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Quantifying Worry in the Face of Uncertainty: Radiation Exposure from Medical Imaging

Michael Coppolino, MD, MSc[a*], Andrew L. Avins, MD, MPH[bcde], Andrew Callen, MD[f] and Walton Sumner, MD[g]

[a] *Department of Critical Care Medicine, Kaiser Permanente San Francisco Medical Center, San Francisco, California, USA*
[b] *Northern California Kaiser-Permanente Division of Research, Oakland, California, USA*
[c] *Department of Medicine, University of California, San Francisco, California, USA*
[d] *Department of Epidemiology & Biostatistics, University of California, San Francisco, California, USA*
[e] *Department of Internal Medicine, Kaiser Permanente Oakland Medical Center, Oakland, California, USA*
[f] *Department of Radiology, University of California, San Francisco, California, USA*
[g] *Department of Medicine, Washington University School of Medicine St. Louis, Missouri, USA*

ABSTRACT

Background: The degree to which people worry about radiation exposure from medical imaging has not been quantified. Such concern is important for clinical decision making and policy generation.

Objective: The aim of this study was to quantify the degree of worry as a consequence of radiation exposure.

Design: A time trade-off methodology was used to estimate health state utilities associated with radiation exposure from computed tomography scans in an inclusive sample of physicians. Health state utilities were elicited from in-person interviews using a software-guided, hypothetical scenario in which the subject is exposed to two separate computed tomography scans.

Results: One hundred and eighteen interviews were conducted. The overall mean and median utility values for the health state of concern due to radiation exposure were 0.95 (95% confidence interval: 0.94–0.96) and 0.98 (interquartile range: 0.91–1.00), respectively. The utility score distribution was highly skewed toward higher values. Five respondents (4.3%) recorded a utility score of $\leq$0.8 and 17 respondents (14.5%) were willing to sacrifice at least 5 or more years of life to live free of the radiation-exposure worry.

Conclusions and relevance: The physician respondents generally demonstrated low levels of disutility; however, a subset of physicians expressed much greater disutility for the future risk of malignancy. Given the potential for physicians to influence health care decisions and policies, further study of radiation-related concerns seems warranted. Physicians, patients, and the general public should be aware of the potential impact such differing views held by physicians may have on their clinical recommendations.

RÉSUMÉ

Contexte : Le degré d'inquiétude de la population face à l'exposition au rayonnement par imagerie médicale n'a pas été quantifié. Ces inquiétudes sont importantes pour la prise de décisions cliniques et l'élaboration des politiques.

Objectif : La présente étude vise à quantifier le degré d'inquiétude face à l'exposition au rayonnement.

Conception : Une méthodologie d'arbitrage temporel a été utilisée pour estimer les valeurs d'usage de l'état de santé associées à l'exposition aux examens de TDM dans un échantillon inclusif de médecins. Les valeurs d'usage de l'état de santé ont été obtenue à partir d'entrevues en personne à l'aide d'un scénario hypothétique guidé par logiciel dans lequel e sujet est exposé à deux examens de TDM distincts.

Résultats : Cent dix-huit entrevues ont été réalisées. Les valeurs d'usage moyennes et médianes pour l'état d'inquiétude face à la santé en raison de l'exposition au rayonnement ont été respectivement de 0,95 (IC 95%: 0,94 à 0,96) et de 0,98 (plage interquartile: 0,91 à 1,00). La distribution des valeurs d'usage était fortement asymétrique vers les valeurs plus élevées. Cinq répondants (4,3%) ont enregistré un score de 0,8 ou moins et 17 répondants (14,5%) étaient près à sacrifier au moins 5 années de vie ou plus pour vivre sans inquiétude liée à l'exposition au rayonnement.

Conclusions et pertinence : Les médecins répondants ont généralement démontré un faible niveau de désutilité; cependant, un sous-ensemble de médecins a exprimé une désutilité beaucoup plus grande face au risque de tumeur maligne future. Compte tenu du potentiel d'influencer les décisions et les politiques en matière de santé des médecins, d'autres études sur les préoccupations liées au rayonnement semblent indiquées. Les médecins, les patients et le grand public devraient être conscients des effets potentiels que de telles opinions discordantes par les médecins peuvent avoir sur leurs recommandations cliniques.

* Corresponding author: Michael Coppolino, MD, MSc, Department of Critical Care Medicine, Kaiser Permanente San Francisco Medical Center, San Francisco, CA.
E-mail address: Micahel.Coppolino@kp.org (M. Coppolino).

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Introduction

How concerned are people about developing cancer as a consequence of radiation exposure from computed tomography (CT) scanning?

Roughly 60 million CT scans are performed annually in the United States [1], comprising 10%–15% [2] of all radiographic procedures. Despite radiation exposure of roughly 100 times greater than conventional radiographs, the annual increase of CT scans in the United States is currently estimated at 10%, a trend seen in both fee-for-service models and integrated health systems reflecting, in part, their immense diagnostic value [3]. Estimates of the increased incidence of future malignancies from CT radiation exposure are imprecise and confounded by the duration of follow-up and technologic advances [4–6].

As diagnostic imaging takes on an increasing role in clinicians' armamentarium, concerns regarding radiation exposure have been raised in both the medical [3, 7, 8] and social media [9, 10]. This attention has been predominantly focussed on attempts at quantifying the risk of future malignancy associated with radiation exposure from diagnostic imaging. The exact incidence of future malignancy is uncertain and the definitive risk estimate is not likely to be precisely quantified. Furthermore, the degree to which patients and physicians are concerned about this uncertain risk is largely unknown. Currently, there are no published reports attempting to quantify the degree of concern among physicians or patients regarding the uncertain risk of malignancy associated with radiation exposure from medical imaging. Quantifying this concern is important from patient, physician, and societal perspectives.

The extent to which patients may want to participate in shared decision making before undergoing radiation-exposing imaging studies is likely to be heavily impacted by their degree of concern over the associated radiation exposure. Similarly, physicians' levels of concern would be expected to influence both their selection of diagnostic imaging strategies and the way they communicate the risks and benefits of medical radiation exposure [11, 12]. Unrealistic perceptions of benefits and risks may lead to suboptimal diagnostic test strategies for both patients and physicians.

The primary aim of this study was to use a time trade-off (TTO) methodology to quantify physicians' concerns regarding the risk of future malignancy associated with radiation exposure from medical imaging. The TTO is a well-recognised health utility estimation approach [13, 14], advocated by health technology assessment organisations such as the Canadian Agency for Drugs and Technologies, having been demonstrated to provide results comparable to the standard gamble as the classic method of utility assessments [14–16]. This methodology provides a standardised assessment of how physicians perceive potential risks from radiation exposure, addressing an existing gap in the medical literature.

Methods

Participants

All physicians in the departments of hospital medicine, critical care, obstetrics and gynecology, and cardiology at the Kaiser Permanente, Northern California (KPNC)-San Francisco Medical Center were eligible to participate. KPNC is an integrated health plan with residency and fellowship programs in multiple specialties. The study group was inclusive, in that entire departmental groups were recruited. Potentially eligible participants were notified via departmental email distribution lists, which included an option to opt out of further study contact. Agreeable participants were then contacted using scripted phone calls or email communications to arrange face-to-face appointments for eligibility screening, consent, and participation. A screening rejection log was maintained.

Participants were excluded from the study if they were pregnant, non-English speakers, had a self-reported cancer diagnosis, or were scheduled for x-rays, nuclear medicine imaging, positron emission tomography or CT imaging anytime between 3 months before and 3 months after the interview. The study was approved by the Kaiser Foundation Research Institute's Institutional Review Board.

Survey Description

Trained research assistants conducted in-person interviews to facilitate administration of a software-guided hypothetical scenario in which the respondent experiences benign abdominal pain and is exposed to medical radiation in the form of two separate abdominal CT scans ([17], Appendix). A TTO analysis was used to quantify the degree to which the resultant uncertain risk of future cancer concerns the respondent. The TTO technique derives an estimate of preferences by finding the point at which respondents are indifferent between a longer, but lower quality of life and a shorter time in full health. To ensure the respondents understood the TTO process, they were first presented with a control question, asking if they would rather live "x" years worry-free, or "y" years with worry to a stated life expectancy of age 80. Any participant preferring to live with worry as opposed to living worry-free for the same duration of life expectancy were provided with clarifying instructions. Subsequently, respondents were asked to choose between an individualised lifespan (x years) free of worry from radiation vs. a longer lifespan ($x + y = 80$ years), which included this worry. Based on the participant's response, the software tailored a subsequent question to have a longer (by y years) worry-free lifespan. This process continued until the respondent reached a point of indifference between a worry-free lifespan (x years) over one with worry ($x +$