

Managing Equipment Downtime: Standardized Definitions and Data Structure For Linac Service Event Reporting

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Innovation/Impact: Standardized definitions and a data structure are proposed to enable reporting of linac service events in a centralized database across multiple radiotherapy centres. This work provides the foundation for development of a province wide linac service event database. The proposed standardized definitions and data structure would provide a minimum standard for reporting service events and enable evaluation among multiple centres of downtime and the associated costs.

Introduction: The importance of recording linac service events is not limited to the Canadian Nuclear Safety Commission requirement. Review of previous service event records provides useful troubleshooting information as service issues arise and can be used to perform predictive preventative maintenance at the appropriate time prior to component failure. Currently individual cancer centres report linac service events and clinical downtime using various tools, some commercial products and some developed in-house. There are no standardized definitions describing service events in provincial use. There is no recommended minimum dataset for service event reporting. As a result there is little consistency in how cancer centres are reporting service events and the corresponding clinical downtime. Aligning linac service event reporting and sharing of linac service event reports among the provincial cancer centre offers a learning opportunity for all physics and service teams. The proposed standardized definitions and data structure provide the framework for a centralized linac service event database that would offer the following benefits to the radiation medicine community:

1. Facilitate learning among physics and service teams within the radiation medicine community.
2. Provide data showing the relationship between linac workload and age on clinical downtime, the corresponding number of affected patient fractions and cost.
3. Identify trends in machine component failures as related to introduction of new treatment delivery technologies.
4. Provide relevant data to inform purchasers and Ministry of Health funders for effective linac procurement.

Materials and Methods: The Radiation treatment program of Cancer Care Ontario formed a Physics Community of Practice with representation from each radiation medicine program in Ontario. A working group developed a project charter to establish definitions and a data

structure describing linac service events. Face-to-face meetings, tele-conferences and individual time were used to develop standardized taxonomy and definitions with regards to linac downtime events. Care was taken such that the definitions and the data structure data elements were vendor independent.

Results and Discussions: Single institution data is insufficient to assess the possible impact of extended clinical days and extended machine replacement cycles on machine reliability, lifetime, cost, downtime and preventative maintenance servicing plans. Implementation of the proposed definitions and data structure would facilitate consistent reporting of clinical downtime, number of affected patient fractions and costs associated with downtime events. Definitions include, but are not limited to, a service event, unscheduled and scheduled clinical downtime, and clinical hours. The proposed data structure is illustrated in three sections shown in Tables 1, 2 and 3. Table 1 summarizes the attributes within the data structure to define a linac. Table 2 includes service event attributes to be recorded such as the date and type of event, number of affected patient fractions etc. The linac HV hours and filament hours are recorded to give a better indication of the machine use. Table 3 summarizes component replacement characterization.

The sharing of machine usage, downtime, repair and service practices can inform reliability and maintenance programs and procurement and service contract planning. Benefits of pooled data include:

1. Increased understanding of the duty cycle usage of a modern linac.
2. Value of service contract versus in-house service.
3. Informed policy for capital replacement cycle at a local and provincial level.
4. Informed policy for lifetime cost and downtime based on machine selection.
5. Standardization of machine service and maintenance practices and the development of best practices.
6. Provide a baseline for evaluation of machine service and QC program.
7. Quantitative assessment of the impact of routine preventative maintenance or scheduled service events.
8. Assessment of machine downtime causes.
9. Ensure consistency of up-time among similar machines in different cancer centres.

Conclusions: Standardized definitions and a data structure for linac service event reporting have been developed. The proposed standardized definitions and data structure provide the framework for a centralized linac service event database which would benefit radiation medicine programs across the province in numerous ways.

Tables:

Object	Attribute	Optional / Mandatory	Definition Notes	Form	Form Options
Linac	Manufacturer	M		Drop Down	
	Model	M		Drop Down	
	Serial Number	M		Free Text	
	MLC Model	M		Drop Down	
	Tmt. Modalities	M		Multi-selection	TSET, 2D, Robotic, SRS, FFF, SBRT, VMAT, 3DCT, SNS IMRT, Sliding window IMRT
	Image Modalities	M		Multi-selection	KV CBCT 2DKV MV MVCT
	Service Contract	M		Drop Down	Full, Cooperative, Partial, None
	Date of Acceptance	M	Clinical Release		
	Geographic Location	O		Free Text	
	Name	O			
	Available Clinical Hours Per Day	M			

Table 1: Attributes used to define a linac within a database. Linac attributes could be used to categorize linacs based on age, type etc. M = mandatory, O = optional.

Object	Attribute	Optional / Mandatory	Definition Notes	Form	Form Options
Service Event	Date / Time Stamp	M		YY-MM-DD, hh:mm	
	Type	M	Remove a cover OR greater than 30 minute clinically unavailable OR one or more patients affected (CNSC definition: intervention outside of User Manual)	Radial Button	Scheduled, Preventative Action; Scheduled, Preventative Maintenance; Scheduled, Field Correction Notice; Scheduled, Beam Tuning; Scheduled, Physics QA; Scheduled, Calibration; Scheduled, Other; Unscheduled
	InHouse Serviceperson Hours	M			
	InHouse Serviceperson Overtime Hours	M			
	Contract Serviceperson Hours	M			
	Return to Service Testing Hours	M			
	Clinical Downtime Hours	M			
	Therapy overtime hours	M			
	Number of Affected Patient Fractions	M	Number of cancelled fractions		
	Available Clinical Hours Per Day	M			
	Description	O		Free Text	
	Cumulative HV Hours	M			
	Filament Hours	M			

Table 2: Attributes surrounding a service event. Attributes can be used to determine costs (time, cancelled fractions, monetary) associated with linac downtime. M = Mandatory, O = Optional.

Object	Attribute	Optional / Mandatory	Definition Notes	Form	Form Options
Component Replacement	Sub-system	M		Drop Down	RF (Including Modulator)
					Dosimetry
					Table
					Mechanical (Including MLC)
					Imaging
	Component	M		Drop Down	Subsystem list
	Part Number	M		Free Text	
	Component Description	O		Free Text	
	Serial Number	O		Free Text	
	Rev	O		Free Text	
	X-Ray Tube HV Hours	O			
	Filament Hours / mAs / HV (?)	O			
Part Cost	M		\$NN NNN.NN		
Manufacturer	M		Drop Down	OEM Third Party	

Table 3: Attributes associated with component replacement. M = Mandatory, O = Optional.