Multi-Institutional Study for IMRT Dose Quality Assurance in Korea

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Background

- Increasing role of radiotherapy on cancer management
  - RT combined with emerging technologies; IMRT, SBRT, SRS, Proton/Carbon RT
  - In Korea, 40% of cancer patients under RT
- Increasing chance of irreparable damage
  - 2005 US NYC St. Vincent's Hosp.: IMRT 7 times overdose > death
  - 2006 UK Glasgow Beatson Cancer Center: 3DCRT 65% overdose > death
  - 2005-6 US Florida Moffitt Center: SRS 50% overdose > not release yet or ??

How about the underdose? > not control tumors

Examples of RT Accidents

The New York Times

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THE RADIATION BOOM

Radiation Offers New Cures, and Ways to Do Harm

By WALT BOGDANICH
Published: January 23, 2010

As Scott Jerome-Parks lay dying, he clung to this wish: that his fatal radiation overdose — which left him deaf, struggling to see, unable to swallow, burned, with his teeth falling out, with ulcers in his mouth and throat, nauseated, in severe pain and finally unable to breathe — be studied and talked about publicly so that others might not have to live

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THE RADIATION BOOM

As Technology Surges, Radiation Safeguards Lag

By WALT BOGDANICH
Published: January 26, 2010

In New Jersey, 36 cancer patients at a veterans hospital in East Orange were overradiated — and 20 more received substandard treatment — by a medical team that lacked experience in using a machine that generated high-powered beams of radiation. The mistakes, which have not been publicly reported, continued for months because the hospital had no system in place to catch the errors.

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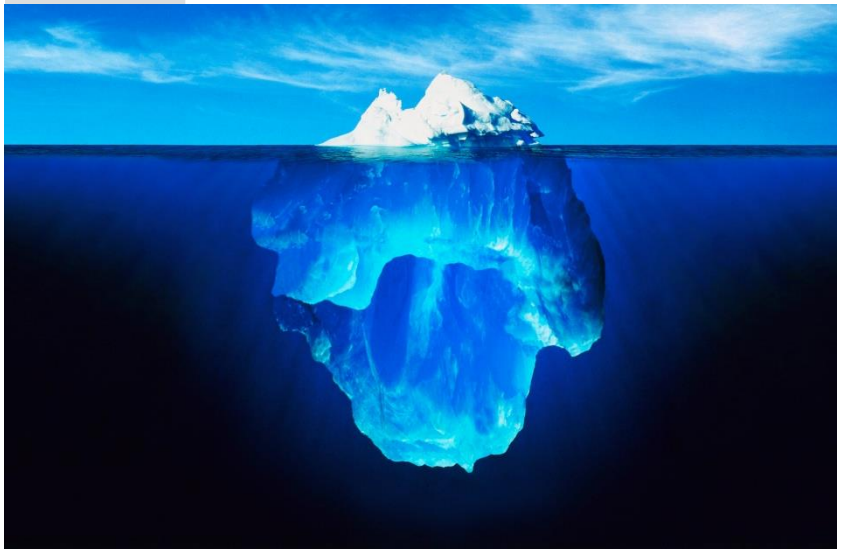
Critical error: The Lisa Norris story

By Samantha Poling
BBC Frontline Scotland

FRONTLINE SCOTLAND

When news broke in February 2006 that teenager Lisa Norris had received a massive overdose of radiation whilst undergoing treatment for brain cancer at the Beatson Oncology Unit in Glasgow, the shock was felt far beyond Girvan, the small Ayrshire town where she lived.



Efforts for IMRT Quality Assurance

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journal homepage: www.thegreenjournal.com

Quality assurance

Dosimetry audit for a multi-centre IMRT head and neck trial

Catharine H. Clark [a,c,*], Vibeke Nordmark Hansen [c], Hannah Chantler [d], Craig Edwards [e], Hayley V. James [f], Gareth Webster [g], Elizabeth A. Miles [b], M. Teresa Guerrero Urbano [b], Shree A. Bhide [b], A. Margaret Bidmead [a], Christoper M. Nutting [*b], On behalf of the PARSPORT Trial Management Group [1]

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TABLE I. List of participating institutions and the systems utilized. Manufacturer's identifications are listed below the table. "DMLC" refers to dynamic M sometimes called "sliding window." "SMLC" refers to static MLC, sometimes called "step and shoot" (Varian, ECLIPSE: Varian Medical Systems, Mil CA; Siemens: Siemens AG, Healthcare Sector, Erlangen, Germany; Elekta, CMS: Elekta Inc., Norcross, GA; PINNACLE: Philips Healthcare, Andover, TOMOTHERAPY: TomoTherapy Inc., Madison, WI).

Institution	Accelerator	Delivery technique	Planning system
Mayo Clinic Arizona	Varian 21EX	DMLC	ECLIPSE V7.5
Thomas Jefferson University Hospital	Elekta Synergy S	SMLC	CMS XIO V3.1
Robert Wood Johnson University Hospital	Varian 21EX	DMLC	ECLIPSE V7.5
Memorial Sloan Kettering Cancer Center	Varian Trilogy	DMLC	In-house
Karmanos Cancer Center/Wayne State University	Varian 23EX	DMLC	ECLIPSE V7.5
Karmanos Cancer Center/Wayne State University	Tomotherapy Hi-Art	BinaryMLC	TOMOTHERAPY V3.0
University of California at San Francisco	Siemens Oncor C	SMLC	PINNACLE V8.0d
University of Florida	Elekta Synergy	SMLC	PINNACLE V8.0d
Virginia Commonwealth University	Varian Trilogy	DMLC	PINNACLE V8.0d
Charleston Radiation Therapy Consultants	Siemens Primus	SMLC	PINNACLE V7.4f

GUIDELINES FOR THE VERIFICATION OF IMRT

Markus Alber
Sara Broggi
Carlos De Wagter
Ines Eichwurzel
Per Engström
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Günther Hartmann
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What's happening in Korea

Korea is an early-user of advanced RT technologies but, how about the infra of RT quality assurance & safety

- Daily No. of patients per RT machine: 30-35 in US vs. 40-60 in Korea
- No. of physicists per RT machine: 1.0 in US vs. 0.4 in Korea
- In July 2011, Governmental approval of IMRT reimbursement for health insurance programs

Purpose

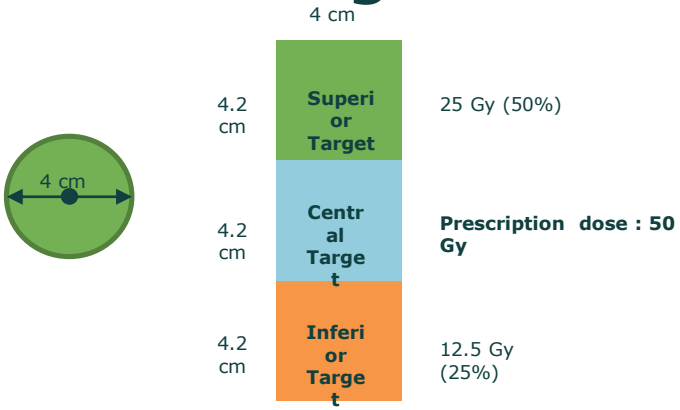
- Strengthen the National Infrastructure for RT QA & Medical Radiation Safety
  - Special emphasis on IMRT QA
  - Disseminate a basic protocol & guideline of IMRT Dose QA (DQA) via multi-institutional study
  - Derive the national tolerance (confidential limit) & action levels for IMRT commissioning

Multi-Institutional Study

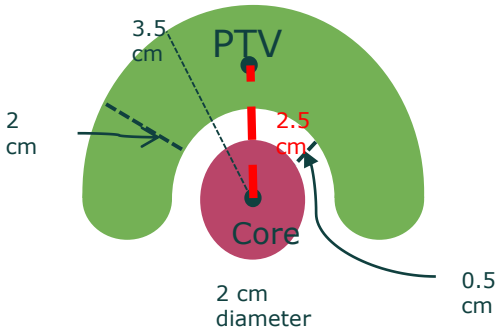
Institute	RT machine	Delivery Method	RTP System
SNUH	Varian iX	Dynamic MLC	Varian Eclipse 8.6
ASAN MC	Varian Trilogy	Dynamic MLC	Varian Eclipse 8.9
Samsung MC	Tomotherapy	Binary MLC	Tomo TPS 3.1.4
Yonsei MC	Tomotherapy	Binary MLC	Tomo TPS 4.0.2
SNUBH	Varian 21Ex	Dynamic MLC	Varian Eclipse 6.5
Donga Univ. H	Varian Novalis	Dynamic MLC	BrainLab iPlan
YUMC	Varian 21ExS	Dynamic MLC	Varian Eclipse 8.6
CUMC	Tomotherapy	Binary MLC	Tomo TPS 4.0.2
EJ D MC	Elekta Synergy	Static MLC	CMS Monaco 2.0
Jeju Univ. MC	Varian iXRA	Dynamic MLC	Varian Eclipse 8.6

Korean MOCK Structures*

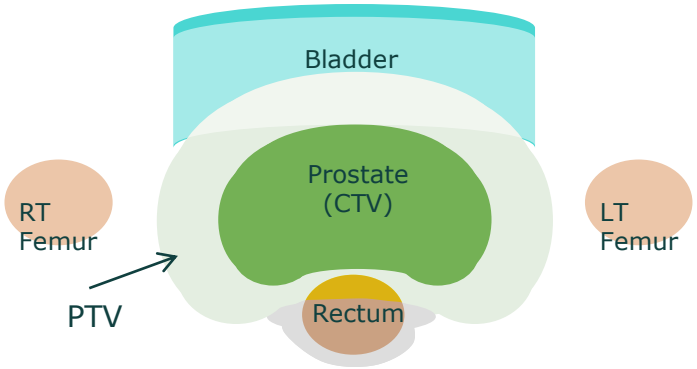
Multi-target



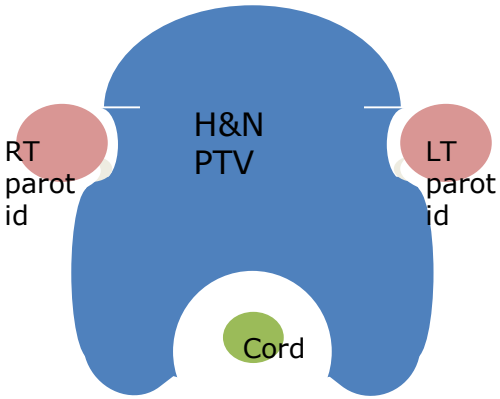
C shape target



Prostate target

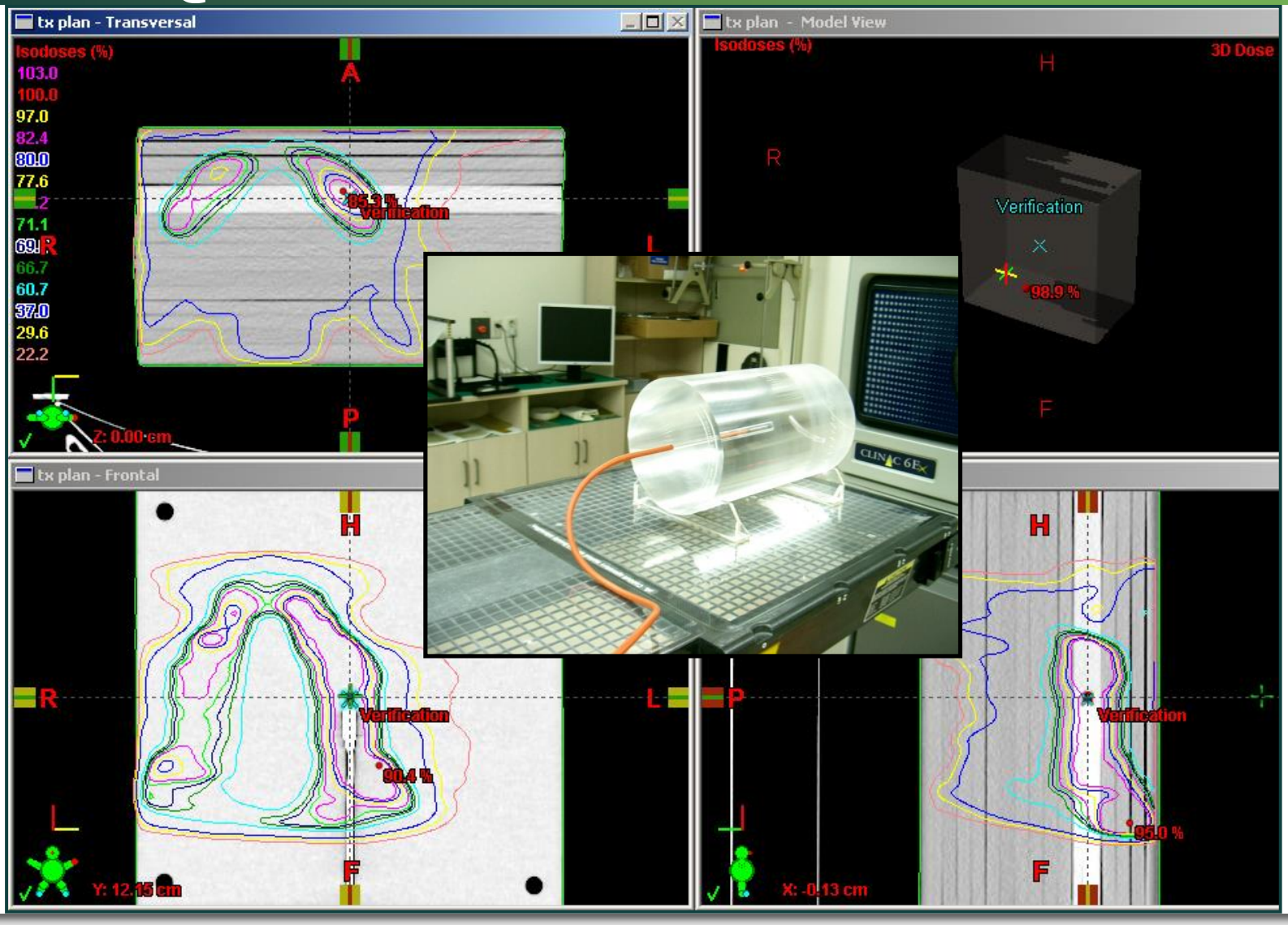


Head & Neck target

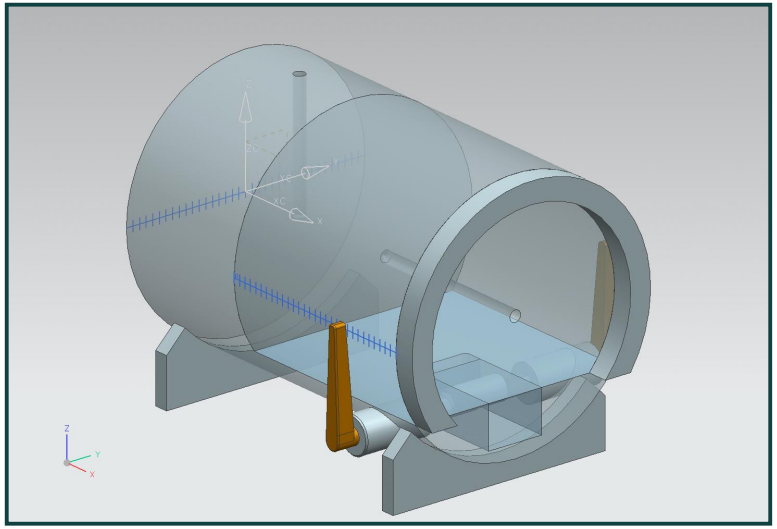


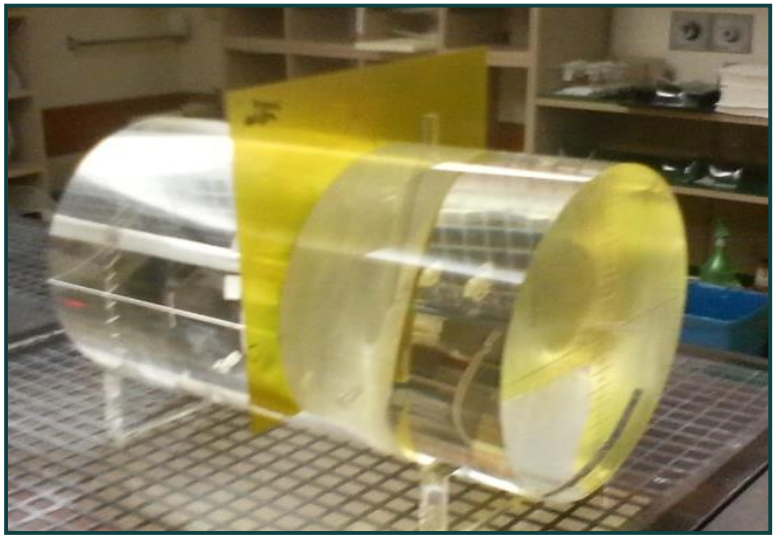
*based on AAPM TG 119

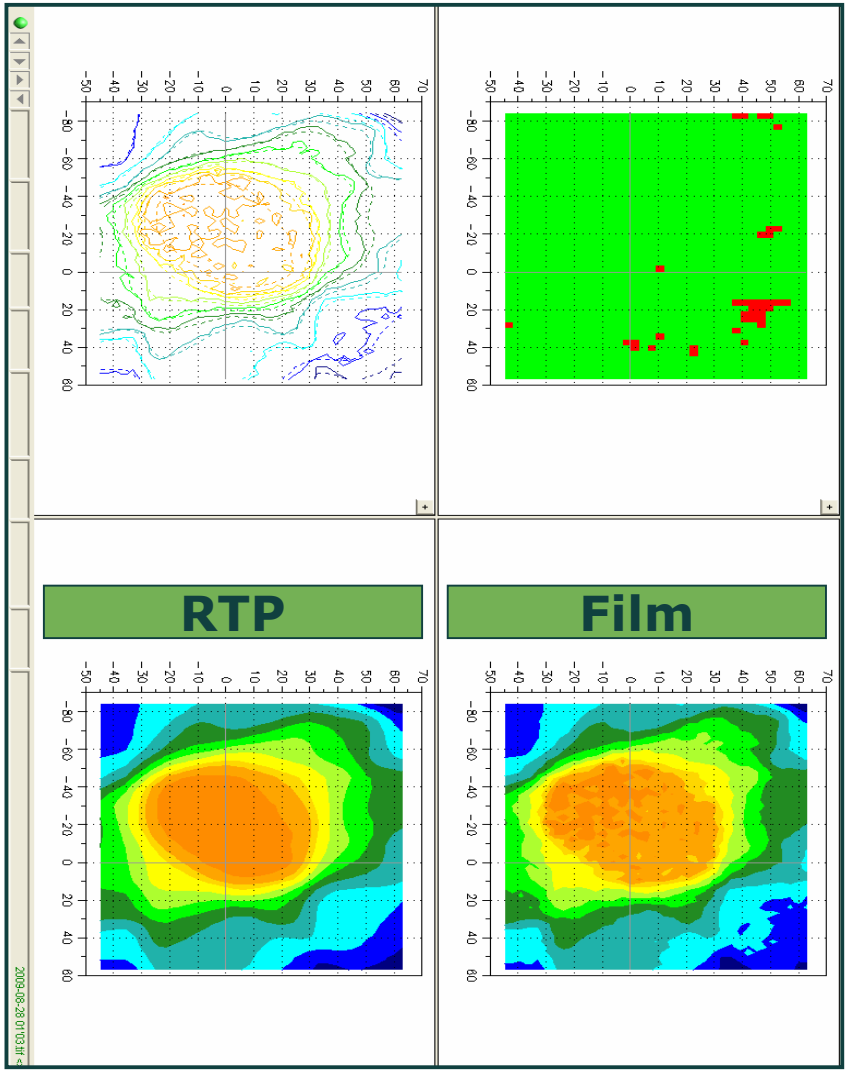
DQA for Absolute Point Dose



DQA for 2D Dose Distributions







Results: Output Auditing

Institution	Date of Measurement	Energy (MV)	Delivered Dose (cGy)	Deviation (%)
A	12/13/2010	6	100	-0.7
B	12/14/2010	6	100	0.0
C	12/15/2010	6	100	+2.4
D	12/22/2010	6	100	+1.8
E	12/22/2010	6	100	-0.5
F	12/23/2010	6	100	-1.4
G	01/15/2011	6	100	+0.4
H	12/15/2010	6	848.6	-0.5
I	12/20/2010	6	860	-1.3
J	12/24/2010	6	878	-1.8

Results

Korean Study	Tolerance level		Action level	
	LINAC	TOMO	LINAC	TOMO
High dose point	±3%	±3%	±6%	±6%
Low dose point	±7%	±5%	±14%	±10%
Per-field*	91%		87%	
Composite field*	94%	93%	88%	86%

	AAPM TG-119		ESTRO Guide line	
Level	Tolerance	Action	Tolerance	Action
High dose	±4.5%	±5%	±3%	±5%
Low dose	±4.7%	±7%	±4%	±7%
Per-field*	- (93%)	90% (film)	95%	90%
Composite*	- (87.6%)	88-90% (film)		

*3%/3mm gamma criteria

Discussion & Conclusions

- Application
  - Below the tolerance level: suitable for high quality RT
  - Exceed the action level: appropriate action should be taken ASAP
  - Between the tolerance & action levels: depending on further investigation
- LINAC & TOMO groups have similar levels but TOMO has a bit tighter in low dose point
- The results of Korea Multi-institutional study are comparable to AAPM/ESTRO guidelines

Symposium on Medical Physicists' Role for Quality Assurance & Radiation Safety

October 29, 2009

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