Comparative dosimetry study of three UK centres implementation of Total Skin Electron Treatment (TSEBT) through external audit

Sarah Misson-Yates

Guy's & St. Thomas' NHS Foundation Trust

Regina Gonzalez[1] Mark McGovern[1],Tony Greener[1], Stephen Morris[2]

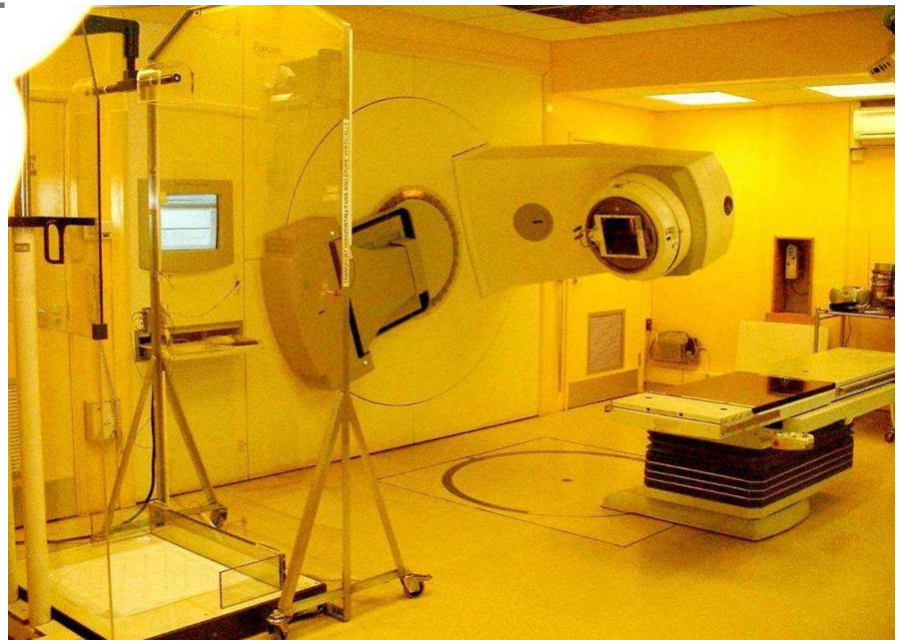
[1] Medical Physics Department,[2] Department of Clinical Oncology, Guy's and ST Thomas' NHS Foundation Trust, London, UK.

Overview

- TSEBT at Guy's and St Thomas' Hospital (GSTT)
- Modified Stanford technique
- Audit Method
  - Beam Dosimetry
  - Clinical Simulations
- Results
- Conclusions

TSEBT at GSTT

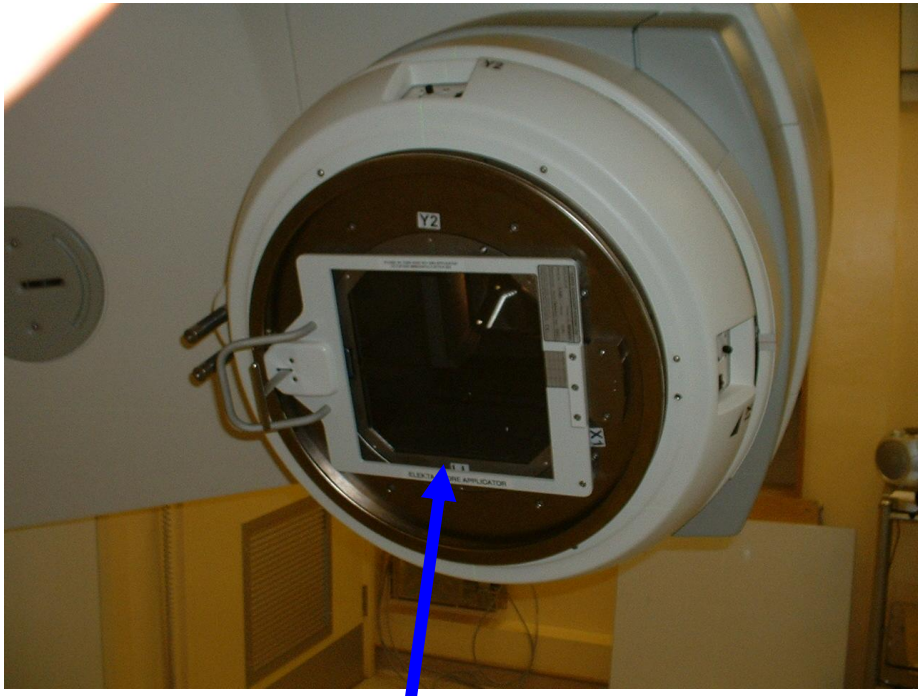
- Mainly for treatment of Mycosis Fungoides
- Over 100 patients treated since 2006
- Typical Fractionation:
  - 6MeV High dose rate
  - 30 Gy in 20#s, 4 days per week over 5 weeks



Elekta Precise Linac

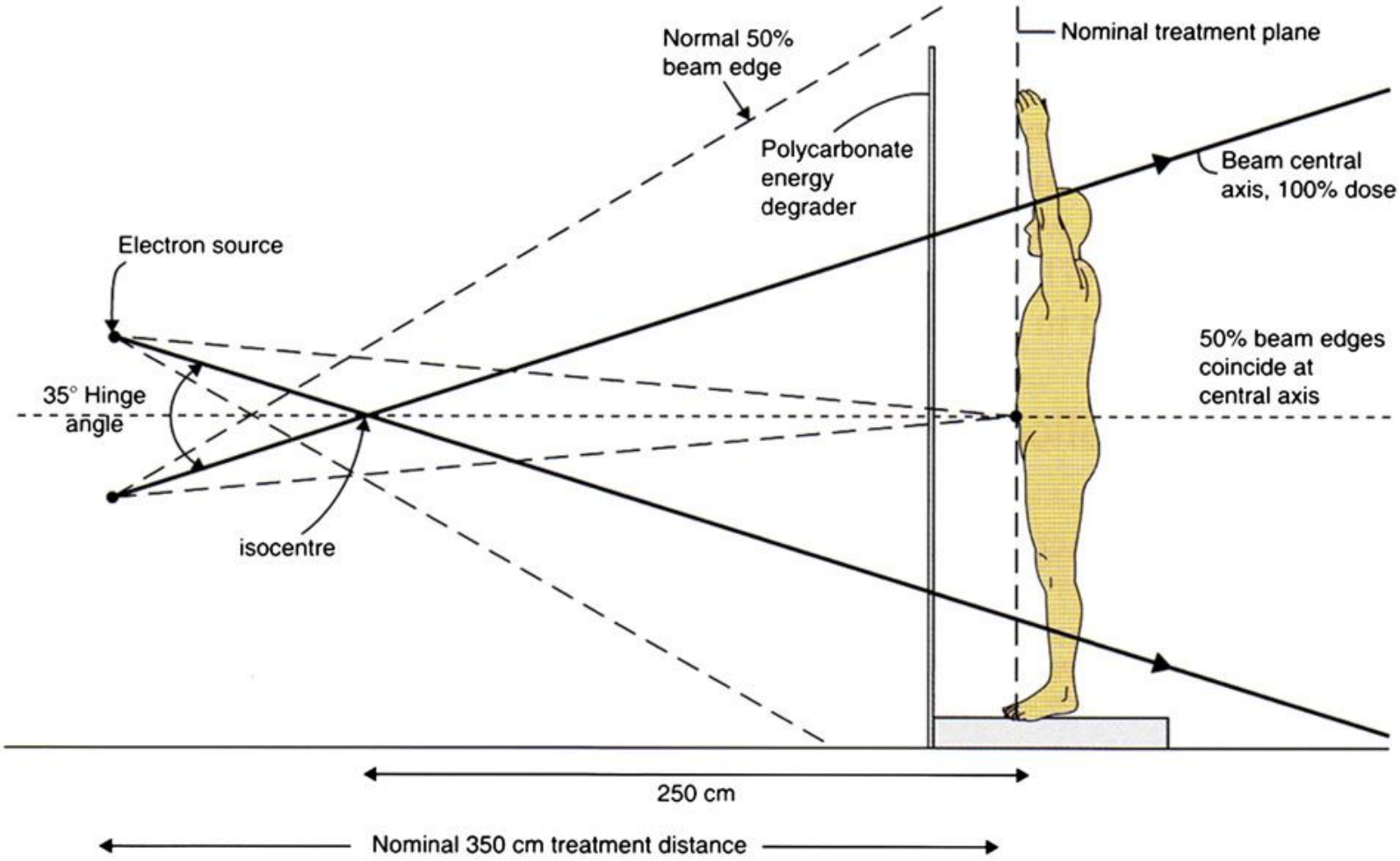
- In-vivo monitoring – 1st # with TLD's
- Daily QC performed with Diodes

TSEBT at GSTT



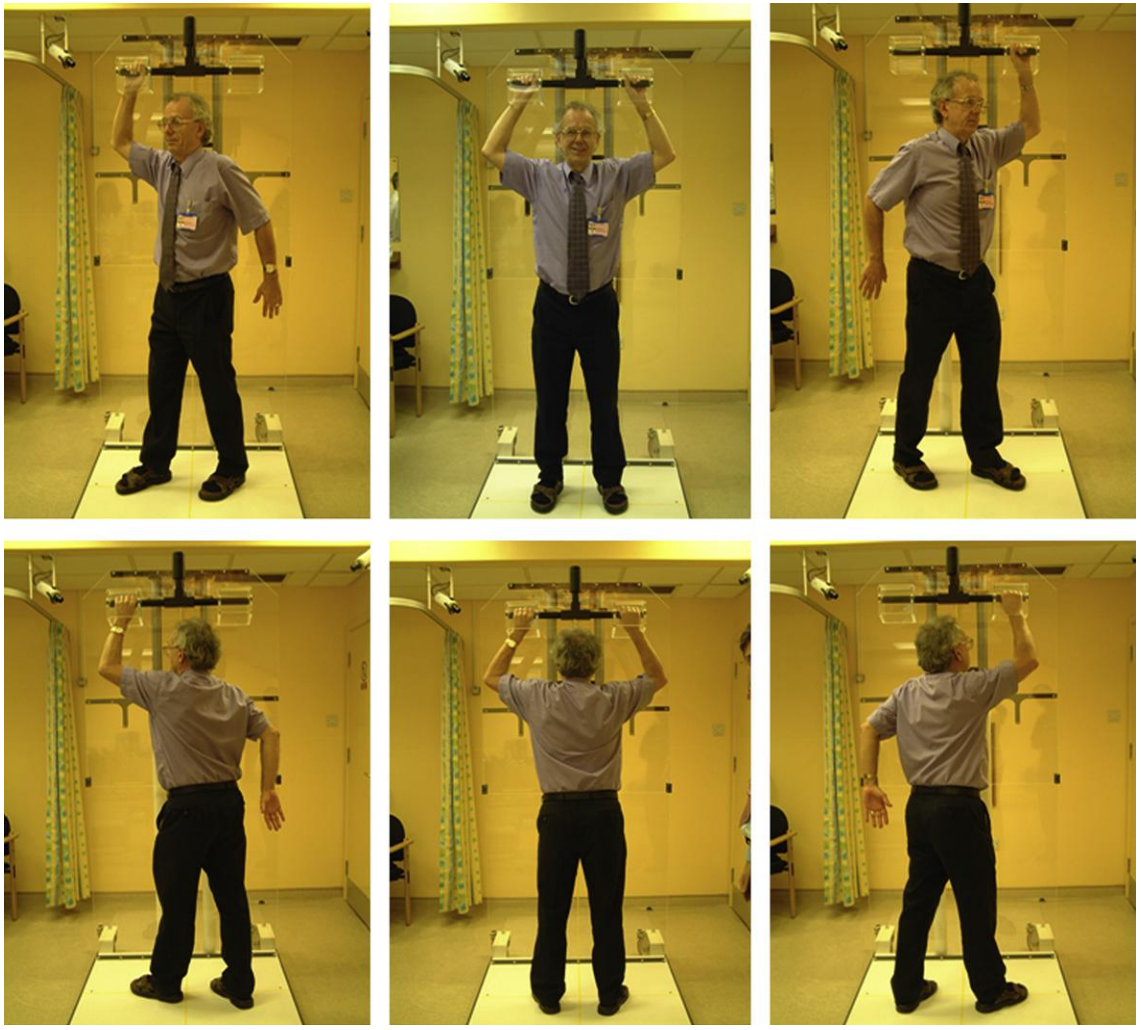
Dummy Applicator

Modified Stanford technique



[1]

Modified Stanford technique



[1]

Techniques at Centres A and B

	Nominal Beam energy (MeV) Elekta	Perspex Degrader Location	Treatment distance	Dual beam treatment angles (Hinge angle)	Dose per Fraction (cGy)	MU delivered per field
GSTT	6	At patient	350	72.5 and 107.5 (35º)	150	93
Centre A	6	At patient	400	288 and 253 (35º)	200	157
Centre B	6	In treatment head	400	70 and 110 (40º)	150	120

Audit Method – Beam Dosimetry

- Minimal guidance on audits for TSEBT
- Tests performed based on QC at GSTT highlighted below

	Monthly	**Quarterly**
Beam Monitoring	Beam Running parameters and basic interlocks	As monthly
Standard Distance (95cm SSD)	Output and energy	Energy, Flatness and Symmetry
Extended Distance (350cm SSD)	Not performed	Single and Dual Field output and Energy
Diodes	Daily QC performed	Calibration check Flatness and Symmetry Daily QC

Audit Method – Beam Dosimetry

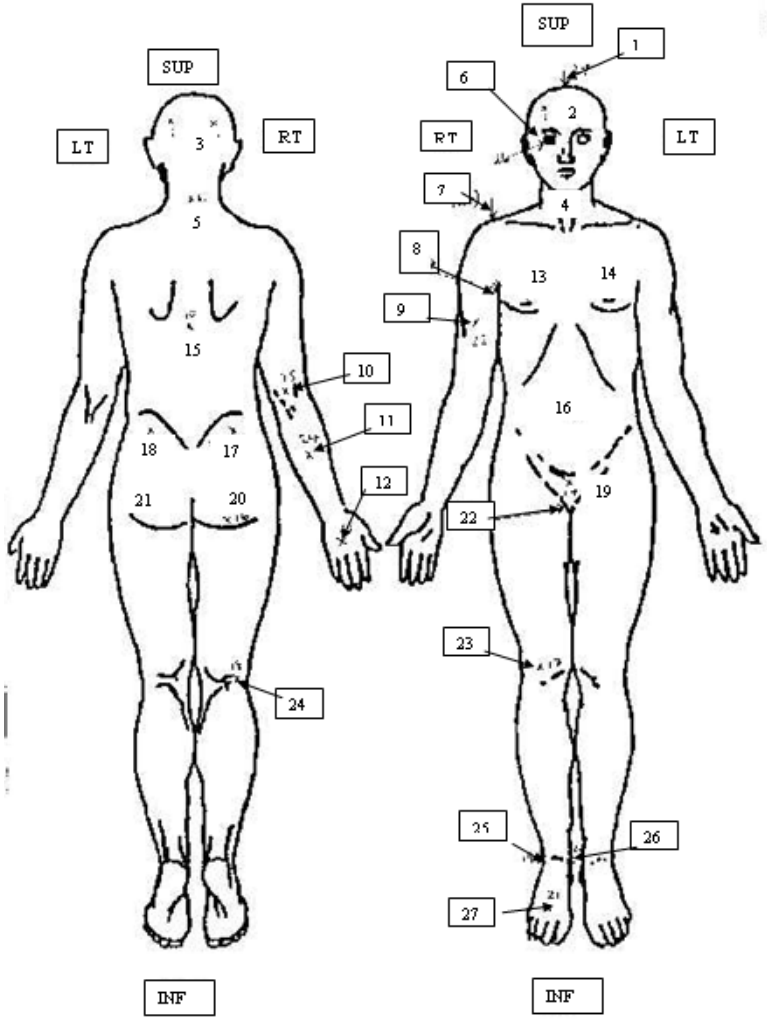
	Standard Distance (95 or 100cm SSD)	**Extended distance (350 or 400cm SSD)**
Output and Energy Check	**Output** –NACP chamber, Wte at d_{max} Gantry 0°. 100MU. **Energy** –ratio at two different depths.	**Output** –Wte at d_{max} for single and dual beams. and 100MU. **Energy** – as standard distance.
Flatness and Symmetry	**Flatness** –Average of TGAB at 12cm **Symmetry** – Ratio of 12cm points in TG and AB.	Not assessed inferred from clinical simulations.

Clinical Simulation

- Clinical Simulation performed using centre's Rando Phantom.
- Rando phantom placed on a custom support stool allowing 60 degree rotations for treatment positions.
- EBT2 Gafchromic film cut to shape and placed transverse in pelvic region
- Gafchromic film calibrated at 6MeV and readout out at GSTT using an EPSON Flatbed scanner and PTW Verisoft v3.1 and subsequently normalised to the dose per fraction.

Clinical Simulation

- TLD's were placed in the head and thorax region corresponding to the positions used clinically at GSTT.
- TLD's were calibrated in a 6MeV beam at d_{max} in the Centre's beam.
- TLD's readout at GSTT using a Harshaw 5500 TLD reader.
- The average trunk dose was determined from the TLD readings.
- Beams delivered as per treatment through MOSAIQ.



Dosimetric Considerations

- Polarity effect and Stem leakage overcome through cable shielding with lead (2mm)
- Ion recombination at standard distances is significant
  - At GSTT cGy/MU calibrated using 6MeV calibration factor and additional p_{ion} of 1.015 to 1.018
- Technique and Dosimetry covered in AAPM Report 23[2] and EORTC Recommendations 2002[3]

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Results – Beam Dosimetry

Beam Dosimetry	Standard Distance (95 or 100cm SSD)					Single / Dual field at treatment distance		Clinical Simulation TLD results	
Centre	Output (cGy/MU)	Energy ratio	Flatness (% ave TGAB)	Symmetry (%)		Output (cGy/MU)	Energy ratio	Dose per # (cGy)	Average Trunk Dose (cGy)
				TG	AB				
Centre A	10.98	0.650	98.1	99.7	100.8	0.500 (S) 0.465 (D)	0.495 (S) 0.490 (D)	200	196.8
Centre B	12.69	0.529	85.0	101	99.5	0.406 (S) 0.446 (D)	0.511 (S) NA (D)	150	139.9
Expected values GSTT	10.0	0.405	98.5	100	100	0.600	0.465	150	148.7

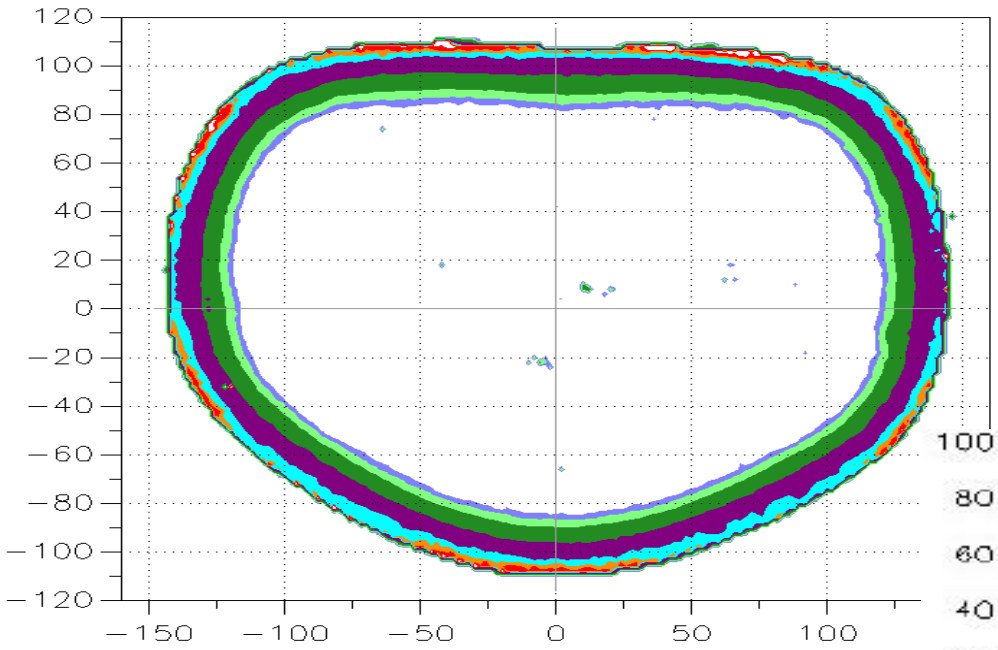
Results – Beam Dosimetry

- Standard SSD
  - Beam output varied depending on calibration methods and position of degrader
  - Overall Flatness lower at Centre B 85% compared to Centre A due to position of degrader
  - Beam symmetry at both centres within ±1.0% in TG and AB.

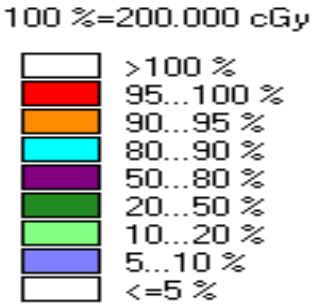
Results – Beam Dosimetry and TLD

- Extended SSD
  - Single and dual output measurements agreed within 1.0% at centre A and 1.5% at centre B
- TLD Trunk Dose
  - Average trunk dose at Centre A within -1.6%
  - Average trunk dose at Centre B within -6.7%
  - Variation in TLD readings between sites:-
    - Centre A 196.8cGy ± 13.6cGy (6.9%)
    - Centre B 139.9cGy ± 5.1cGy (3.6%)
    - Clinical GSTT results to date 148.7cGy ± 12.2cGy (8.2%)

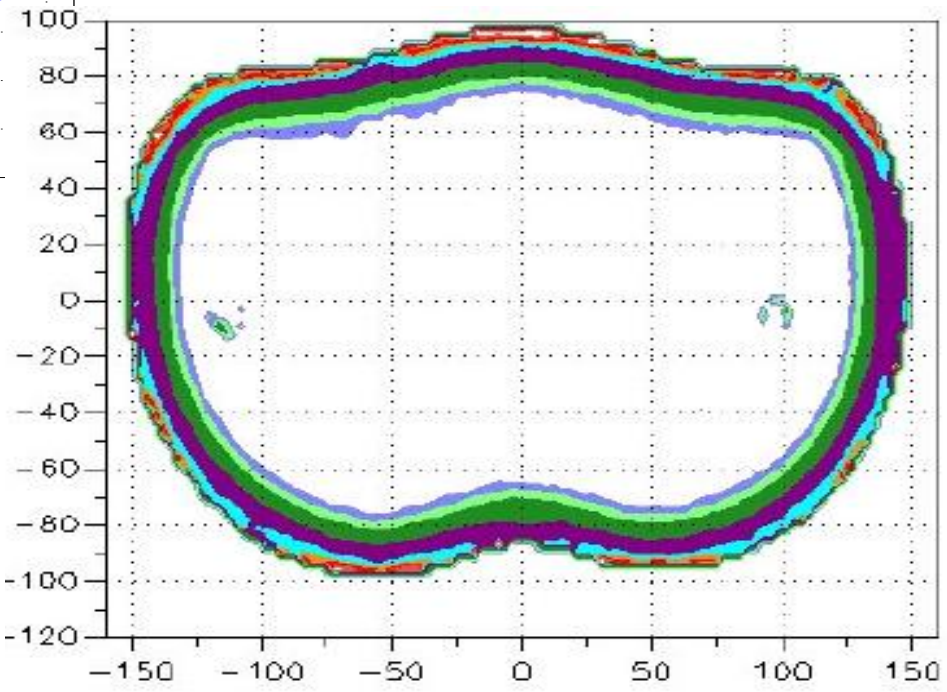
Results – Clinical Simulation



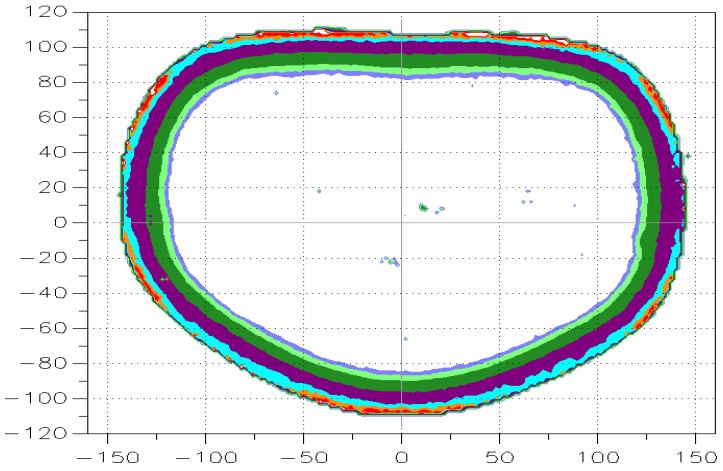
(a) Centre A



(b) Centre B



Results – Clinical Simulation



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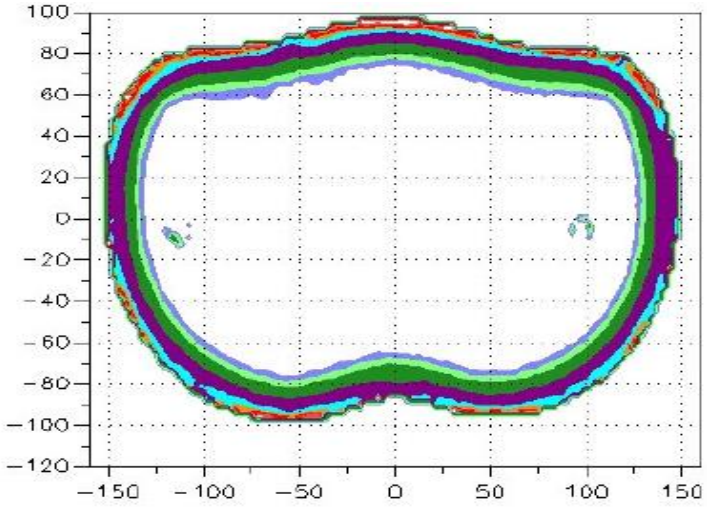
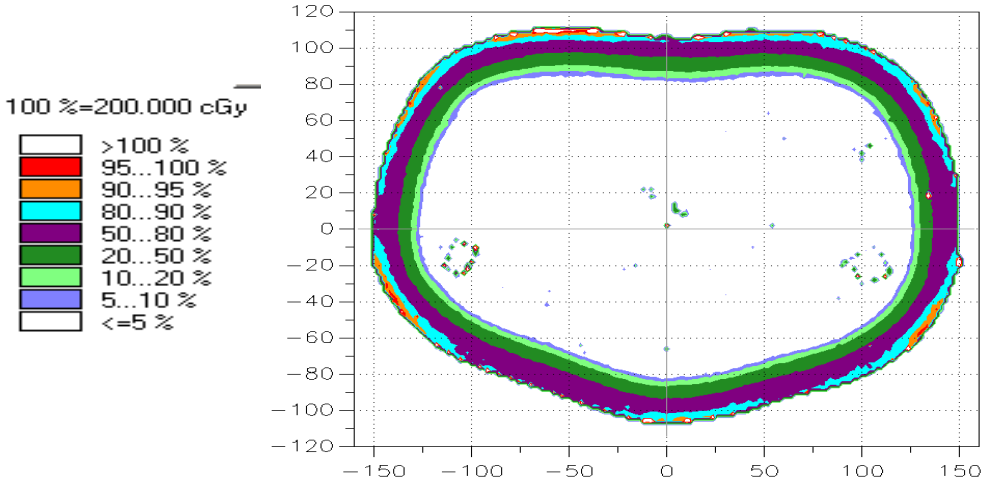


(b) Centre B



(c) GSTT

Results – Clinical Simulation

- General isodose shape similar between GSTT and centres A and B
- All distributions met EORTC requirements of 80% at ≥ 4mm and 20% at ≤ 20mm
- All exhibited a lower dose region laterally where 80% comes closer to the surface
- To be expected with no lateral beams

Conclusions

- HDRE beam dosimetry at centre A and B were acceptable at the standard and extended treatment distances.
- TLD results showed the average trunk dose was within 2.0% of expected at centre A and -6.7% at centre B.
- Gafchromic film results showed that GSTT and centres A and B comply with the EORTC recommendations [3].

References

- [1] Morris SL (2012), *Skin Lymhoma*, Clin Oncol (R Coll Radiol). Jun;24(5):371-85. doi: 10.1016/j.clon.2012.02.007. Epub 2012 Apr 4. Review
- [2] Karzmark CJ et al (1987) AAPM Report No. 23, *Total skin electron therapy: Technique and dosimetry.* Report of Task Group 30, Raditaion Therapy Committee, AAPM.
- [3] Jones G et al (2002). Total skin electron radiation in the management of mycosis fungoides: *Consensus of the European Organisation for Research and Treatment of Cancer (EORTC) Cutaneous lymphoma Project group.* J Am Acad Dermatol, 47: 364-370.

Acknowledgments

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Any Questions?

sarah.misson-yates@gstt.nhs.uk