Comments on ICRP draft report for consultation:
Optimisation of Radiological Protection in Digital Radiology Techniques for Medical Imaging

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General remarks
This document elaborates on the challenges and opportunities for dose optimization when using digital radiological techniques for medical imaging. Since medical imaging using ionizing radiation is a major and increasing contribution to population exposure, this is an important topic. We appreciate the ICRP for addressing this important topic. Our expertise is mainly focused on the process of optimization and the analysis of patient doses. Therefore, our review is limited to chapters 1, 3 and 4.

In general, the structure of the document regarding chapters is well set up. However, the structure within the chapters is lost, in some chapters more than in others, with many phrases repeated at multiple places. One example is a statement (in various forms) “…requires clinicians and healthcare professionals to work closely together within an organization” (for example in lines 442-443 and in paragraph (31)). Obviously, we recognize the importance of this message, yet its frequent repetition makes the text lengthy and less to the point. Consequently, the document might become more difficult to comprehend, which would be unfortunate.

Furthermore, we suggest to conduct an editorial review to correct typos and grammar. For example add “the” to “according to traditional ALARA principle” in line 338, and add “n” to “an LNT” in line 493.

Remarks on “Main points” and “Executive summary”
In line 161 “clinical information” should better read “clinical image quality”. Among clinicians, the term clinical information is reserved for the information provided by the referring clinician when requesting imaging.

Remarks on Chapter 1

General impression
In general, the structure of this chapter could be improved. It was difficult for us to follow the train of thought. It would be of great benefit to the reader if the purpose of this chapter (and that of the entire document) would be explained at the beginning. First in line 644 (paragraph 25), the objective became clear to us.

Furthermore, readability of this chapter would benefit from removing repetitive remarks. For example, in paragraph (12), three sentences are used to each describe the same thing, namely the balance between low dose and sufficient image quality. Also, the phrases in paragraph (12) are very similar to paragraph (22).

The topic regarding “image quality versus radiation dose” is discussed in several paragraphs in this chapter. The arguments concerning this are presented in several paragraphs. For example: situation 1) (way) too much radiation dose for picture perfect images, but one would be fine with a little less
image quality (paragraph (17)), situation 2) ALARA dose for image quality perfectly matching the clinical question at hand (paragraph (12)), situation 3) too little radiation dose resulting in inconclusive images (paragraph (23)). All of which are illustrated in figure 1.

Overall we would like to propose to reconsider the structure of this chapter. So that the chapter becomes more concrete and concise.

Specific remarks
Line 315-318: in the current wording, it seems that it is justified to give higher radiation dose. Suggestion: ... is likely to outweigh the small additional risk from the radiation dose necessary for sufficient image quality.

We found paragraph (4) difficult to read, we think it might benefit from simplification.

Although we do understand that this document addresses optimization of radiation dose, in our opinion this cannot be viewed separate from justification. We recognize that paragraphs (6) and (7) discuss justification, but also in other parts of chapter 1 justification is an important factor. Another question that arises concerns the increasing use of CT imaging in both developed and developing countries. Is this increase because of demand from a clinical point of view, or because of availability of the technique? In other words, is there a market for it or is a market being created? Both justification and optimization are important issues here.

The sentences 456 “Under normal ...” until line 460 “...develop with time.” raise some questions: what is meant by “normal circumstances”? What is the connection to the next sentence starting with “However, there is also a risk of lens opacities”? A dose >500 mGy is most certainly not a normal situation. What is one trying to convey here? According to us, this paragraph contains several statements that are true in itself, but lack coherence in the current context.

In paragraph 1.3 on risks from radiation exposure due to medical imaging, in our opinion what is missing is the radiation exposure due to repeated examinations. This is for example an issue for cancer patients (in follow up), so their underlying condition often poses a larger health risk than the radiation risk. On the other hand, many forms of cancer have become a chronic disease rather than fatal, which will impact the risk balance between disease follow up with medical imaging and risk from radiation. Furthermore, repeat imaging is also an issue in non-cancerous conditions, for example inflammatory processes. This topic is now only briefly touched upon in paragraph (21).

Line 520 “Any potential health ... dose within them” is also discussed in section 1.3.

Line 522-525 about performing a chest X-ray with the patient facing away from the x-ray tube → a chest X-ray is taken PA mainly because this gives the most accurate assessment of the heart and mediastinum size (least magnification), not because of reduced dose to the breast.

Line 525-526 “Simple examples of poor optimization are if a larger field size is used for a radiographic exposure than is necessary...” → note that having to redo imaging because of incomplete depiction of the target of interest will cause extra dose.

Line 531-536 → Not using shielding of gonads is not related to the development of digital imaging, but more to advancing insight that this is not useful at all in terms of dose reduction, or can even
paradoxically introduce more dose to the gonads. So, although a (partially) true statement in itself, this sentence is not appropriate as an example for the statement in line 531-532.

Line 542-544 “Acceptable images can ... with lower exposures”: in conventional radiology this had already been used, and therefore this is not specific to digital radiology.

Line 556 “Optimal” would better read as “sufficient”. “Optimal” describes a much more static situation than is the case, and is actually argued for in paragraph (17).

Line 557-560 “As technology develops ... for many years”: in our opinion this sentence is redundant, while the rest of paragraph (18) covers this sufficiently. The sentence has an unpleasant undertone.

Section 1.6 is a summary of previous ICRP publications, but does not link much to the topic at hand. We suggest to describe this abbreviated and indicate what is missing in those previous publications that is described here. This makes it (more) explicit what the usefulness/purpose of the current publication is in relation to what has already been written in previous publications.

Remarks on chapter 3

General impression
In general the structure of chapter 3 is easy to follow. The purpose of this chapter is clear: ICRP proposes an optimization process which – as we understand it – follows a graded approach. However, it is not referred to as such and therefore we suggest to mention this more explicitly.

In this chapter, optimization of level D does not return.

Specific remarks
Line 1089 “The grades currently fulfilled and those that it is possible for different facilities to achieve will...”: the sentence seems grammatically incorrect

Section 3.2 has somewhat confusing title, and is more about “Development steps in optimization”, whereas the next sections are adequately titled “Professionalism”, “Methodology” and “Process”, respectively.

Line 1208- 1210 “This section will cover... IT and informatics specialists: The list of professionals in the optimization process is in our view almost complete. We believe, the intervention cardiologist should also be added here, even though they are mentioned later in the same paragraph (line 1218). The interventions they carry out make a major contribution to the average radiation dose (especially the skin dose) to the patient. They often work outside a radiology department, which is why it is important to involve them in the optimization process.

Line 1217: “refers to explicitly to radiologists” → “refers explicitly to radiologists”
Line 1240 : “The preparation of specifications, ... as well as bio-medical engineers.”: Bio-medical is written as “biomedical” throughout the document.

Line 1278 “Finally, there needs to be communication between... for management of the patient’s treatment.”: From our point of view, the radiographer also has an important role in this communication. We suggest to mention them as well.

Remarks on Chapter 4
General impression
In this chapter there is frequent mention of local and national DRLs. Local DRLs are defined as being based on 10-20 X-ray rooms in a specific area. For some smaller, less developed countries this may represent a large part of the countries’ facilities. For bigger, more developed countries national DRLs may be based on hundreds of X-ray rooms. It would be worth mentioning this difference.

Another general remark is that if there are technical examples for optimisation given that influence the image quality and the patients dose it concerns conventional radiology (for example in paragraph 16 and table 4.1). The radiation dose used in computed tomography is higher than conventional radiology. At least in developed countries computed tomography gives the highest contribution to the population dose from medical radiation. -> please consider mentioning technical examples for optimization that influence image quality and patients dose for computed tomography.

Specific remarks
Line 1569: “The magnitude of the radiation dose is not immediately obvious from the appearance of an x-ray image, ...” please add: digital (from the appearance of a digital x-ray image).

Line 1655-1656: “Metrics used in surveys should be representative of how the dose to the patient varies, so quantities such as air kerma-area product (KAP, PKA), entrance surface air kerma (ESAK, Ka,e), dose length product (DLP, PKL) and CT volume averaged dose index (CTDIdvol, Cvol) are preferred.” please write out abbreviations PKA and PKL

Line 1751: “(and relate them to the results of QC performance tests)…” “it” instead of “them”

Line 1780: “ NCRP suggested that achievable dose values should be set at the median value of the distribution of a national DRL quantity (NCRP, 2012)” We suggest to explain upfront this paragraph how a national DRL should be set. This could be explained first before making a suggestion about setting an achievable dose.

Line 1829: There is a large overlap between the beginning of para 145 and that of 138. We suggest a restructuring of the text, for example by two consecutive paragraphs on exceeding a DRL.

Table 4.2. Level D, third bullet “Purchase of range of instruments sufficient for carrying out QC tests on all imaging modalities.” This table is on doses and not on quality control, that was chapter 3 we think. Possibly the table could be explained more.

Line 1594-1597: “ Other external factors … effects on patient dose and / or image quality.” Most of these external factors on patient dose and image quality are in conventional radiographic imaging. We are missing some external factors on patient dose and image quality in computer tomography; new (iterative) reconstruction techniques add a new dimension to the process of dose optimization.