

Pediatric radiotherapy

PATIENT'S GUIDE

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Outline

Craniospinal irradiation

Intra-cranial irradiation (germ cell tumour, glioma, craniopharyngioma)

Neuroblastoma

Ewing's

Rhabdomyosarcoma

Lymphoma

Total body irradiation

Total lymphatic irradiation

Outline

Work flow

Toxicities

Follow up

Resources

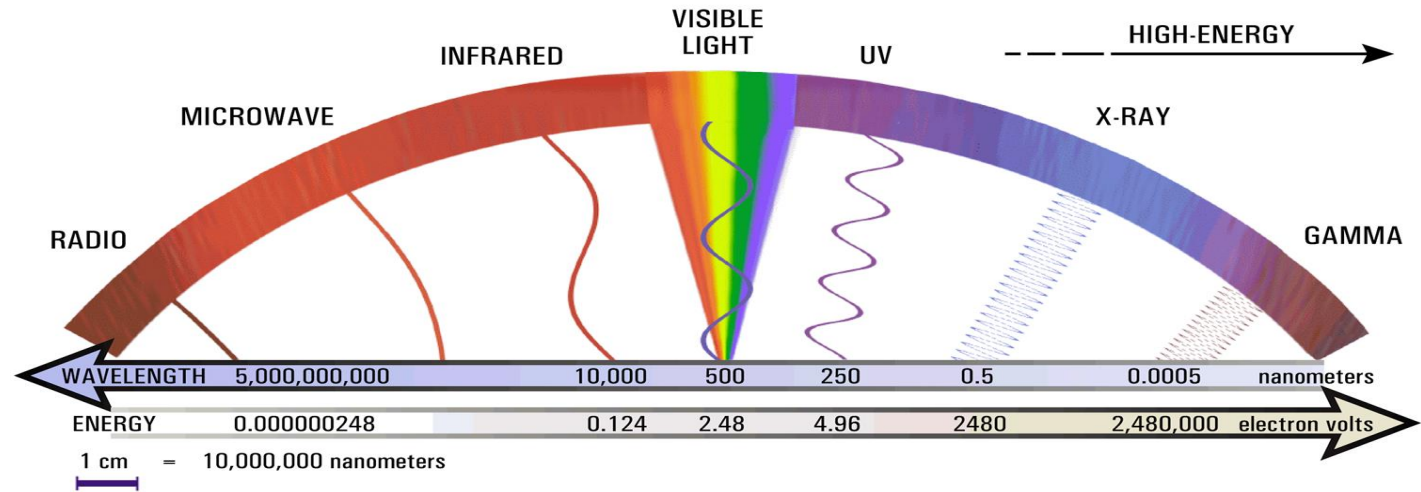
Proton therapy indications in Singapore

Cancer subtypes for patients younger than 25 years				
<u>Central and peripheral nervous system</u>				
17	Retinoblastoma	2	\$500 per treatment	\$360 per treatment
18	Chordoma/ chondrosarcoma base of skull or spine	3	\$1,800 per treatment	\$2,800 per treatment
19	Ependymoma			
20	Craniopharyngioma			
21	Pineal parenchymal tumours (not pineoblastoma)	1	\$300 per treatment	\$80 per treatment
22	Medulloblastoma			
23	Intracranial germ cell tumour			
24	Primitive neuroectodermal tumours			
25	Esthesioneuroblastoma			
26	Neuroblastoma			
<u>Musculoskeletal</u>				
28	Ewing sarcoma	1	\$300 per treatment	\$80 per treatment
29	Spinal/ paraspinal bone and soft tissue sarcoma			
30	Rhabdomyosarcoma: orbit, parameningeal, head and neck, pelvis			
31	Pelvic Sarcoma			
32	Osteosarcoma			
<u>Others</u>				
33	Salivary gland cancer	1	\$300 per treatment	\$80 per treatment

Generally indicated in pediatric cancers with curative intent

What is radiotherapy

High energy XR



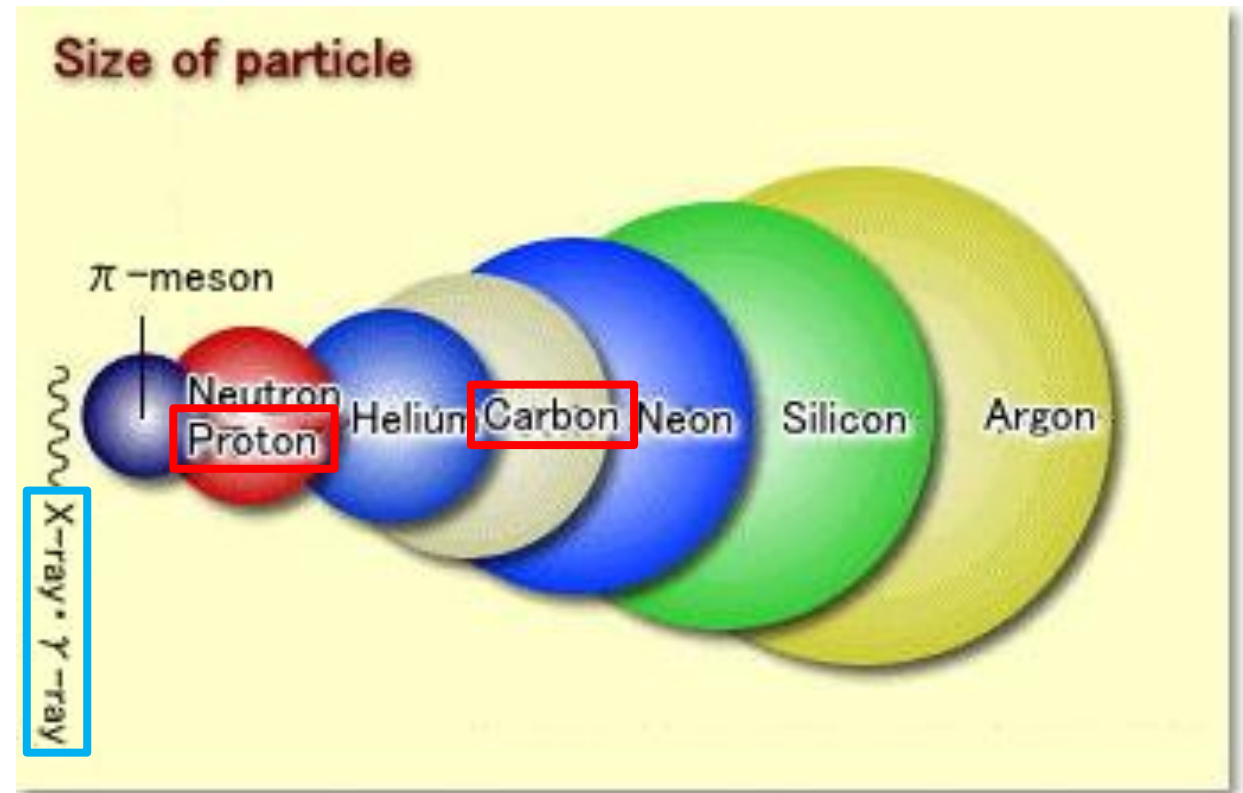
WHAT IS PARTICLE THERAPY?

Conventional radiotherapy

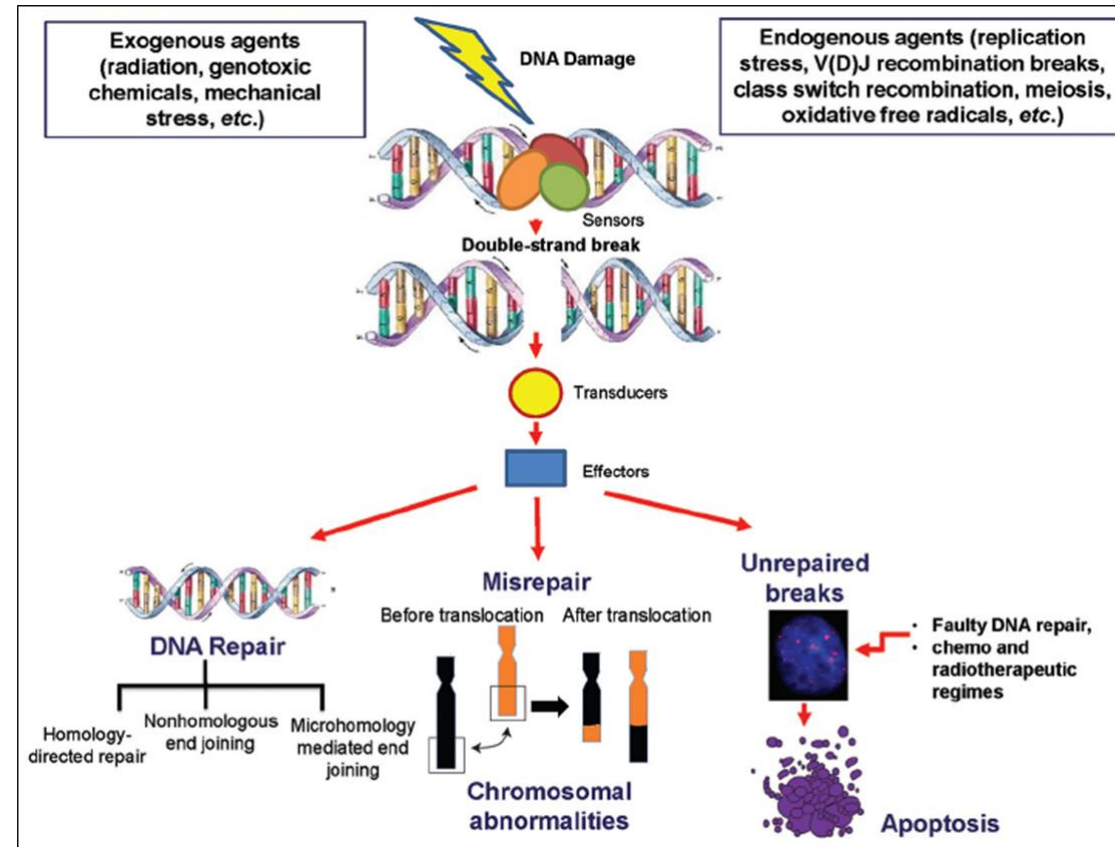
- X-rays, γ -rays
 - Waves of light
 - Electric charge (-)
 - Mass (-)

Particle therapy

- Protons, carbon ions
 - Particles of ion
 - Electric charge (+)
 - Mass (+)



How Radiotherapy Works



Cranio-spinal irradiation

Indications

- Medulloblastomas
- Metastatic ependymoma
- ATRT
- Higher risk germ cell tumours

Medulloblastoma

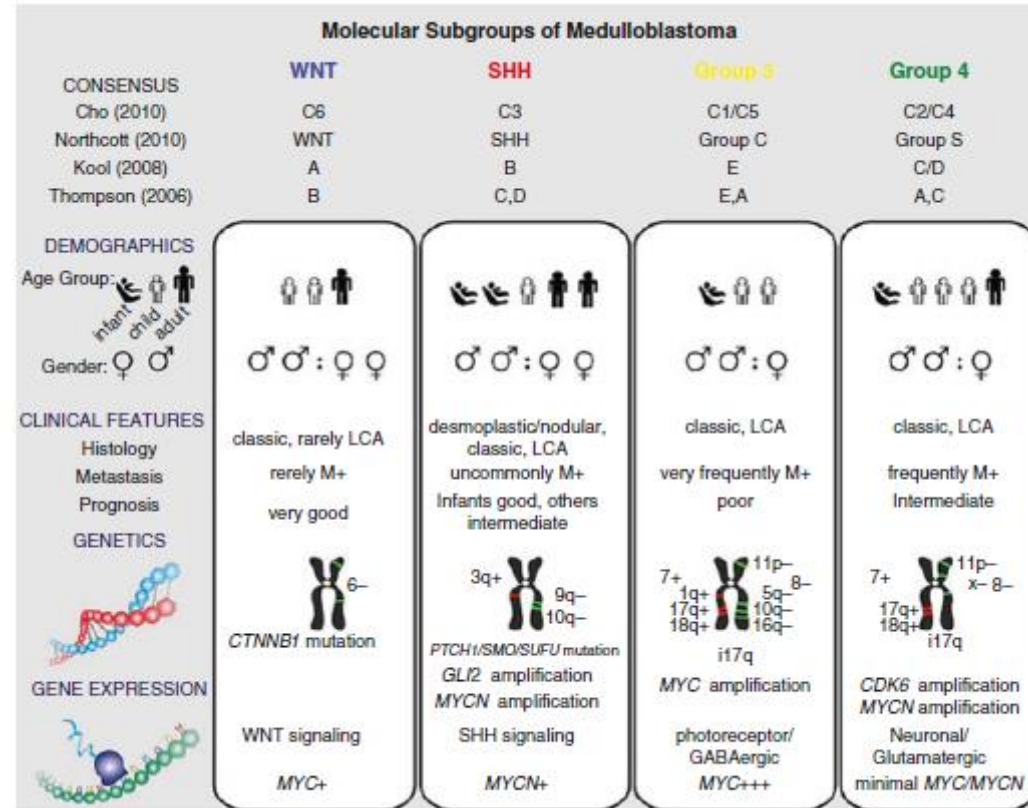


Fig. 9.2 Representation of the four molecular medulloblastoma groups. Source: Taylor, M. D., Northcott, P. A., Korshunov, A., *et al.* 2012. Molecular subgroups of

medulloblastoma: the current consensus. *Acta Neuropathol*, 123, 465–72

Medulloblastoma

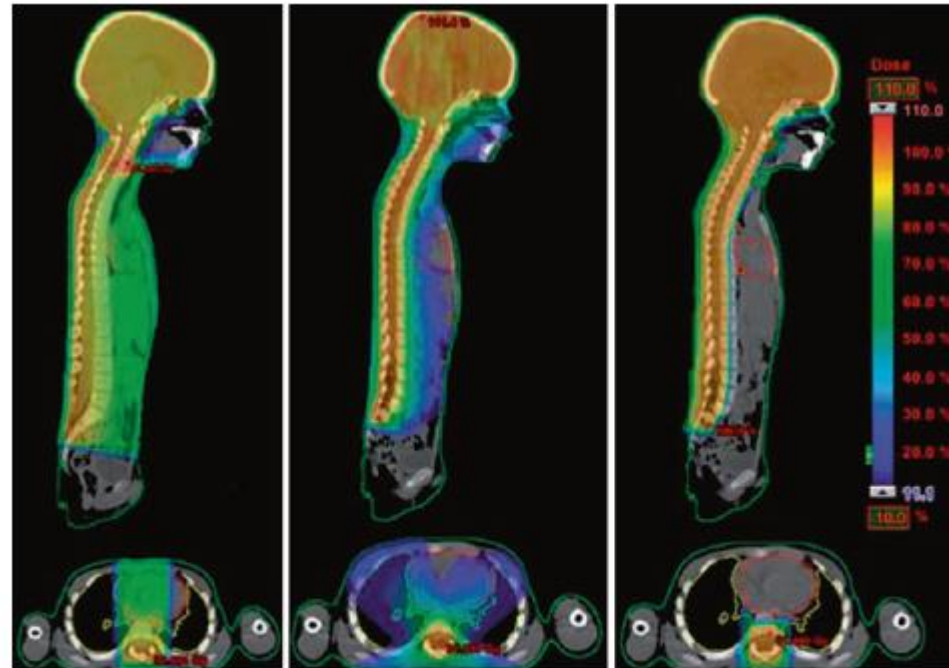


Fig. 9.5 Comparison of craniospinal dose delivered with (from left to right) 3D-conformal photon therapy, intensity modulated radiation therapy or proton therapy. Adapted from Brodin, N. P., Munck AF Rosenschold, P., Aznar, M. C., Kiil-Berthelsen, A., Vogelius, I. R., Nilsson,

P., Lannering, B. & Bjork-Eriksson, T. 2011. Radiobiological risk estimates of adverse events and secondary cancer for proton and photon radiation therapy of pediatric medulloblastoma. *Acta Oncol*, 50, 806–16

Medulloblastoma

SJMB12 dose: With addition of low risk (WNT subgroup), and de-escalation of boost doses.

Risk Classification	CSI Dose	Primary Site Dose	Metastatic Site Dose
Low*	15	51	n/a
Standard	23.4	54	n/a
High	M0-1: 36	54	n/a
	M2 brain: 36-39.6	54	50.4-54
	M2 spine: 36-39.6	54	n/a
	M3 brain: 36-39.6	54	50.4-54
	M3 spine: 36-39.6	54	50.4-54



CSI 13 times, 2.5 weeks
Then boost 17 times, 3.5 weeks

Intra-cranial irradiation

Indication

- Craniopharyngioma
- Gliomas
- Germ cell tumours
- Ependymoma

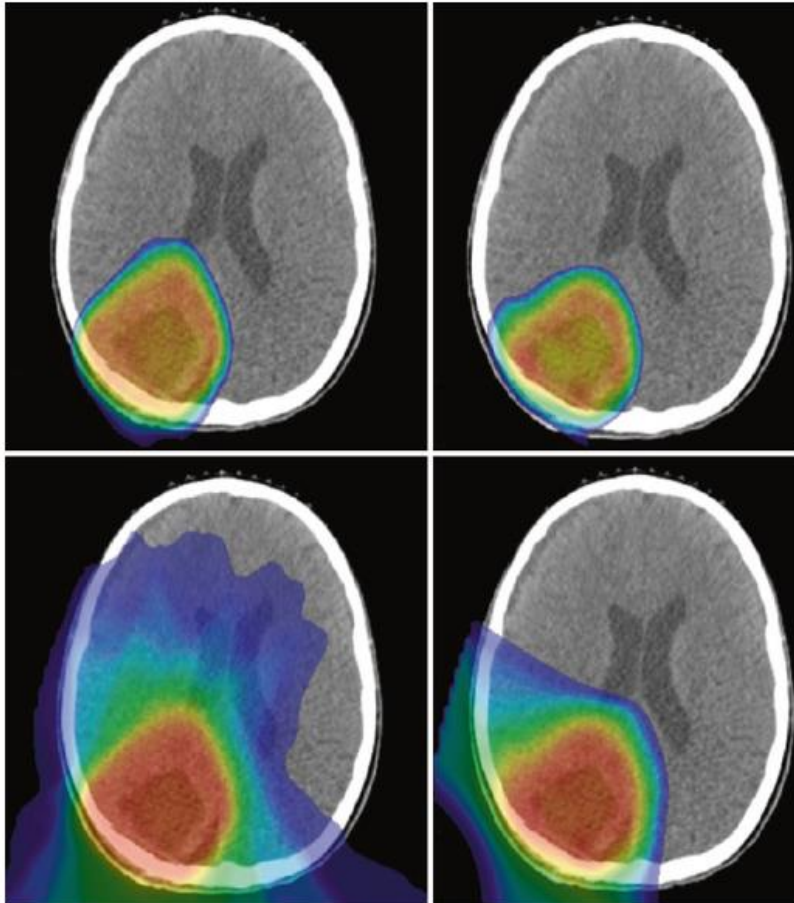
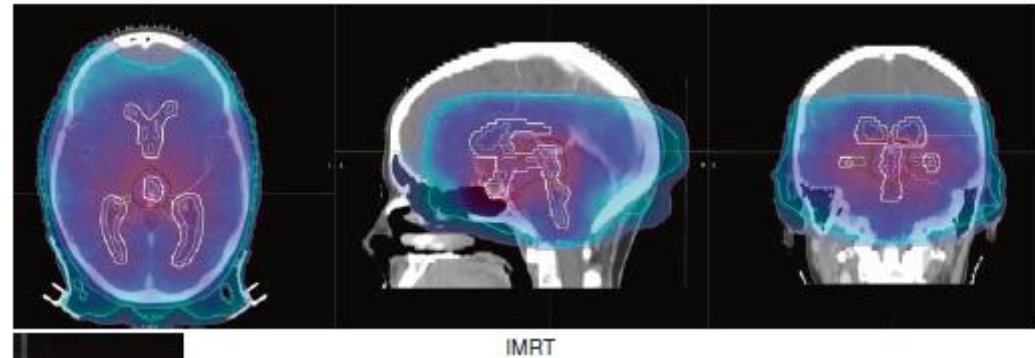
Intra-cranial irradiation

Germ cell – 25 times, 5 weeks

Ependymoma – 31 times, 6 weeks

Intra-cranial irradiation

Whole ventricles



Focal RT after resection

Fig. 12.4 Intensity-modulated photon (left, top and bottom) and proton (right, top and bottom) therapy plans displaying dose distributions greater than 40 (top row) or 10 (bottom row) Grey or Cobalt-Grey Equivalent, respectively

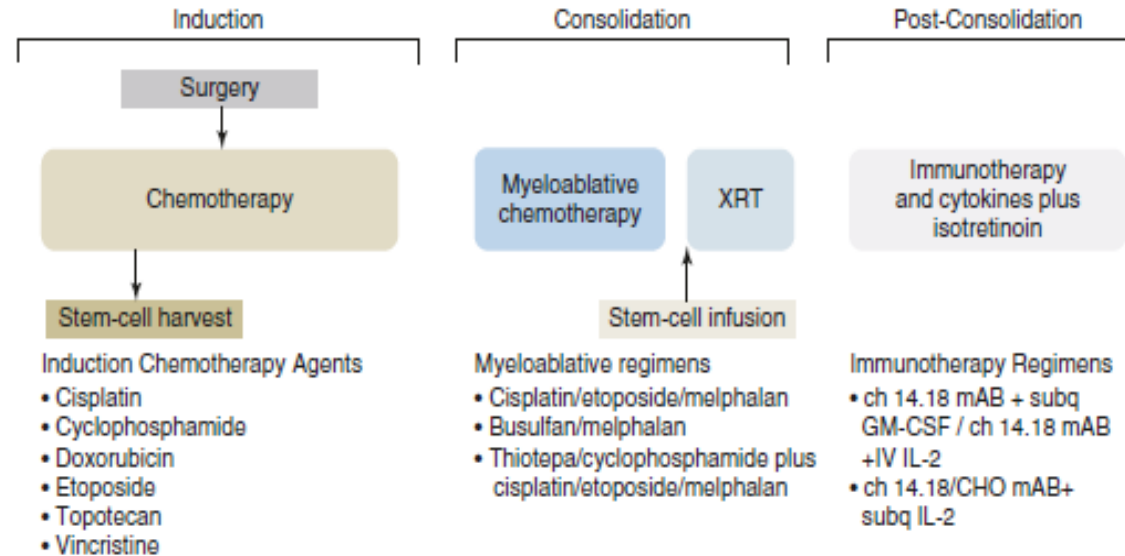
Source <https://link.springer.com/book/10.1007%2F978-3-319-43545-9>

Neuroblastoma

Radiotherapy for high risk patients

- Primary site
- Active metastatic sites after chemotherapy
- Lower doses

Neuroblastoma



Source

<https://link.springer.com/book/10.1007%2F978-3-319-43545-9>

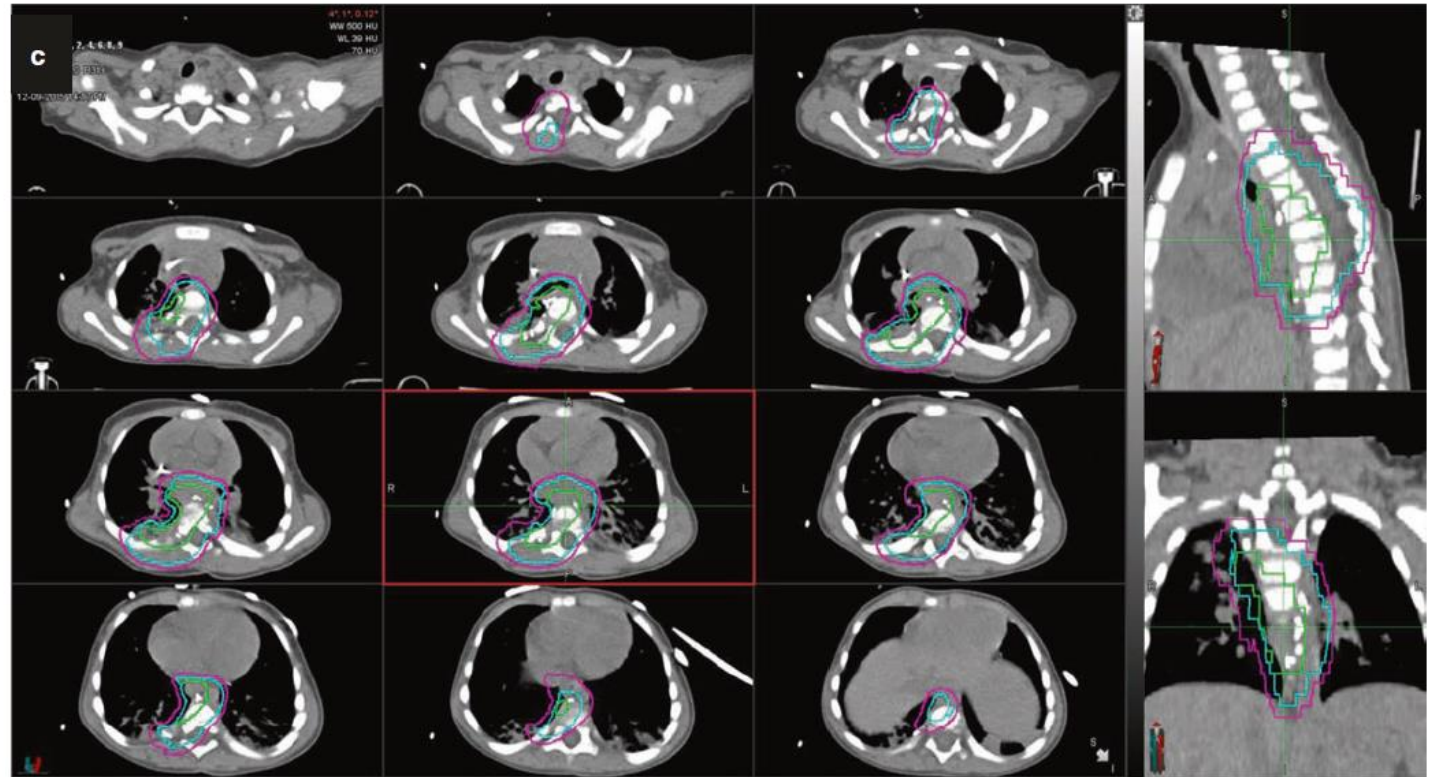
Neuroblastom

21.6 Gy

12#

2.5 weeks

+/- boost



Include entire vertebral body to ensure symmetrical growth

Ewing

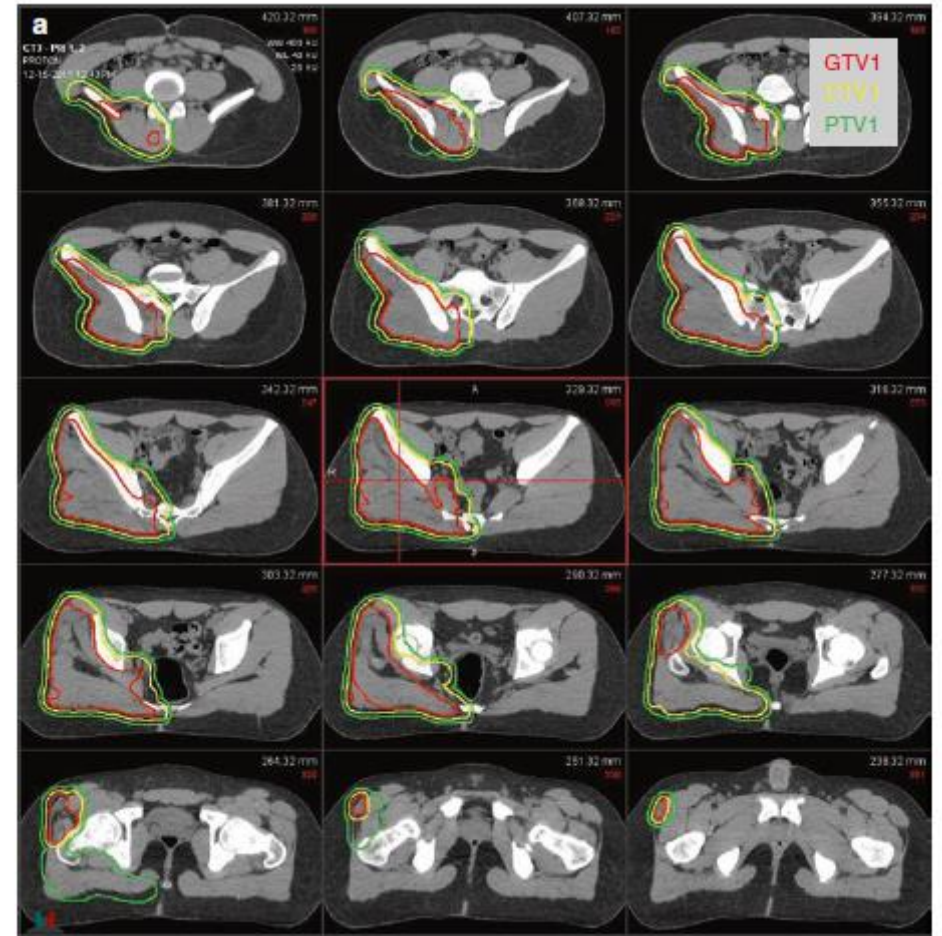
Indications

- Definitive radiotherapy
- Adjuvant if margins +, poor chemo response
- Whole lung
- Metastatic sites

Ewing

45-54 Gy: ~5 weeks

Whole lung: 16.5 Gy ~ 2 weeks



Definitive radiotherapy

Rhabdomyosarcoma

Very radiosensitive

Almost every patient needs RT

- Except smaller localized favorable histology
- 36-50.4 Gy~ 5 weeks

Rhabdomyosarcoma

Definitive

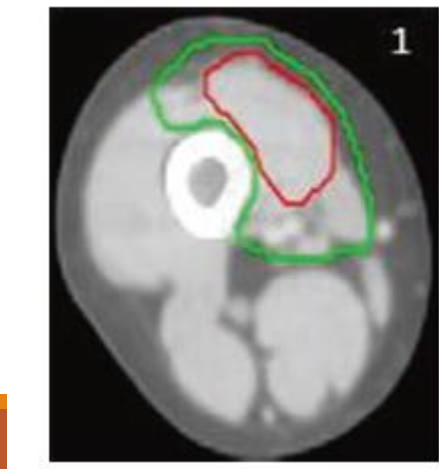
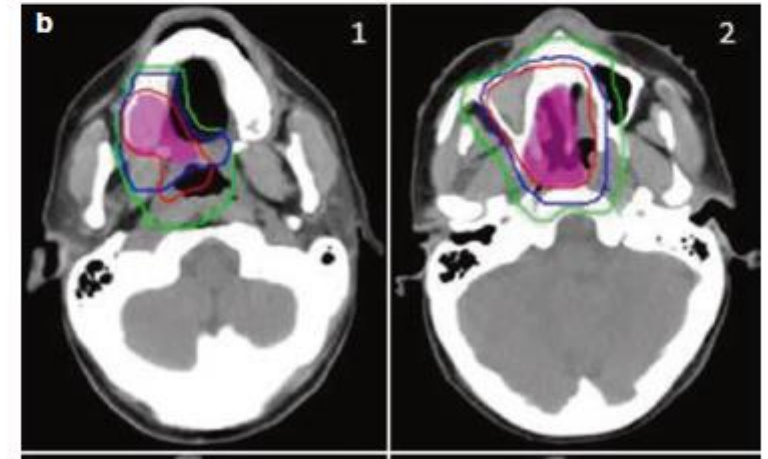
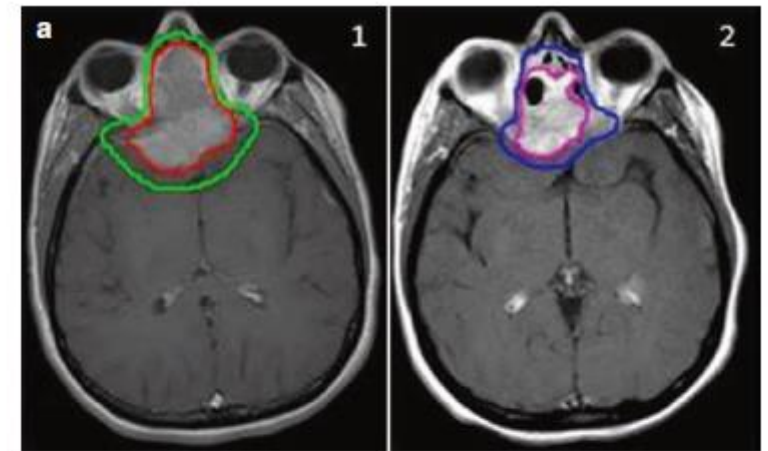
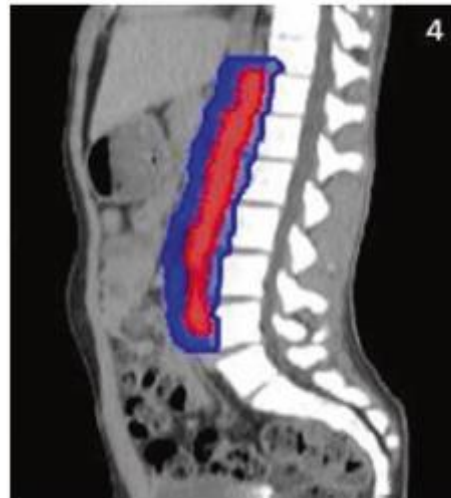
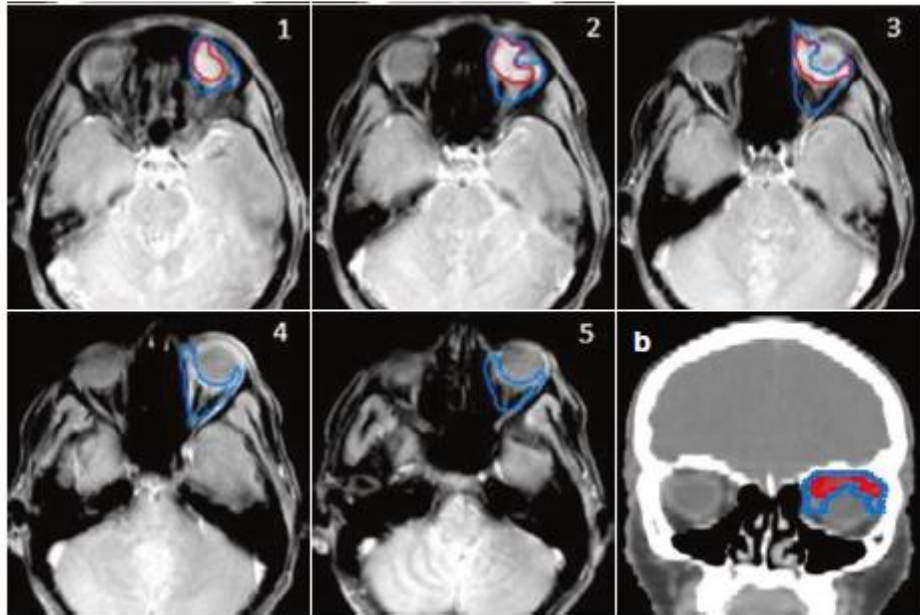
Post-operative

Metastatic sites

Whole lung

Whole abdomen

Rhabdomyosarcoma



Lymphoma

Hodgkin

- Incomplete response
- Slow response

Non-Hodgkin

- Refractory

Lymphoma

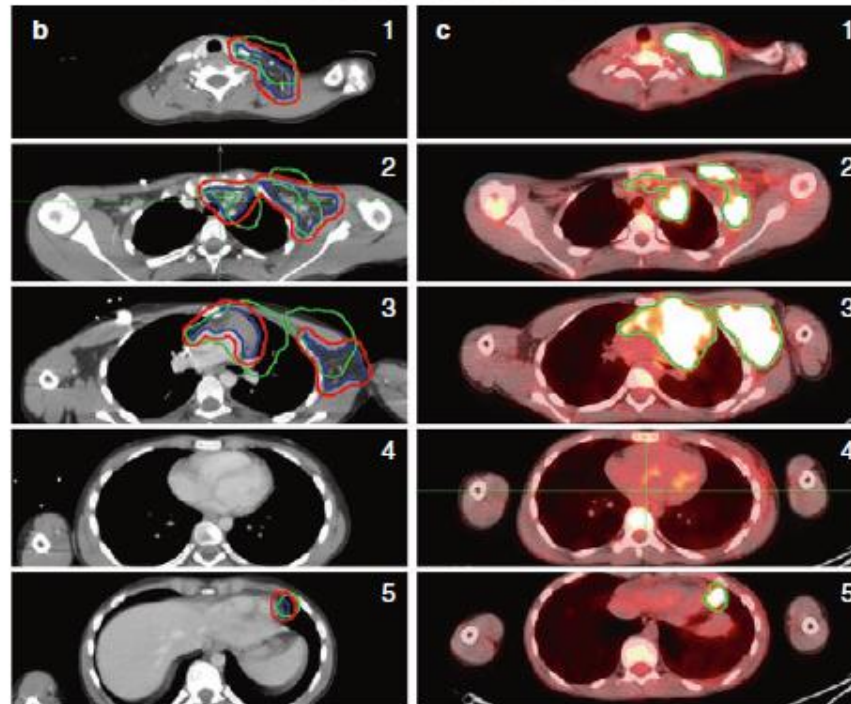
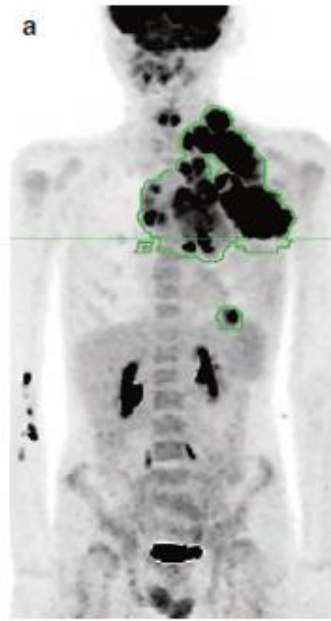
Lower doses

<30 Gy ~ 3 weeks

Involved node

Involved site

Involved field



Source
[https://link.springer.com/
book/10.1007%2F978-3-
319-43545-9](https://link.springer.com/book/10.1007%2F978-3-319-43545-9)

Total body irradiation

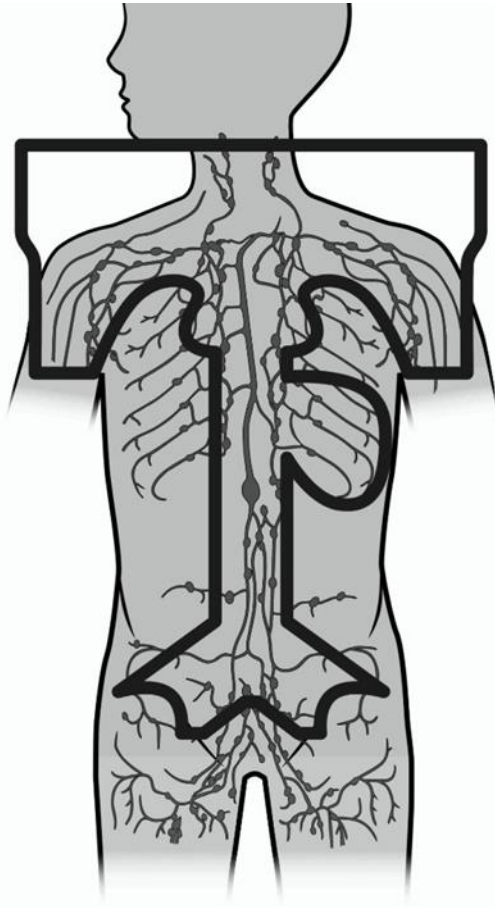
Kill residual cancer

Condition body for transplant

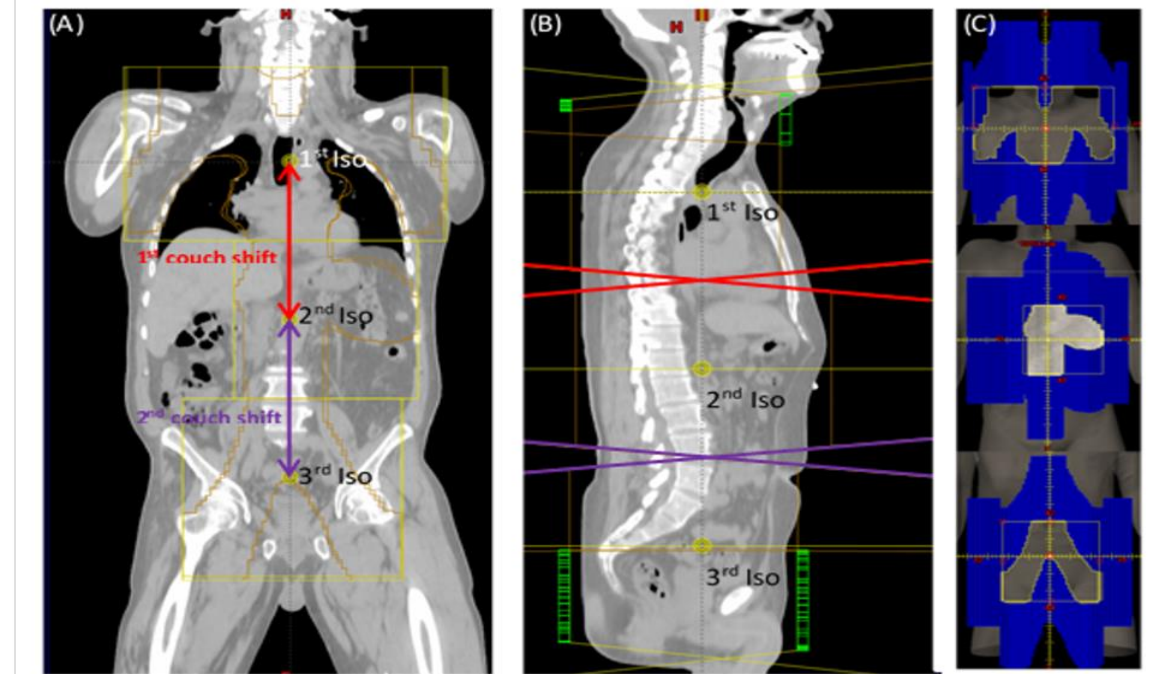
~12 Gy / 6 times



Total lymphatic irradiation



Conditioning for cell transplants
~ 4 treatment over 2 days
Low doses



Radiotherapy process

Consultation, Child life therapy and orientation

Sedation

Immobilization

Simulation

Planning

Delivery



~2 weeks

Schedule

1st week | 2nd week | 3rd week | 4th week | 5th week | 6th week



5 times a week

Immobilization and simulation

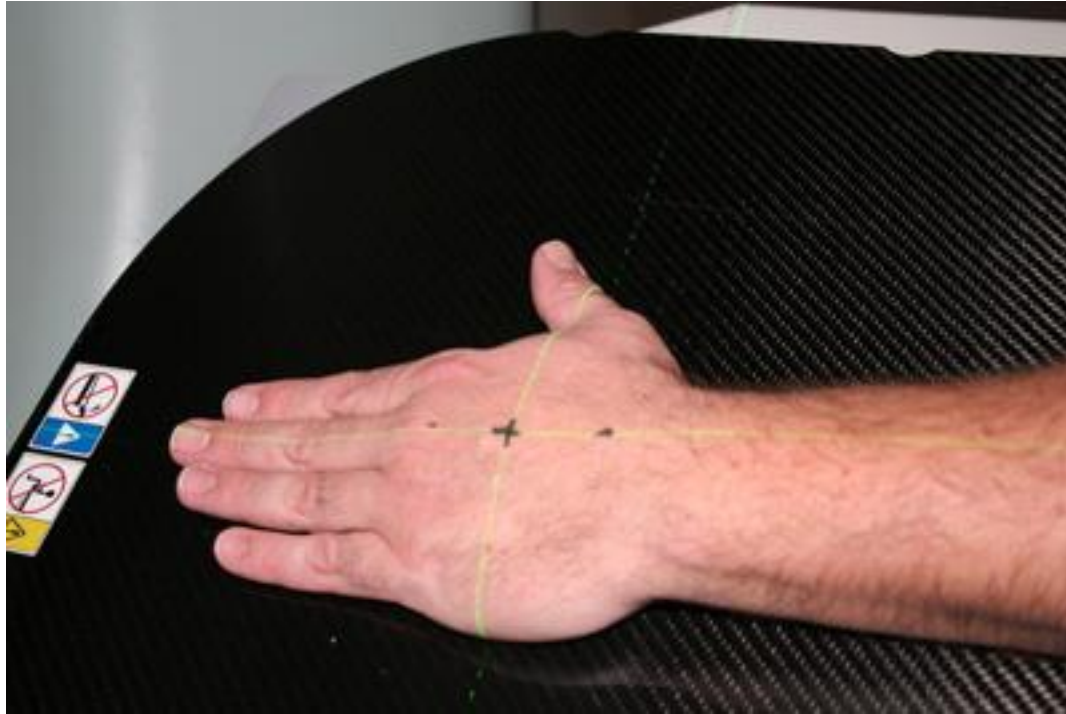


Source: www.qfix.com



www.civcort.com

Tattoo



www.oncolink.org



Community.macmillian.org.uk

Treatment room



Varian probeam

Side effects

Acute

Long term

Acute side effects

Fatigue

Nausea/vomiting

Alopecia

Dermatitis

Diarrhea

Lung inflammation

Will resolve

Late side effects

CNS

- IQ
- Vascular malformations
- Meningiomas
- Scar epilepsies

Late side effects

Ears

- Cochlea
- Cisplatin
- Radiotherapy

Eyes

- Cataracts
- Optic nerve damage (rare)

Late side effects

Endocrine

- Pituitary
 - Sex hormones
 - Growth
 - ACTH
- Thyroid gland
- Pancreas
 - Increased risk of diabetes

Late side effects

Cardiac

- Heart failure
 - Chemo
 - Radiation

Late effects

Respiratory

- Fibrosis
- Chest wall deformity

Late effects

Musculoskeletal

- Short stature
- Asymmetry
- Muscle atrophy
- Joint stiffness

Skin

- Dryness
- Pigmentation

Late effects

Gastrointestinal

- Stricture (<5%)
- Perforation (<5%)

Late effects

Genito-urinary

- Stricture
- Telangiectasia

Fertility

Ovaries

Testes

Secondary malignancy

Dose dependent

>5 years later

Genetic predisposition

Proton therapy

Singapore

- NCCS
- Mt E Novena
- Singapore Advanced Medicine (Biopolis)

Follow up

Close monitoring initially

Survivorship clinics

Multi-disciplinary

- Neuropsychology

- ENT

- Endocrine

- Oncology

- Physiotherapy etc

Resources for patient and family

St Jude patient education

Pedsoncologyeducation.com

Uptodate.com patient information

Children's Cancer Foundation Singapore

Questions

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