Cumulative radiation dose from multiple CT examinations: stronger justification, fewer repeats, or dose reduction technology needed?

Denis Remedios¹

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Key Points

- *Clinical decision support systems for imaging referral provide generic justification for the clinical situation, but personal justification is needed particularly when dose is high or when the patient is sensitive to the effects of radiation.*
- *Strategies to address cumulative high doses include stronger justification between radiologists and referrers; guidance for the frequency of surveillance procedures; and the drive to reduce CT doses through innovation in industry.*

The wakeup call to the relentless rise in medical exposures came when man-made radiation per head of population reached the same magnitude as natural background radiation [1]. Rehani et al [2] draw our attention to the more alarming metric that, over 5 years, some patients have been exposed to radiation doses of more than 100 mSv, a threshold figure above which Japanese atomic bomb survivors had a significant increase in malignancies with proportionality of incidence to dose [3]. Although accounting for typically 11% of ionizing imaging procedures [4], CT is responsible for as much radiation dose as all other modalities combined [3] and usage grows at about 10% pa [4].

CT examinations typically produce doses of 2–20 mSv, equivalent to 1–10 years of background radiation in Europe [5]; multiple examinations may rapidly result in a figure of > 100 mSv. An estimated 1.3% of patients may receive such doses from a large study of 2.5 million patients [6]. Instinctively, the assumption would be that these patients were all investigated, staged, or followed up for malignancy, in which case the risk-benefit equation may be understandable—90% were. In Rehani et al's study, 123 (1.4%) patients were 40 years of age or under, with non-malignant diagnoses. Approximately 40% of diagnoses were cardio-respiratory with CT chest being the most commonly performed investigation.

In the cold light of day, with sanguine or sanctimonious considerations of decision regret by patient and clinician, the Socratic questions should be: (i) were the procedures appropriate and justified; (ii) did procedures need repeating; and (iii) could lower dose CT protocols be used?

Justification of specialized investigations requires considerable knowledge of risks and benefits which are supported by technology in some higher-income countries, particularly in North America and Europe. Clinical decision support systems (CDS) such as the American College of Radiology's ACR Select [7], European Society of Radiology's iGuide [8], and the Royal College of Radiologists' iRefer CDS [9] offer the referrer evidence-based guidance at the point-of-care, recommending the best test first. In the USA, the need for CDS has mandated its use with effect from 1 January 2020 [7]. Whereas the valuable advice through CDS for performing CT relates to the generic clinical setting, the personal circumstances may not have been taken into account. Does previous radiation exposure influence choice for the investigation needed now? Strictly speaking no, but should there be an equivalent choice of modalities than this may be relevant. Of the CDS ratings for CT procedures performed on young patients in Rehani et al's study [2], only 27% were "usually appropriate." This raises the issue as to whether personal justification, taking into account the radiation sensitivity of a younger patient, should have been of greater priority in such cases. Of the 2/3 of patients for whom the selected CT procedure may not have been most appropriate, surely the CDS technology could be further tweaked to nudge the referrer towards the best test first, particularly if a lower dose alternative were feasible. Alternatively, recourse for discourse with the local clinical radiologist should be encouraged, perhaps in the setting of the multi-disciplinary team meeting.

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✉ Denis Remedios
denis.remedios@imperial.ac.uk

¹ Department of Clinical Radiology, Northwick Park Hospital, Harrow HA1 3UJ, UK

The interval or frequency to repeat a procedure is not always clear. Incidental lung nodules may be worrying but sadly ubiquitous in some populations. Clinical probability and epidemiological factors should be taken into account when suggesting follow-up examinations. Guidance for this is needed from trusted sources, usually professional societies.

Low- or ultra-low dose CT protocols may solve or salve the dose concerns for multiple examinations, but will not address the economic or human cost. Nevertheless, in a society in which litigation is rife and mitigation attractive, follow-up examinations to console the clinician's conscience will continue, initiating further investigations for incidental findings, as technology improves. Safeguards against such medico-legal practice can only come from guidance developed by trusted professional bodies, with judicial systems supporting the evidence-based practitioner who follows such guidelines.

Rehani et al may have awoken a dozing giant by eloquently pointing out the 100-mSv threshold step between precautionary protection and proven hazard. It is incumbent on clinical radiologists and referring clinicians to take on board this small step in order to make the giant leap from CDS generic justification to personal justification particularly when dose matters. We also look to industry for lower-dose protocols which will mitigate the increasing need for and appropriate use of CT.

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