« THE PLANNING PROCESS IN GENERAL »

M. Goitein

« Some concepts and simple cases in the Planning process »
A. Mazal, B. Schaffner, M. Engelsman, Nieck Schreuder
The planning process: Ophthalmologic tumors
(clinical presentation Pr Hug this afternoon)

1: Patient Evaluation:
Evaluate the patient using all relevant diagnostic tools, and decide whether to employ radiation therapy.

Enucleation, plaques, protons...

Melanoma (90%)  Hemangioma (10%)
2. Imaging
Obtain and inter-register imaging studies: CT, MRI, fundus, angiography, ultrasound

In general:
patient immobilised
position to be used for therapy
(masks, frames, …)

and/or...
Use of implanted fiducials

Tentalum clips implanted
under local/general
anaesthesia
3. Delineate the target volumes and normal tissues in the treatment planning system (Eyeplan®) according to imaging & clips position
4. Establish the planning aims for the treatment
(protocols & individual specs)
5. Beam design
Design one or more sets of beams

Indeed for eyes:
Choice of the gaze angle to avoid critical organs

In the beam’s eye view:
Design a collimator

Calculate dose distribution

Margin: 2.5 mm

Beam model (see B. Schaffner)

Ray tracing
Penumbra
Distal fall off
8a. Simulate the selected plan to ensure it is deliverable
8b. Simulate the selected plan to ensure it is deliverable
Daily set-up control

Lateral radiography  upfront radiography
Lateral beamview  upfront beamview

« Image Guided Radiation Therapy  IGRT»
Clinical applications:
Base of the skull tumors

Photons-protons
Non coplanar beams

Junctions, patching

Intensity Modulated
IMPT-IMZT

And many other targets
Inc. Pediatrics…
(see M.Engelsman)
<table>
<thead>
<tr>
<th>step</th>
<th>The planning process in general (M.Goitein)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Evaluate the patient using all relevant diagnostic tools, and decide whether to employ radiation therapy.</td>
</tr>
<tr>
<td>2</td>
<td>Obtain and inter-register imaging studies with the patient lying in the position to be used for therapy.</td>
</tr>
<tr>
<td>3</td>
<td>Delineate on the planning CT the target volumes (GTV, CTV and PTV) and normal tissues.</td>
</tr>
<tr>
<td>4</td>
<td>Establish the planning aims for the treatment.</td>
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<tr>
<td>5</td>
<td>Design one or more sets of beams, together with their weights, each of which fulfills, to the extent possible, the requirements of the prescription.</td>
</tr>
<tr>
<td>6</td>
<td>Evaluate these plan(s) and either select one of them for use OR revise the planning aims and return to step 5.</td>
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<tr>
<td>7</td>
<td>Finalize the prescription.</td>
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<td>8</td>
<td>Simulate the selected plan to ensure it is deliverable.</td>
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<td>9</td>
<td>Deliver the treatment, and verify that the delivery is correct.</td>
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<tr>
<td>10</td>
<td>Re-evaluate the patient during the course of treatment and, if necessary, return to step 5, or even 2, to re-plan the remainder of the treatment.</td>
</tr>
<tr>
<td>11</td>
<td>Document and archive the final treatment plan.</td>
</tr>
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<td>12</td>
<td>Review the treatment plan at the time of patient follow-up or possible recurrence.</td>
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</table>
## The planning process in general

- and the differences between protons and x-rays

(M.Goitein)

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<tr>
<th>step</th>
<th>Description</th>
<th>protons vs. photons</th>
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<td>Design one or more sets of beams, together with their weights, each of which fulfills, to the extent possible, the requirements of the prescription. <strong>lung and H&amp;N</strong></td>
<td>different</td>
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<td>Deliver the treatment, and verify that the delivery is correct.</td>
<td>~same, but QA harder.</td>
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- Large targets
- Complex geometry
- Meaning of PTV may be different
- Dose algorithm (depth-dose, lateral profile, field-size dependence, inhomogeneities, MU)
- Set up the configuration data for the dose calculation algorithm
- The effects of inhomogeneities
- Compensation for inhomogeneities
- Beam delivery techniques
- The planning target volume (PTV)
- Design of single beams:
  - Design of plans
  - Immobilization, localization and verification
  - Uncertainty analysis
- 3D dose measurement capability needed
Modèles de calcul

• Ray tracing : le proton ne diffuse pas
• Pencil beam : diffusion gaussienne de mini-faisceaux
• Monte Carlo : modélisation exacte proton/proton

(H. Paganetti & others)
Compensating heterogeneous bodies...

(« pristine » = not modulated beams to show the effect)
Inhomogeneities or heterogeneities

Water Level

Inhomogeneities or heterogeneities

air

bone

Final Collimator

200 MeV proton Beam
Patient Contour

Target Area

Proton Beam

Inhomogeneity (Air Pocket)
Target Area

Patient Contour

Compensator

Inhomogeneity (Air Pocket)
In practice:

Touch them!

(several in this room)
“Phallic Target”

(Acoustic neurinoma; meningioma,...)
Final Collimator

"Phallic compensator"

"Phallic isodoses"

Water Level

200 MeV proton Beam
What if Drilling a too tiny hole?

"Phallic isodoses"

"Isodoses without Viagra"
As a preliminary task, need to work out the compensator in order to get the desired deep peak effect.

« Smearing the compensator »

Multiple scattering
2nd reason to smear:

Imagine you have the right peak for the right target...

Final Collimator

200 MeV proton Beam

Water Level

Critical organ
2nd reason to smear:

Imagine you have the right peak for the right target...

But everything moves!!
2nd reason to smear: misalignments & movements
2nd reason to smear: misalignments & movements

Final Collimator

200 MeV proton Beam

Water Level

Critical organ
2nd reason to smear: misalignments & movements
2nd reason to smear: misalignments & movements

Final Collimator

200 MeV proton Beam

Water Level

Critical organ
2nd reason to smear: misalignments & movements

Final Collimator

200 MeV proton Beam

Critical organ

Water Level
« Perturbations » by heterogeneities: Depth dose curves

Final Collimator

200 MeV proton Beam

Water Level
质子治疗系统
Data acquisition at Wanjie, city of Zibo, prov. Shangdon, China
Complex situation for TPS validation
Profiles in depth

Pristine, high energy

Modulated, low energy

Simple…

Fun?

Wanjie
How can we see these effects in clinics???
This is still not an apple

Clinical presentations this afternoon….

This is still not a patient

Thank you !!
Xie Xie