The use of cumulative effective dose – an educational debate: In support of cumulative dose

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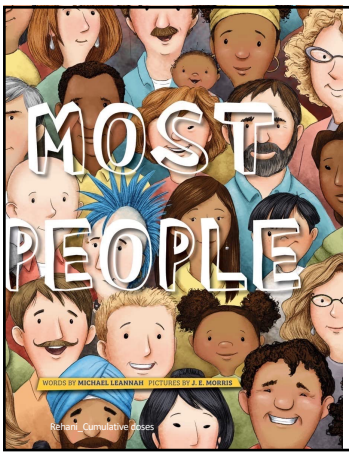
1

What we are sure of

Is there anyone who does not think that medical imaging is IMMENSLY USEFUL?

2



If I am prescribed a CT scan by the doctor, I will not think a bit about the radiation risk.

True, but…

We are not among those in whom cumulative dose is of concern

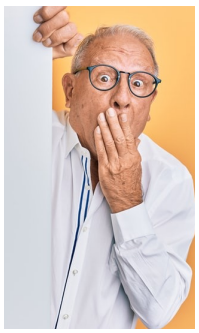
3

Why cumulative doses?

- **Not talking about doses in a single or double digits of mSv or mGy but in 3 or even 4 digits of mSv or mGy to an individual patient.**
- **There was never a time in history when such a situation was encountered (Unprecedented era).**
- **A couple of years ago: Lower single digit of mSv dose or at the most 10-20 mSv.**

4

Three digit of mSv



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Contents lists available at ScienceDirect
European Journal of Radiology
journal homepage: www.elsevier.com/locate/ejrad

Organ doses and cancer risk assessment in patients exposed to high doses from recurrent CT exams

Nahom Zewde [a,*], Francesco Ria [b], Madan M. Rehani [c]

Cohort CED ≥ 100 mSv

- *Mean dose for each organ >100 mGy.*
- *Organ doses higher than 200 mGy for stomach and liver,*
- *100-200 mGy for nine organs (lungs, breasts, colon, red bone, marrow, urinary bladder, esophagus, testicles, ovaries, and skin).*

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Organ doses in cohort with CED ≥ 100 mSv

- 0 to 3000 mGy to some of the important organs like
  - breast (38% >100 mGy)
  - Heart (89% >100 mGy)
  - Lungs (89% >100 mGy)
  - Eye (31% 100-5900 mGy)
  - Brain (24% with 100-4400 mGy)
  - Colon (83% above 100 mGy)

7

Such patients with high doses may only be a few

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From published papers (324 hospitals, 2.5 million patients)

- Likely a quarter of a million every year in USA with CED ≥ 100 mSv from CTs alone
- Not rare (definition of rare by NIH/NCI).
- 0.03% getting 100 mSv+ in a single day
- 4% with CED ≥ 100 mSv from FGI
- Triple rate with hybrid imaging
- Total dose not yet known

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Take-home Points

1. If studies on cumulative dose were not done, we will not know the magnitude of doses involved
2. Miss millions of patients with such doses

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The patients with such doses are those with malignant disease who get mega quantity of radiation dose in any way. So why worry.

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Fact

- Medical physicists are employed to optimally impart max radiation dose to TUMOR tissue, and avoid dose to normal tissues
- Industry spends Billions of $ -machines to minimize radiation dose to normal issues

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Take-home Points

1. If studies on cumulative dose were not done, we will not know the magnitude of doses involved
2. Miss millions of patients with such doses
3. Myth that cancer patients get high doses in any way. We need to recognize the role of medical physicists.

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Justify each exam first and then
Optimize the exam

Patient safety is achieved

14

Let us look at data: of these patients with high cumulative doses

Optimized or not?

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Rehani et al. Eur Radiol. April 2020; 30(4):1828-1836

Median DLP values in mGy.cm

Institution	CT Chest without contrast	CT Head/ brain without contrast	CT abdomen/ pelvis without contrast	CT abdomen/ pelvis with contrast	CT Chest angio heart with and without contrast
American College of Radiology Dose Index Registry	339	869	669	682	541
MGH	254 (75%)	772 (89%)	561 (84%)	476 (70%)	204 (38%)

38 to 89% of national benchmark, i.e. 11 to 62% below

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Let us look at data: of these patients with high cumulative doses

Optimized or not?

Justified or not?

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AUC METHODOLOGY

DIAGNOSTIC PROCEDURES

Rating	*Category Name*	*Category Definition*	*Disagreement*
7, 8, or 9	Usually appropriate	The study or procedure is indicated in certain clinical settings at a favorable risk-benefit ratio for patients, as supported by published peer-reviewed scientific studies, supplemented by expert opinion.	The dispersion of the individual ratings from the panel median rating is assessed to determine if there is no disagreement. When the individual ratings are too dispersed from the panel median (disagreement), "May be appropriate" is the rating with a note that there was disagreement.
4, 5, or 6	May be appropriate	The study or procedure may be indicated in certain clinical settings, or the risk-benefit ratio for patients may be equivocal as shown in published peer-reviewed, scientific studies, supplemented by expert opinion.	
1, 2, or 3	Usually not appropriate	Under most circumstances, the study or procedure is unlikely to be indicated in these specific clinical settings, or the risk-benefit ratio for patients is likely to be unfavorable, as shown in published peer-reviewed, scientific studies supplemented by expert opinion.	

The RAND/UCLA Appropriateness Method

ACR Appropriateness criteria and others societies criteria are built into the system

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Institution	Total number of patients with CED≥ 100 mSv (%)
MGH	8,952 (3.4%)
Orlando	5888 (1.4%)
Slovakia	12,198 (1.5%)
252 hospitals USA	6,369 (0.64%)
	33,407 (1.33%)

Despite use of the BEST system available today for CDS with latest appropriateness criteria from ACR and optimization through ACR DIR

Can our current day system of justification stop this from getting doubled in 10 years ?

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Take-home Points

1. If studies on cumulative dose were not done, we will not know the magnitude of doses involved
2. Miss millions of patients with such doses
3. Myth that cancer patients get high doses in any way. Role of medical physicists
4. **Despite use of the BEST system for imaging appropriateness and optimization, thousands of patients with 3-digit doses**

20

Observational Study > BMJ Open. 2021 Jan 17;11(1):e041883.
doi: 10.1136/bmjopen-2020-041883.

Probability of receiving a high cumulative radiation dose and primary clinical indication of CT examinations: a 5-year observational cohort study — **Netherland**

Cécile R L P N Jeukens [1], Hub Boere [2], Bart A J M Wagemans [2], Patty J Nelemans [3], Estelle C Nijssen [2 4], Rebecca Smith-Bindman [5 6], Joachim E Wildberger [2], Anna M Sailer [2 7]

Computed Tomography | Open Access | Published: 12 March 2021

Cumulative effective dose from recurrent CT examinations in Europe: proposal for clinical guidance based on an ESR EuroSafe Imaging survey

Guy Frija, John Damilakis, Graciano Paulo, Reinhard Loose, Eliseo Vano & European Society of Radiology (ESR)

European Radiology 31, 5514–5523 (2021) | Cite this article

> Eur J Radiol. 2020 Apr;125:108898. doi: 10.1016/j.ejrad.2020.108898. Epub 2020 Feb 13.

Which patients are prone to undergo disproportionate recurrent CT imaging and should we worry? — **Netherland**

Thomas C Kwee [1], Hildebrand Dijkstra [2], Daan G Knapen [3], Elisabeth G E de Vries [3], Derya Yakar [2]

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We cannot sum doses received at different times to get cumulative dose

Two aspects (MP, other scientists)

23

Medical Physicists think that it is controversial subject.
What do radiation effects scientists think?

IOMP-ICRP Webinar: Are radiation risks below 100 mGy for example through recurrent CT procedures of real concern for radiological protection?

Wednesday, 20th April 2022 at 12 pm GMT; Duration 1 hour

Speakers:
Werner Rühm, Chair, ICRP,
Dominique Laurier, Chair Radiation Effects Committee (C1)
Richard Wakeford , member C1
Moderator: Sc. Sec. ICRP

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Monograph on epidemiological studies of low-dose ionizing radiation and cancer

NCI Monograph, 2020

Conducting a formal assessment of the potential impact of biases
- Confounding and selection bias
- Sources of dose errors
- Study power, lost of follow-up and outcome uncertainty
- Model misspecification

Eligible studies
- 22 studies published since the BEIR VII report in 2006
- With individualized dose estimates, and mean dose < 100 mSv
- Providing risk estimates and confidence intervals for the dose-response for cumulative radiation dose

[Berrington de Gonzalez et al; Hauptmann et al. JNCI Monographs, 2020]

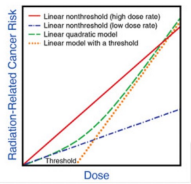
Most estimates of dose-risk relationship are free of substantial bias

The results directly support the existence of excess risks associated with low doses for solid cancers and leukemia, with a magnitude consistent with estimates derived from the Life Span Study

25

NCRP COMMENTARY No. 27

IMPLICATIONS OF RECENT EPIDEMIOLOGIC STUDIES FOR THE LINEAR-NONTHRESHOLD MODEL AND RADIATION PROTECTION



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NCRP Commentary 27

cancers combined (ERR Gy^{-1} of 0.47; 90 % CI: 0.18, 0.79). For solid cancer there was no evidence of nonlinearity (p = 0.44). These risk estimates were similar to those in the LSS data. Even when the cumulative colon dose was restricted to 0 to 100 mGy, a marginally statistically significant dose response was seen for all cancers excluding leuke-

inconclusive. It should be noted that all the studies being considered, except for the LSS of atomic-bomb survivors, had exposures at low dose rates or multiple small exposures. Furthermore, the preponderance of study subjects had cumulative doses <100 mGy. Thus these stud-

Radiation effects below 100 mGy of acute or protracted

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Mutation Research - Genetic Toxicology and Environmental Mutagenesis 873 (2022) 503436

Contents lists available at ScienceDirect

Mutation Research - Genetic Toxicology and Environmental Mutagenesis

journal homepage: www.elsevier.com/locate/gentox

Cancer risk following low doses of ionising radiation – Current epidemiological evidence and implications for radiological protection

W. Rühm [a,*], D. Laurier [b], R. Wakeford [c]

[a] Helmholtz Center Munich German Research Center for Environmental Health, Neuherberg, Germany
[b] Institut de Radioprotection et de Sûreté Nucléaire (IRSN), Fontenay-aux-Roses, France
[c] Centre for Occupational and Environmental Health, The University of Manchester, Manchester, M13 9PL, UK

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Ruehm et al. 2022

The epidemiological evidence of radiation-related cancer, with particular emphasis on doses of low-LET ionizing radiation of several tens and a few hundred mGy (or mSv), and of higher cumulated doses if delivered at low dose rates or as a number of temporally separated low dose exposures.

tion or radioactive contamination. Taken together, the overall evidence summarized here is based on studies including several million individuals, many of them followed up for more than half a century. In summary, substantial evidence was found from epidemiological studies of exposed groups of humans that ionizing radiation causes cancer at acute and protracted doses above 100 mGy, and growing evidence for doses below 100 mGy. The significant radiation-related solid cancer risks observed at doses of several 100 mGy of protracted exposures (observed, for example, among nuclear workers) demonstrate that doses accumulated over many years at low dose rates do cause stochastic health effects. On this basis, it can be concluded that doses of the order of 100 mGy from recurrent application of medical imaging procedures involving ionizing radiation are of concern, from the viewpoint of radiological protection.

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Messages

1. **There is evidence for radiation risks <100 mGy**
2. **Not only for acute exposure but protracted also**
3. **At the moment summing of doses at different times is the only way as no correction factors are available**
4. **Need to press for research to establish gap correction factors**

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Take-home Points

1. If studies on cumulative dose were not done, we will not know the magnitude of doses involved
2. Miss millions of patients with such doses
3. Myth that cancer patients get high doses in any way. Role of medical physicists
4. Despite use of the BEST system for imaging appropriateness and optimization, thousands of patients with 3-digit doses with sizable number with long life expectancy
5. **We should press for research to establish gap correction factors, till that time cumulative dose is the way**

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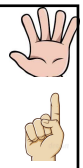

Decision to perform a medical imaging exam should be based only on clinical grounds and not on the dose from prior imaging-related radiation exposures

Two aspects (MP, Clinician)

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Medical Physicist

- I will ask myself if I am making day-to-day decisions for ordering of exams for patients?
- How much teaching medical physicists do to ordering clinicians?
- How much interactions we have with clinicians on issue of ordering an exam [Remember, every single day nearly quarter of a million CTs are ordered in the US]
- Am I stepping out of my boundary and elevating myself as a King or God?
- This is an area where our role is to provide information on dose, potential risk and principles of radiation protection.

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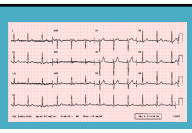
Radiation dose



- **One of the most important tools for MP**
- **Can we do without it?**
- **Risk-benefit or benefit-risk is fundamental aspect**
- **Can one say that do not worry about cumulative aspects of contrast agent, chemotherapeutic drugs, scheduled drugs**
- **How can we say about cumulative radiation dose**

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Take-home Points

1. If studies on cumulative dose were not done, we will not know the magnitude of doses involved
2. Miss millions of patients with such doses
3. Myth that cancer patients get high doses in any way. Role of medical physicists
4. Despite use of the BEST system for imaging appropriateness and optimization, thousands of patients with 3-digit doses with sizable number with long life expectancy
5. We should press for research to establish gap correction factors, till that time cumulative dose is the way
6. **Risk-benefit is the fundamental principle, not just benefit alone (Clinician part?)**

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Patients with high cumulative doses have short life expectancy, not to live long enough to manifest stochastic radiation effects

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Long survival diseases

- Crohn's disease
- Heart disease
- Trauma
- Many cancers are curable
  - Prostrate,
  - Testicular
  - Thyroid
  - breast
  - melanoma

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There is scientific data to show that cumulative doses have led to refusal of a needed examination?

41

Eur Radiol. 2021 Apr;31(4):2106-2114. doi: 10.1007/s00330-020-07290-x. Epub 2020 Sep 21.

Radiation dose management systems–requirements and recommendations for users from the ESR EuroSafe Imaging initiative

Reinhard W Loose [1 2], Eliseo Vano [3], Peter Mildenberger [4], Virginia Tsapaki [5], Davide Caramella [6], Johan Sjöberg [7], Graciano Paulo [8], Alberto Torresin [9], Sebastian Schindera [10], Guy Frija [11], John Damilakis [12], European Society of Radiology (ESR)

Review. Br J Radiol. 2021 Oct 1;94(1126):20210389. doi: 10.1259/bjr.20210389. Epub 2021 Jun 23.

Radiation risk issues in recurrent imaging

Charles Brower

Editorial. Br J Radiol. 2021 Oct;94(1126):bjr20219004. doi: 10.1259/bjr.20219004.

Contemporary issues in radiation protection in medical imaging: introductory editorial

42

Eur J Radiol. 2022 Jun;151:110293. doi: 10.1016/j.ejrad.2022.110293. Epub 2022 Apr 4.

Cervical and lumbar spine imaging after traffic and occupational accidents: Evaluation of the use of imaging techniques, cumulative radiation dose and associated lifetime cancer risk

Bieke De Roo [1], Klaus Bacher [2], Koenraad Verstraete [3]

J Patient Saf. 2022 May 22. doi: 10.1097/PTS.0000000000001041. Online ahead of print.

Characteristics of Cumulative Annual Radiation Exposure in Young Intensive Care Unit Survivors

Guramrinder Singh Thind [1], Ahmed Hussein [1], Vedant Mishra [2], Vidhya Ramachandran [3], Mehul Lohia [1], Sravanthi Ennala [4], Nagamani Gudugunta [5], Siddharth Dugar [1], Charles Martin 3rd [6], Ajit Moghekar [1], Divyajot Singh Sadana [7], Sudhir Krishnan [1]

43

> Radiat Res. 2022 Jun 1;197(6):605-612. doi: 10.1667/RADE-21-00203.1.

Cumulative Radiation Exposure in Covid-19 Patients Admitted to the Intensive Care Unit

Lama Hadid-Beurrier [1 2], Axel Cohen [2], Bouchra Habib-Geryes [3], Sébastian Voicu [4], Isabelle Malissin [4], Nicolas Deye [4], Bruno Mégarbane [4], Valérie Bousson [2 5]

> Diagnostics (Basel). 2021 Dec 18;11(12):2387. doi: 10.3390/diagnostics11122387.

Cumula
Inflam

Agata Łukaws
Radosław Ker

ELSEVIER

Physica Medica
Volume 99, July 2022, Pages 10-15

Original paper

Quality assurance of dose management systems

Eleni Theano Samara [a], Niki Fitousi [b], Hilde Bosmans [c]

44

> J Radiol Prot. 2022 Jan 18;42(1). doi: 10.1088/1361-6498/ac31c1.

How much should we be concerned about cumulative effective doses in medical imaging?

Colin J Martin [1], Michael Barnard [2]

> Chin J Acad Radiol. 2021 Oct 8;1-5. doi: 10.1007/s42058-021-00083-1. Online ahead of print.

Assessment of radiation doses and image quality of multiple low-dose CT exams in COVID-19 clinical management

> BMC Pulm Med. 2021 Apr 23;21(1):132. doi: 10.1186/s12890-021-01486-7.

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Gar

Cumulative radiation dose incurred during the management of complex pleural space infection

Christopher R Gilbert [1], Anee S Jackson [2], Candice L Wilshire [3], Leah C Horslen [3], Shu-Ching Chang [4], Adam J Bograd [3], Eric Vallieres [3], Jed A Gorden [3]

45

Radiation Protection Dosimetry (2013), pp. 1–7 doi:10.1093/rpd/nct185

TEMPLATES AND EXISTING ELEMENTS AND MODELS FOR IMPLEMENTATION OF PATIENT EXPOSURE TRACKING

Madan M. Rehani* and Theocharis Berris
International Atomic Energy Agency, Radiation Protection of Patients Unit, Vienna International Centre, PO Box 100, A 1400 Vienna, Austria

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Table 2. Potential benefits of patient radiation exposure tracking.

(I)	Benefits to patients
(a)	Receiving minimal radiation exposure needed for optimal care
(b)	Knowledge that there is accountability/responsibility in the delivery of medical radiation
(c)	Facilitation of dialogue with health care providers regarding radiation exposure
(d)	Improvement in patient confidence in health care providers' care
(II)	Benefits to health care providers referring patients for imaging/intervention
(a)	Improvement in justification including decision support
(b)	Control of resources/costs from unneeded duplicate tests
(c)	Minimisation of radiation effects by tracking cumulative exposure
(d)	Assistance in choosing among imaging/intervention providers and facilities
(e)	Assistance in choosing between modalities and techniques
(f)	Facilitation of dialogue with patients regarding radiation exposure
(g)	Improvement in patient confidence in health care providers' care
(III)	Benefits to health care providers involved in performance of imaging/intervention
(a)	Improvement in justification including decision support
(b)	Control of resources/costs from unneeded duplicate tests
(c)	Minimisation of radiation effects by tracking cumulative exposure
(d)	Assistance in protocol optimisation
(e)	Establishment and continuous review of reference levels
(f)	Dosimetry feedback mechanism for health care provider quality improvement
(g)	Facilitation of dialogue with patients regarding radiation exposure
(h)	Improvement in patient confidence in health care providers' care
(IV)	Benefits to policymakers
(a)	Improved quantitative tools to protect the public health and safety
(b)	Improved quantitative approaches to radiation safety policymaking
(c)	Control of resources/costs from unneeded duplicate tests
(V)	Benefits to regulators
(a)	Establishment and continuous review of reference levels
(b)	Data-rich regulatory environment enabling assessment of practice patterns beyond a single reference level
(c)	Ability to quantitatively audit individual providers, practices and facilities
(VI)	Benefits to researchers
(a)	Extensive and robust radiation safety data sets to address research questions
(b)	Incorporation of patient-specific radiation metrics into research studies, including observational, epidemiologic, comparative effectiveness, outcomes and randomised control
(c)	Quantitative basis for development of best practices
(d)	Incorporation of radiation metrics into appropriateness criteria
(VII)	Benefits to researchers
(a)	Facilitation of partnership with other stakeholders in establishing radiation cumulative exposure programmes

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Message

- **Cumulative dose data has been available via thousands of "dose management systems" installed in US and Europe for many years, without any evidence suggesting information on cumulative doses prevents necessary clinical imaging**
- **On the contrary, experience from Europe shows that it improves the process of justification and optimization:** *How tracking of radiologic procedures and dose helps: experience from Finland. AJR 2013 200(4):771-5*

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What can be taken as Evidence

- **Opinions?**
- **Case reports?**
- **Large scale data (Science)?**

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A point to learn

EuroIntervention. 2012 Jan;7(9):1081-6. doi: 10.4244/EIJV7I9A172.

Brain tumours among interventional cardiologists: a cause for alarm? Report of four new cases from two cities and a review of the literature.

Roguin A, Goldstein J, Bar O.

Interventional Cardiology, Rambam Medical Center, Bruce Rappaport Faculty of Medicine, the Technion, Israel Institute of Technology, Haifa, Israel. aroguin@technion.ac.il

Abstract

AIMS: Interventional cardiologists who work in cardiac catheterisation laboratories are exposed to low doses of ionising radiation that could pose a health hazard. DNA damage is considered to be the main initiating event by which radiation damage to cells results in development of cancer.

METHODS AND RESULTS: We report on four interventional cardiologists, all with brain malignancies in the left hemisphere. In a literature search, we found five additional cases and thus present data on six interventional cardiologist and three interventional radiologists who were diagnosed with brain tumours. All worked for prolonged periods with exposure to ionising radiation in the catheterisation laboratory.

CONCLUSIONS: In interventional cardiologists and radiologists, the left side of the head is known to be more exposed to radiation than the right. A connection to occupational radiation exposure is biologically plausible, but risk assessment is difficult due to the small population of interventional cardiologists and the low incidence of these tumours. This may be a chance occurrence, but the cause may also be radiation exposure. Scientific study further delineating occupational risks is essential.

Int J Clin Pract. 2012 Jun;66(6):521. doi: 10.1111/j.1742-1241.2012.02958.x. ı of radiation

Brain cancer in interventional cardiologists and physicians - is occupational radiation exposure the cause?

Jackson G.

Comment on

Lack of radiation awareness among referrers: implications and possible solutions. [Int J Clin Pract. 2012]

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Brain tumours among interventional cardiologists: a cause for alarm?

Report of four new cases from two cities and a review of the literature

Country	[Ref] and publication year	Year diagnosed	Age	Years of radiation exposure (Latency period)	Type	Side
Toronto, Canada	[8] 1998	1997	62	20	Glioblastoma	NA
Toronto, Canada	[8] 1998	1997	53	20 (including Nuclear Medicine)	Glioblastoma	NA
Haifa, Israel		1998	48	14	Meningioma	Left side
Paris, France		2001	56	25	Glioblastoma	Left side
Paris, France		2005	49	22	Glioblastoma	Left side
Haifa, Israel		2009	62	32	Glioblastoma	Left side
Sweden	[10] 2001	NA		20	Acoustic neurinoma	NA
Sweden	[10] 2001	NA		28	Meningioma	NA
Sweden	[10] 2001	NA		31	Oligodendrinoma	NA

Roguin A, EuroIntervention 2012;7:1081

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Radiology

Mortality in U.S. Physicians Likely to Perform Fluoroscopy-guided Interventional Procedures Compared with Psychiatrists, 1979 to 2008[1]

2017

Martha S. Linet, MD
Carl M. Kitahara, PhD
Estelle Nilsen, MS
Ruth A. Kleinerman, PhD
Ethel S. Gilbert, PhD
Neal Nathi, MD
Rebecca S. Lipner, PhD
Donald L. Miller, MD
Amy Berrington de Gonzalez, DPhil
For the Multi-Specialty Occupational Health Group

Purpose: To compare total and cause-specific mortality rates between physicians likely to have performed fluoroscopy-guided interventional (FGI) procedures (referred to as FGI MDs) and psychiatrists to determine if any differences are consistent with known radiation risks.

Materials and Methods: Mortality risks were compared in nationwide cohorts of 45 634 FGI MDs and 64 401 psychiatrists. Cause of death was ascertained from the National Death Index. Poisson regression was used to estimate relative risks (RRs) and 95% confidence intervals (CIs) for FGI MDs versus psychiatrists, with adjustment (via stratification) for year of birth and attained age.

Results: During follow-up (1979–2008), 3506 FGI MDs (86 women) and 7014 psychiatrists (247 women) died. Compared with psychiatrists, FGI MDs had lower total (men: RR, 0.80 [95% CI: 0.77, 0.83]; women: RR, 0.80 [95% CI: 0.63, 1.00]) and cancer (men: RR, 0.92 [95% CI: 0.85, 0.99]; women: RR, 0.82 [95% CI: 0.58, 1.16]) mortality. Mortality because of specific types of cancer, total and specific types of circulatory diseases, and other causes were not elevated in FGI MDs compared with psychiatrists. On the basis of internal comparisons, mortality was elevated among male FGI MDs who graduated from medical school before 1940 (RR, 2.36; 95% CI: 1.21, 12.2).

Conclusion: Overall, total deaths and deaths from specific causes were not elevated in FGI MDs compared with psychiatrists. These findings require confirmation in large cohort studies with individual doses, detailed work histories, and extended follow-up of the subjects to substantially older median age at exit.

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1978-2008 (30 years) NIH Study

45,634 physicians likely performing FGI procedures

- women were 9.1%.
- 9933 interventional cardiologists/ cardiac electrophysiologists,
- 27,378 cardiovascular disease specialists,
- 5520 interventional radiologists, and
- 2803 neuroradiologists

64,401 psychiatrists

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Conclusions from recent paper

- **Overall, total deaths and deaths from specific causes were not elevated in MDs performing Fluoroscopic guided interventions as compared with psychiatrists.**
- **Message: Individual case reports vs analysis of large sample with controls**

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What can be taken as Fact

- ~~**Opinions**~~
- ~~**Case reports**~~
- **Large scale data (Science)**

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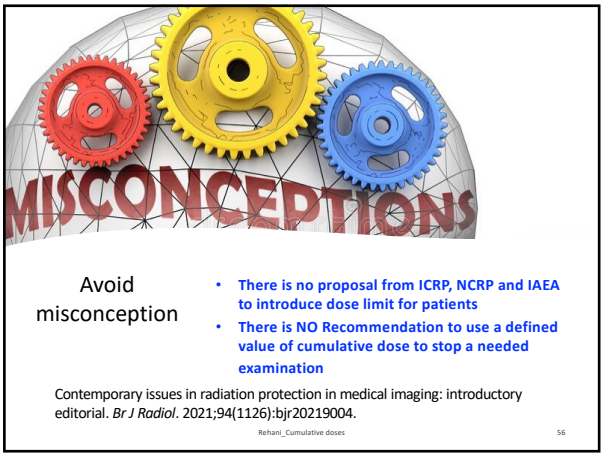

Avoid misconception

- **There is no proposal from ICRP, NCRP and IAEA to introduce dose limit for patients**
- **There is NO Recommendation to use a defined value of cumulative dose to stop a needed examination**

Contemporary issues in radiation protection in medical imaging: introductory editorial. *Br J Radiol*. 2021;94(1126):bjr20219004.

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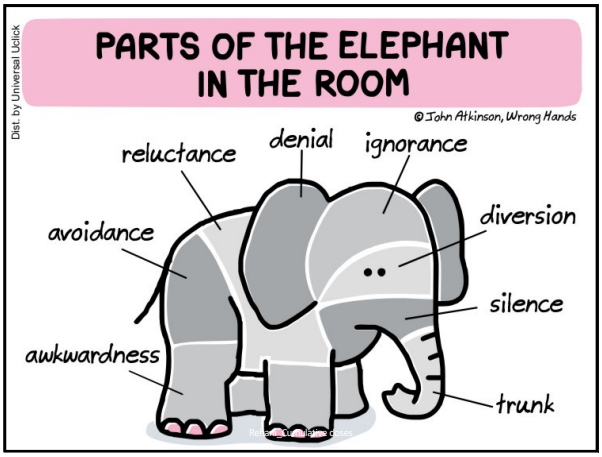

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Patient champion

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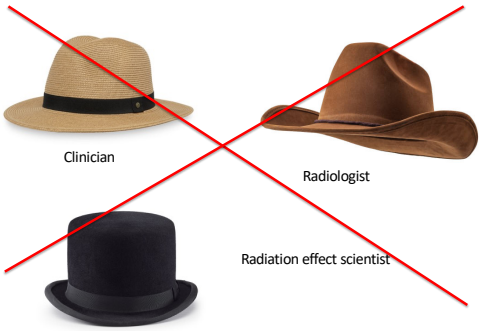
Not competent



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What I can do is

- **Cite their research**
- **Collaborate with them**
- **Produce joint publications**
- **Do surveys with them**

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List of actions where MPs can contribute

- Risk-coefficients, probabilities in age groups and different diseases
- Modeling to assess what % of the high dose group patients are likely to be radio-sensitive
- More than a dozen points on medical physicists can work listed at:

https://www.iaea.org/sites/default/files/position_statement_final_endorsed.pdf

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What medical physicists can do?

- **Brain-storm: How to deal with Elephant in the room**
- **Identify patient population**
  - **where radiation risk is of High, moderate or of low importance (end stage disease, age, radiation risks of no significance). It will not be wise to assume that all patients fall in one category of going to die from the disease in any way**
  - **where there is high probability of higher doses**

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Concluding remarks

This area needs collaborative work/ projects, not just debate (Best brains)

Remember: Sizable group of patients with long life expectancy with 3-digit doses despite use of BEST systems of today (Elephant in the room)

We should value our tools the way others do

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Thank You

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Rehani et al. Eur Radiol. April 2020; 30(4):1828-1836

Institute	Duration (Years & months)	Number of Hospitals	Number of CT scanners	Total number of patients undergoing CT
MGH	5 yrs	5 sites	19	267,013
Orlando	2 yrs 7 m	16 sites	35	430,049
Slovakia, National data	5 yrs	70	108	807,526
Hospitals in USA	1 yr 1 m	252	326	999,997
Total		324	488	2,504,585

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Rehani et al. Eur Radiol. April 2020; 30(4):1828-1836

Institution	Total number of patients with CED≥ 100 mSv (%)	Duration	Maximum CED mSv	Median CED mSv	Mean number of CT exams per patient	Median number of CT exams per patient	Maximum number of CT exams in any patient
MGH	8,952 (3.4%)	5 yrs	1185	146.9	21	19	109
Orlando	5888 (1.4%)	31 m	785.7	129.9	12	11	57
Slovakia	12,198 (1.5%)	5 yrs	864.7	130.7	6.3	6	67
252 hospitals USA	6,369 (0.64%)	13 m	800.3	125.5	7	6	89
	33,407 (1.33%)						

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Physica Medica
Volume 76, August 2020, Pages 173-176

Technical note

Estimates of the number of patients with high cumulative doses through recurrent CT exams in 35 OECD countries

Madan M. Rehani [a], Michael Hauptmann [b]

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https://doi.org/10.1016/j.ejmp.2020.07.014

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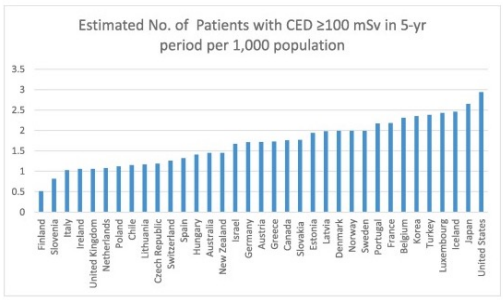

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Fig. 1. Estimated number of patients with CED ≥ 100 mSv in 5-yr period per 1,000 population in 35 OECD countries in increasing order.

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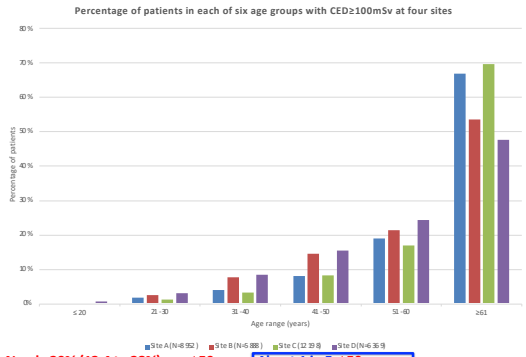
Rehani et al. Eur Radiol. April 2020; 30(4):1828-1836



Nearly 20% (13.4 to 28%) are ≤ 50 years About 1 in 5 ≤ 50 years

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Review · Eur Radiol. 2022 Mar 16. doi: 10.1007/s00330-022-08675-w. Online ahead of print.

Notifications and alerts in patient dose values for computed tomography and fluoroscopy-guided interventional procedures

Eliseo Vano [1], Reinhard Loose [2], Guy Frija [3], Graciano Paulo [4], Efstathios Efstathopoulos [5], Claudio Granata [6], Riccardo Corridori [7], Alberto Torresin [8], Jonas S Andersson [9], Virginia Tsapaki [10], Josefin Ammon [11], Christoph Hoeschen [12], European Society of Radiology

Eur Radiol. 2021 Apr;31(4):2106-2114. doi: 10.1007/s00330-020-07290-x. Epub 2020 Sep 21.

Radiation dose management systems-requirements and recommendations for users from the ESR EuroSafe Imaging initiative

Reinhard W Loose [1 2], Eliseo Vano [3], Peter Mildenberger [4], Virginia Tsapaki [5], Davide Caramella [6], Johan Sjöberg [7], Graciano Paulo [8], Alberto Torresin [9], Sebastian Schindera [10], Guy Frija [11], John Damilakis [12], European Society of Radiology (ESR)

71

Vano et al. Eur Radiol. 2022 Mar 16.
doi: 10.1007/s00330-022-08675-w

Key Points

• *Notifications and alerts on patient dose values for computed tomography (CT) and fluoroscopy-guided interventional procedures (FGIP) allow to improve radiation safety and contribute to the avoidance of radiation injuries and unintended and accidental exposures.*

• *Alerts may be established before the imaging procedures (as in CT) or during and after the procedures as for FGIP.*

• *Dose management systems should include notifications and alerts and their registry for the hospital quality programmes.*

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J Radiol Prot. 2021 Aug 19;41(3). doi: 10.1088/1361-6498/ac0df3.

Referring physician perspective on how to handle frequent use of CT imaging

Elliott Winford [1], Ankur Bharija [2]

Affiliations – collapse

Affiliations

1 Massachusetts General Hospital, Boston, MA, United States of America.
2 Medicine Department Stanford University School of Medicine, Stanford, CA, United States of America.

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J Radiol Prot. 2021 Aug 19;41(3). doi: 10.1088/1361-6498/ac0df3.

Referring physician perspective on how to handle frequent use of CT imaging

Elliott Winford [1], Ankur Bharija [2]

Affiliations – collapse

Model suggested by referring physicians

- All body CT scans (head, chest, abdomen, and pelvis) must be considered 'controlled imaging' modalities due to the known safety risks. This recommendation will be in line with European Directive [12].
- The use of all 'controlled imaging modalities' should be monitored at an individual, prescriber, and institution level.
- Radiation risk stratification of an individual patient based on the cumulative burden of 'controlled imaging modalities' over the recent years will be desirable.
- Individual's radiation risk-stratified in different risk levels should be available for use by the referring/ordering clinicians at the point of care.

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J Radiol Prot. 2021 Aug 19;41(3). doi: 10.1088/1361-6498/ac0df3.

Referring physician perspective on how to handle frequent use of CT imaging

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1 Massachusetts General Hospital, Boston, MA, United States of America.
2 Medicine Department Stanford University School of Medicine, Stanford, CA, United States of America.

We need to know the different grades of risks such as low, medium, high, very high, critical, and very critical.

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Survey among referring clinicians_1

- The preference for basing decisions solely on the indication for the CT scan was a minority choice, with the lowest response for the U.S. (17%) and the highest for Hungary (34%).
- There was majority support for basing the decision on medical reasons and radiation risks, with 56% being the lowest response (South Korea) and 85% the highest (Canada), followed closely by the USA (81%).
- 67% respondents think that radiation risk should form part of the consideration when deciding whether to request a CT exam.
- *Conclusions*: A majority of the surveyed clinicians consider radiation risk, in addition to clinical factors, when prescribing CT exams. Most respondents are in favor of, or would consider, regulation to control the number of CT scans that could be performed on a patient annually.

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Survey among referring clinicians_2

- When asked whether there should be a regulation to limit the number of CT scans that can be prescribed for a single patient in one year, only a small fraction (143, 28%) answered 'No', 182 (36%) answered 'Maybe' and 166 (33%) answered 'Yes'. Most respondents (337; 67%) think that radiation risk should form part of the consideration when deciding whether to request a CT exam.

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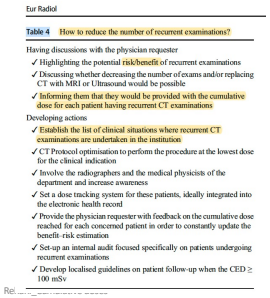
Eur Radiol. 2021 Aug;31(8):5514-5523. doi: 10.1007/s00330-021-07696-1. Epub 2021 Mar 12.

Cumulative effective dose from recurrent CT examinations in Europe: proposal for clinical guidance based on an ESR EuroSafe Imaging survey

Guy Frija [1], John Damilakis [2], Graciano Paulo [3], Reinhard Loose [4], Eliseo Vano [5], European Society of Radiology (ESR)



Eur Radiol

Table 4 How to reduce the number of recurrent examinations?

Having discussions with the physician requester
- ✓ Highlighting the potential risk/benefit of recurrent examinations
- ✓ Discussing whether decreasing the number of exams and/or replacing CT with MRI or Ultrasound would be possible
- ✓ Informing them that they would be provided with the cumulative dose for each patient having recurrent CT examinations

Developing actions
- ✓ Establish the list of clinical situations where recurrent CT examinations are undertaken in the institution
- ✓ CT Protocol optimisation to perform the procedure at the lowest dose for the clinical indication
- ✓ Involve the radiographers and the medical physicists of the department and increase awareness
- ✓ Set a dose tracking system for these patients, ideally integrated into the electronic health record
- ✓ Provide the physician requester with feedback on the cumulative dose reached for each concerned patient in order to constantly update the benefit–risk estimation
- ✓ Set-up an internal audit focused specifically on patients undergoing recurrent examinations
- ✓ Develop localised guidelines on patient follow-up when the CED ≥ 100 mSv

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Clin Transl Gastroenterol. 2021 Apr 27;12(5):e00347. doi: 10.14309/ctg.0000000000000347.

Burden of Ionizing Radiation in the Diagnosis and Management of Necrotizing Pancreatitis

Nikhil R Thiruvengadam [1 2 3], Janille Miranda [3], Christopher Kim [4], Spencer Behr [4], Carlos Corvera [5], Sun-Chuan Dai [3], Kimberly Kirkwood [5], Hobart W Harris [5], Kenzo Hirose [5], Eric Nakakura [5], James W Ostroff [3], Michael L Kochman [1 2], Mustafa A Arain [3]

Affiliations + expand

PMID: 33904509 PMCID: PMC8081480 DOI: 10.14309/ctg.0000000000000347

- 30% received>500 mSv
- Most patients are young
- With timely, proper treatment, a person who has had necrotizing pancreatitis should make a full recovery.

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