Practical optimisation of patient doses
What is optimisation?

Optimisation is a balancing act: image quality vs patient dose.

- Dose too low: undiagnostic image, repeat exposure
- Dose too high: diagnostic image (perhaps), but at increased risk to patient
- Dose just right: image quality ‘adequate’ for diagnosis or treatment planning = optimisation

How can you achieve this in practice?
X-ray equipment

Dental GNs, **Chapter 4** covers

- X-ray equipment and how it affects optimisation
- ancillary equipment and how it affects optimisation
- how equipment should be **used** to achieve optimisation
- table 4.1 summarises where to find the guidance

<table>
<thead>
<tr>
<th>Topic</th>
<th>Brief description of requirement</th>
<th>Relevant section of this guidance</th>
</tr>
</thead>
</table>
| Operation of X-ray equipment  | Operators to select the most appropriate X-ray equipment, radiographic technique and appropriate protocol (including collimation and field of view where relevant) in order to keep patient dose ALARP; for  
  - Intra oral X-ray equipment  
  - Hand-held dental X-ray equipment  
  - Panoramic and cephalometric equipment  
  - Dental CBCT equipment  
  - Image receptors                                                                 | 4.3.1  
  4.3.2  
  4.3.3  
  4.3.4  
  4.3.5                                                                                                 |
| Use of patient contact shielding | Protective aprons and thyroid shields are not recommended for routine use on patients.                                                                                                                                           | 4.4                                         |
|                               | - Display screens should meet the recommended standard  
  - Specially designed light-boxes should be used to view film radiographs  
  - Attention should be paid to the adequacy of the viewing conditions for all dental radiographs or dental CBCT images                                                                 | 4.2                                         |
Intra oral: effect of collimation

Circular
6 cm diameter
beam area = 28.3 cm²

Rectangular
3.5 x 4.5 cm
beam area = 15.75 cm²
Intra oral: effect of collimation
Intra oral: effect of focus to skin distance
Intra oral: effect of technique

Bisecting angle vs Paralleling technique
## Intra oral: effect of imaging system

<table>
<thead>
<tr>
<th>Imaging system</th>
<th>3rd quartile patient entrance dose, mGy*†</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-speed film</td>
<td>1.9</td>
</tr>
<tr>
<td>E-speed film</td>
<td>1.4</td>
</tr>
<tr>
<td>E/F-speed film</td>
<td>1.2</td>
</tr>
<tr>
<td>F-speed film</td>
<td>1.3</td>
</tr>
<tr>
<td>Computed radiography (CR)</td>
<td>1.1</td>
</tr>
<tr>
<td>Direct radiography (DR)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*The patient doses were measured at the settings normally used for an adult mandibular molar radiograph

† Source: PHE-CRCE-59: Dose to patients from dental radiographic X-ray imaging procedures in the UK - 2017 review
Intra oral: selection of exposure settings

Operating potential

- using 70 kV rather than 60 kV results in about 25% less patient dose

Tube current (mA) and exposure time must be well-matched to:

- the imaging system used
- anatomical view
- patient size
Intra oral: hand-held X-ray sets
Panoramic and cephalometric: collimation

Selection of the correct clinical view will significantly reduce patient dose
Panoramic and cephalometric: positioning
## Panoramic: effect of imaging system

<table>
<thead>
<tr>
<th>Imaging system</th>
<th>3rd quartile dose area product, mGy cm(^2)*†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film</td>
<td>82</td>
</tr>
<tr>
<td>CR</td>
<td>80</td>
</tr>
<tr>
<td>DR</td>
<td>81</td>
</tr>
</tbody>
</table>

*The patient doses were measured at the settings normally used for an standard adult panoramic radiograph

† Source: PHE-CRCE-59: Dose to patients from dental radiographic X-ray imaging procedures in the UK - 2017 review
### Cephalometric: effect of imaging system

<table>
<thead>
<tr>
<th>Imaging system</th>
<th>3rd quartile dose area product, mGy cm²*†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film</td>
<td>39</td>
</tr>
<tr>
<td>CR</td>
<td>46</td>
</tr>
<tr>
<td>DR - static</td>
<td>69</td>
</tr>
<tr>
<td>DR - scanning</td>
<td>23</td>
</tr>
</tbody>
</table>

*The patient doses were measured at the settings normally used for an adult lateral cephalometric radiograph

† Source: PHE-CRCE-59: Dose to patients from dental radiographic X-ray imaging procedures in the UK - 2017 review
Dental CBCT: collimation

- Only the region of clinical interest should be imaged
- The whole imaged volume should be reported on
- Dentists may not report on anatomy outside the dento-alveolar region (without additional training)

Selection of the correct clinical view will significantly reduce patient dose
Dental CBCT: other factors

As for panoramic and cephalometric equipment

• Patient preparation
• Patient positioning – including use of scout views
• Patient instructions
• Correct exposure factors (patient size etc)

Other factors that could reduce patient dose for dental CBCT

• Use lower exposure factors where possible (mA, time, voxel size, resolution settings)
• Partial rotation scans
• Partial volume reconstructions (to omit artefacts caused by metallic restorations etc)

For more information on optimising patient doses in dental CBCT, please refer to chapter 4 of the Dental GNs
Optimisation of patient dose – all equipment

And don’t forget these, which also support optimisation:

• Routine checks on condition of X-ray equipment (arm counterweights, tubehead etc)
• Servicing as per manufacturer’s recommendations
• Routine performance tests on X-ray equipment
• Compliance with any local or national DRLs
• QA for digital equipment (plates, sensors, readers, display screens)
• QA for film processing, darkrooms, lightboxes
• QA of viewing conditions