "Daily QA of the third pod is not completed" -dr (UPDATED: 1/11/2016 7:43:15 AM - Alight DOWN. Cannot capture monthly calibration images. Alight engineer received in and even after power cycles of cameras and workstation we could not get the system to capture monthly calibration images. He's attempting to contact who did some work on the system last Friday, but currently the system is down pending investigation of why pods are non-responsive.			0
Select 5033	Open	1/5/2016 7:30:08 AM	Daily QA not passing after several attempts. Will need Physician to calibrate. First case at 9:30am, thanks!	None		0
Select 5045	Open	12/29/2015 6:37:34 AM	Alight not passing Morning QA after several attempts. Will need Physics calibration.	None		0
Select 5042	Open	12/27/2015 6:32:00 AM	Did not pass Daily QA after several attempts. Need calibration, thanks!	None		0
Select 5037	Open	12/20/2015 4:02:07 PM	Alight program crashed while performing calibration.	None		0
Select 5036	Open	12/20/2015 12:48:29 AM	Alight computer crashed after reacquiring image.			0

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TABLE 2. Performance data before and after introduction of the new support and service model.

	# of Events	Pre-model	Post-model	% Change
Total Number of Clinic Days	389	203	186	
Total Number of Machine-Down Events	119	59	60	
Median Time to Vendor Response (minutes)		45	8	-82%
Resolved by On-site Vendor Engineer	56	36	20	-44%
Resolved by Clinic Staff	63	23	40	+74%
Resolved by Clinic Staff with Remote Assistance		2	22	
Total Downtime (minutes)		7391	3906	-47%
Median Weekly Downtime (minutes)		60	20	-67%
Median Downtime per Event (minutes)		45	20	-56%
Treatment Cancellations	286	217	69	-68%
Patients Transferred to Other Machines	62	27	35	+30%

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Hoisak et al, JACMP 15:257-264, 2014

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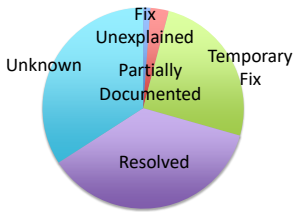
Old Way	New Way
Telephone calls through multiple points of contact and repeated verbal descriptions of the problem before receiving technical assistance from a local service engineer.	Electronic description of the problem, including fault codes, is delivered immediately to local staff and the field service dispatch person.
Greater reliance on field service engineers to resolve problems.	Clinical users learned how to resolve technical events with remote assistance; issues could be resolved in minutes.
Greater uncertainty about the potential length of down time resulted in more cancellations of patient appointments.	More accurate estimate of the duration of a machine-down event and its impact upon the patient treatment schedule.

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Hoisak et al, JACMP 15:257-264, 2014

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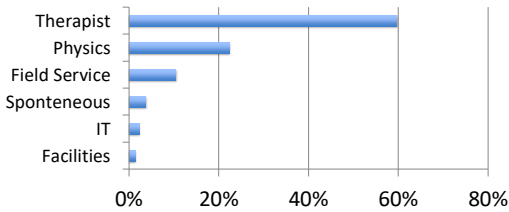


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Sutlief, SU-F-T-462 (2016) (poster)

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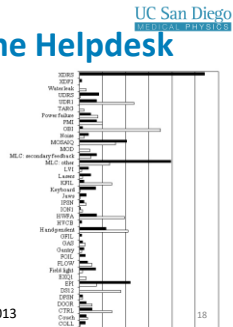
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Illawarra CCC Online Helpdesk

- Implemented an Online Helpdesk
- Users select faults in a series of dropdown menus
- Enables free-text entry and attaching files or images



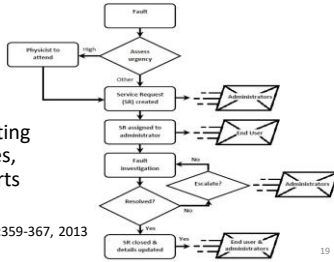
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McNamara et al, JACMP 14:359-367, 2013

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ICCC Fault Notification Chain

- Notify appropriate staff ASAP
- Create service request
- Configuration: routing and escalation rules, due dates, and alerts



McNamara et al, JACMP 14:359-367, 2013

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ICCC Results

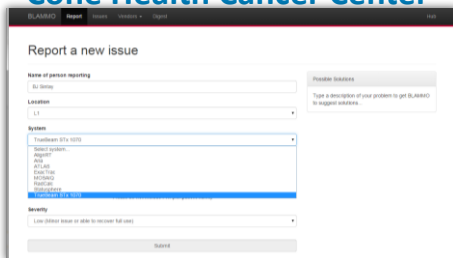
- Consistency and utility of equipment fault information has improved.
- Incorrect categorization of faults can skew reporting trends and mask common problems.
- An online helpdesk does not replace the need for communication among staff and with service engineers.

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McNamara et al, JACMP 14:359-367, 2013

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Cone Health Cancer Center



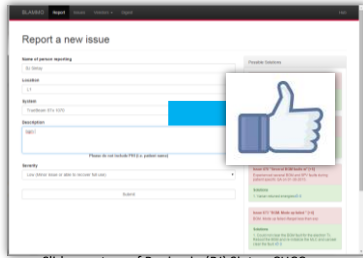
Slide courtesy of Benjamin (BJ) Sintay, CHCC

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Cone Health Cancer Center

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MEDICAL PHYSICIAN



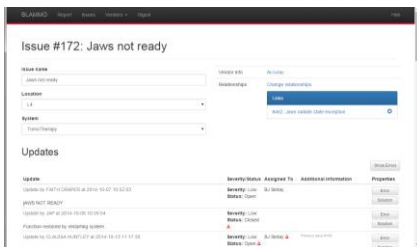
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Cone Health Cancer Center

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MEDICAL PHYSICIAN



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Preemptive maintenance

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MEDICAL PHYSICIAN

- Using SPC to predict component failure or system dysfunction in order for maintenance to be performed prior to the actuation of interlocks.
- Forty-five synthetic errors/changes were introduced to test the effectiveness of the initial chart limits.
- Forty-three of the forty-five errors (95.6 %) were detected in either the Individual or Moving Range chart for each of the subsystems monitored.

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Able et al. Radiat Oncol 11:36. 2016

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Take-home points



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Take-Home Points

- Read the manual
- Document solutions to problems for future reference
- Use periodic quality assurance to anticipate future problems
- Create searchable repositories for machine logs, associated files and images, field service reports, and vendor notifications

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References

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