Received:
19 October 2015

Revised:
3 December 2015

Accepted:
7 December 2015

<http://dx.doi.org/10.1259/bjr.20150868>

Cite this article as:

Shyu JY, Sodickson AD. Communicating radiation risk to patients and referring physicians in the emergency department setting. *Br J Radiol* 2016; **89**: 20150868.

EMERGENCY RADIOLOGY SPECIAL FEATURE: REVIEW ARTICLE

Communicating radiation risk to patients and referring physicians in the emergency department setting

JEFFREY Y SHYU, MD, MPH and AARON D SODICKSON, MD, PhD

Department of Radiology, Brigham and Women's Hospital/Harvard Medical School, Boston, MA, USA

Address correspondence to: Dr Jeffrey Y Shyu

E-mail: jshyu@partners.org

ABSTRACT

Heightened awareness about the radiation risks associated with CT imaging has increased patients' wishes to be informed of these risks, and has motivated efforts to reduce radiation dose and eliminate unnecessary imaging. However, many ordering providers, including emergency physicians, are ill prepared to have an informed discussion with patients about the cancer risks related to medical imaging. Radiologists, who generally have greater training in radiation biology and the risks of radiation, often do not have a face-to-face relationship with the patients who are being imaged. A collaborative approach between emergency physicians and radiologists is suggested to help explain these risks to patients who may have concerns about getting medical imaging.

INTRODUCTION

In 2014, it was estimated that 81 million CT scans were performed in the USA, an increase of about 17% since 2007.^{1,2} This rapid increase in usage has contributed greatly to the rising concerns about the collective radiation exposure to patients, especially to more vulnerable populations, including young patients and those who have had multiple studies for recurrent medical problems.^{3–5} More and more patients are expressing a desire to be informed of these cancer risks.⁶ However, many providers have little understanding of the carcinogenic risks of imaging examinations, or how to communicate those risks.⁶

Usage of CT clearly has its benefits. In the emergency department (ED), increased accessibility and use of multi-detector CT has greatly improved patient outcomes through improved diagnostic accuracy, which results not only in more appropriate treatment but also more conservative management, such as in cases where patients present with traumatic injuries or other acute conditions.^{7,8}

However, a concomitant rise in CT imaging has resulted in greater population exposure to ionizing radiation. Ionizing radiation-based imaging, primarily in the form of CT and fluoroscopy, has been estimated to account for as much as 2% of all cancers in the USA.^{3,9} From a single CT with an effective dose of 10 millisieverts (mSv), the United States Food and Drug Administration estimates that a patient has a 1 in 1000 chance of developing a cancer, and a 1 in 2000 chance of that cancer being fatal.¹⁰

Radiologists often have the most formalized training on the potential risks of radiation and on strategies to reduce radiation exposure. Radiologists are among those that can speak best about the potential risks, albeit with large uncertainties in the risk estimates, to both the variability in the radiation doses used and in underlying carcinogenesis risk models. However, they often have little interaction with patients and limited clinical information at their disposal to make a judgment on the benefits of a study. ED physicians and other allied health personnel have direct patient contact and are in a better position to explain the risks and benefits of the procedure or therapy they are recommending to a patient, but they often do not have the background knowledge necessary to fully inform patients about the risks of imaging. Ordering providers are often in a better position to speak about the benefits of imaging and how the imaging results might guide medical management.

The ED setting creates additional challenges but also potential opportunities for discussing cancer risk from medical imaging. Challenges include the fact that patients often present acutely and with little available medical history to the ED physician. The ED provider, worried about the acute medical issues and appropriate triage for a patient, may have limited time and interest in explaining to the patient about a small, imprecisely estimated risk of a disease that may take decades to develop. However, more and more, at least in large medical centres, radiologists are immediately available in person to provide a consultative

role when asked. There are greater opportunities for collaborative discussions on appropriate diagnostic and clinical work-up between ED physicians, radiologists and consulting specialists.

RADIOBIOLOGY AND RISK ESTIMATION

One of the challenges of discussing the cancer risks related to medical imaging is that the data and risk models apply to populations and not to individual patients. While controversy remains about the nature of the dose-response curve linking radiation exposure to cancer risk, the most commonly used models for population risks incorporate the “linear no-threshold” assumption, in which a doubling of the risk imparts double the cancer risk. This assumption is the one accepted by most major scientific organizations involved in radiation safety, including the Committee on the Biologic Effects of Ionizing Radiation (BEIR), United Nations Scientific Committee on the Effects of Atomic Radiation, National Council on Radiation Protection and Measurements and International Committee on Radiological Protection.¹¹

Under this model, the carcinogenesis risk is assumed to be cumulative over time, and directly proportional to radiation dose, with no threshold below which the cancer risk is absent. For example, the BEIR VII data are primarily extrapolated from the one-time acute exposures of the atomic bomb survivors. While evidence for cancer risk from lower exposure rates is not yet as strong, several large epidemiologic studies have supported the linear no threshold notion that even low doses of ionizing radiation confer a non-zero cancer risk.^{12–16} Ionizing radiation is thought to increase the risk of carcinogenesis by damaging the DNA, with these DNA errors accumulating over time and overwhelming the body’s natural DNA repair mechanisms. The latency period between an ionizing radiation-based imaging study and cancer development is on the order of decades.¹¹

Radiation biologists and physicists have attempted to develop metrics to estimate the cancer risk from ionizing radiation, by incorporating not only information about the radiation dose delivered to the patient, but also organ sensitivity to carcinogenesis. Although our estimation tools have improved greatly, they are not yet able to provide a precise cancer risk estimate that is individualized to the patient. The BEIR VII model is the most widely accepted one for estimating carcinogenesis from radiation exposure, but it contains wide error bars that greatly limit its applicability to individual cases.¹¹ Cancer risk sensitivity also varies considerably by age and gender, and yet one of the most widely used radiation dose metrics used to estimate cancer risk—effective dose—averages out these important age- and gender-related differences.¹⁷ Many medical practices do not even have the information needed to perform these admittedly imprecise calculations.

DOSE-REDUCTION STRATEGIES

Despite the limitations of risk assessment, the consensus is that the risk is likely non-zero and can be substantial for patients who have had many prior CT or fluoroscopy studies. There are a number of ways in which radiation exposure can be reduced. Indeed, it can sometimes be avoided entirely if prior studies are available (such as a prior CT performed at an outside hospital)

and can be uploaded to the local picture archiving and communication system.¹⁸

Also, for some diagnoses like uncomplicated acute pyelonephritis or acute pancreatitis, imaging may not be appropriate or required for diagnosis, and it is important that the radiologist educate the ordering physician on when certain studies may or may not be indicated. In certain cases, if the institution has the capability and the radiologist has the appropriate training, an alternative imaging modality could be considered—for example, MRI for young people with chronic inflammatory bowel diseases and many prior CT scans.¹⁹ Automated decision-support software can be of benefit in these cases.²⁰

In addition, a number of institutions have been incorporating dose-reduction techniques in their CT protocols.²¹ These may include reducing the number of phases in a CT study, routine incorporation of automated tube current modulation or incorporation of iterative reconstruction in concert with reductions in X-ray flux. Imaging parameters may be tailored to fit the needs of the study, such as lowering the kVp for CT angiography in order to preserve image quality at reduced radiation dose.^{22,23} It is important to convey to the ED providers and patients that dose-reduction strategies have been adopted to reduce potential risks without sacrificing diagnostic accuracy.

Although fluoroscopic studies are less commonly performed in the emergency setting, doses can also be reduced by using a variety of techniques, such as using intermittent or pulsed fluoroscopy instead of continuous fluoroscopy, avoiding magnification, taking advantage of features such as last image hold and adjusting beam quality through the use of appropriate metal filters.²⁴

PATIENT AND PRACTITIONER UNDERSTANDING

Surveys of patients and providers have demonstrated that patients have poor understanding of the risks associated with CT, that they desire to be informed about the radiation risks of imaging, but are often not told about these risks.^{25–27} Providers also wish to inform patients about these risks, but may not feel comfortable having these discussions because they are unfamiliar with the doses imparted by CT studies and how they relate to cancer risk.^{28–31}

Related to this issue is the fact that some patients may have misconceptions about which types of imaging modalities actually involve radiation. Even some practitioners believe imaging modalities such as ultrasound and MRI emit ionizing radiation.³²

COMMUNICATING WITH THE PATIENT: COMPARING RISKS

As mentioned above, one of the challenges with discussing imaging-related cancer risks is that they are hard to personalize. Although we have a large amount of data from atomic bomb survivors, large studies of occupational exposures and retrospective databases of people who have had CT imaging, it is still not possible at this time to individualize these risks.^{11–16} Widely used metrics, such as effective dose, which aims to provide an

estimate of cancer risk from a study, are not individualized to specific patients but are averaged over populations.

A common communication strategy is to compare the amount of radiation from an imaging study with the radiation that people receive from the ambient environment (Table 1). Phrases such as “a chest X-ray provides about as much radiation as a transcontinental US flight” are sometimes used in an effort to put the subject in more relatable terms. The same is sometimes done with CT, comparing it with the average annual background dose from cosmic radiation. A commonly used approximation is to compare the effective dose from a CT with the annual dose from background radiation (CT examinations delivering approximately 2–20 mSv, compared with an annual average 3 mSv from background radiation).³³ However, these types of comparisons inadvertently imply that background radiation is inherently “safe”, and comparison with these abstract exposures does not truly help to communicate the potential magnitude of the risk.

Another strategy is to make a comparison with mortality risks from common activities, about which patients may have a better intuition about the risks.³⁴ For example, estimated radiation risks may be compared with more common everyday activities, such as the mortality risk associated with smoking or driving an automobile. For example, according to 1994 data, the mortality risk from a chest radiograph was estimated to be equivalent to smoking nine cigarettes or driving 23 miles on the highway.³⁴ This type of comparison may be more intuitive to the patient than a comparison with background radiation exposure. Furthermore, if the patient is willing to assume risks associated with common activities, then they may be more comfortable with accepting the small cancer risk from certain types of medical imaging. An issue with this type of comparison is that the latency period for cancer to develop from radiation exposure is on the order of decades, which can alter peoples’ perceptions of risk in ways that make comparison with death from an automobile accident or a plane crash less appropriate.³⁵

Yet another strategy is to compare the added cancer risk from one imaging study with the overall risk that any one patient will develop a cancer over his or her lifetime. Discussed in this way, the added cancer risk from medical imaging, which is typically

a small fraction of a percent, is small when placed in the perspective that approximately 42% of all people will develop a cancer of some type during their lives.¹¹ However, this fact may not be comforting to patients who otherwise would not have known that baseline cancer risks were so high.

Some crude “rules of thumb” can also be made about the cancer risks relative to other patients, depending on characteristics such as age, gender, number of prior studies and anticipated life expectancy.¹¹ The cancer risk for females is higher than for males, although the difference becomes smaller as the age at exposure increases. Also, children are at higher risk of developing cancer from radiation exposure. For example, from a single CT study, on average, a 10-year-old girl has an approximately 2.5 times higher risk of developing cancer, compared with a 30-year-old female. A female child also has a 1.5–2 times higher risk for developing cancer compared with a male child of the same age. However, by age 70 years, for both males and females, the approximate risk for developing a cancer from CT is only one-third of that for a female at age 30 years.

COMMUNICATING WITH THE PATIENT: HOW TO COMMUNICATE, AND INFORMED CONSENT FOR ALL?

If one is asked to assist in a discussion about these risks, it is always important to introduce yourself appropriately and express empathy to the patient and/or to the patient’s designated healthcare decision-makers. In discussing the risks and benefits of any diagnostic modality or therapeutic regimen, it is important to translate medical terms into understandable concepts and avoid medical jargon.³⁶ Important techniques for effective patient communication also include speaking in a concise manner and giving the patient opportunities to make sure they understand the issues. Patients should be given opportunities to ask questions if they remain confused about a topic. Although the risk comparison strategies described above have their limitations, they can still be helpful in contextualizing the cancer risk from a CT study.

It is important to recognize that some of the older literature that provide ballpark estimates of the radiation risk from a study may not accurately reflect current doses from more recently developed study protocols, which are often much lower with

Table 1. Communication strategies for discussing radiation risk from imaging

Communication strategy	Advantages	Disadvantages
Compare radiation exposure from one imaging study with exposure from ambient environment	Communicates the fact that radiation exposure is an ubiquitous part of everybody’s life	May imply that ambient radiation is “safe”
		Does not make a direct link from exposure to cancer risk
Compare mortality risk from imaging with risks from common activities (e.g. smoking, driving an automobile)	People may have better intuitive understandings of these risks	Peoples’ perceptions of risk, and willingness to take on risks, differ depending on latency (e.g. time to mortality)
Compare cancer risk from one imaging study with overall cancer risk in one’s lifetime	Puts into perspective that the incremental risk from an imaging study is a very small fraction of the overall cancer risks	People may not have known that their baseline risk for developing cancer was so high, and making this comparison may result in patient anxiety

optimal use of newer technology capabilities. Many institutions have employed various dose-reduction strategies that result in patient doses much lower than the general literature estimates, and sharing this additional information may help by reassuring patients that the radiology department takes this issue seriously. One might try to convey the fact that our goal is to use imaging in a judicious, evidence-based manner, aimed at the patient's best interests. It is also important to reassure patients that if they are receiving an MRI or ultrasound, these modalities do not produce ionizing radiation and therefore do not impart any cancer risk from radiation.

A controversial topic in radiology is the question of whether patients ought to undergo informed consent of the radiation cancer risks prior to receiving a CT. One of the arguments against informed consent is that we currently do not know enough to accurately inform patients what their cancer risk is, especially on an individual level.³⁷ Other concerns include workflow issues—informing every patient about the cancer risk would require staffing that most radiology practices are not equipped to handle.

However, the process of informed consent also includes discussing with the patient what we do not know, that the data may be insufficient; but, to the best of our knowledge, this is what we can say. How we balance the risks and benefits of informing patients requires careful consideration and artful explanation. Although written consent documents may be used, signing such a document does not always reflect a full understanding of risks.³⁸

Regardless of institutional policies around informed consent, when a patient expresses a concern about the cancer risk from medical imaging, or simply seeks more information, it is important to engage the patient in a discussion that provides them with an understanding of these risks, but also the potential benefits, such as timely and accurate diagnosis, and limitations of an imaging study, so that the patient and his or her physicians can engage in a shared decision-making process.³⁶

PRACTICE-RELATED CHALLENGES AND POTENTIAL SOLUTIONS

Workflow is one of the biggest obstacles to discussions of cancer risk between radiologists and patients. Similarly important is that few people feel comfortable enough with the risk models and their limitations to carry out an informed discussion about the risks. Although some radiologists may welcome discussing these matters with patients, currently, in the USA, payment systems do not reimburse for these types of consultative services. Discussions with patients regarding CT risks are sometimes carried out by the technologist, who may ask about potential allergic reactions and other potential contraindications to receiving a study. However, radiation risk is discussed seldomly, and the technologist may also lack the requisite knowledge to carry out an informed conversation about these risks.³⁹ Differences in practice settings also create different challenges for direct radiologist-to-patient communication. If the radiology suite is remotely located, then a face-to-face talk with the patient may not be possible.

In addition to these workflow and structure-related challenges, providers may fear that by discussing the radiation risk from a CT scan, patients or their parents may decline a CT study because they might then worry excessively about the cancer risk. On the other hand, an appropriate perspective of the cancer risks is often reassuring to patients and providers who otherwise have assumed the risks to be much higher than what is currently supported by the available data. Also, in patients who are critically ill, it may seem out of place to discuss cancer risks that may take decades to manifest, if at all.²⁸

Some practices have started using a consultative service to aid in discussing radiologic findings and recommendations.⁴⁰ These services employ an assistant who communicates directly with patients regarding concerns about their imaging results. Such a person could provide a similar service, especially for radiologists who may be time constrained or otherwise uncomfortable with handling these discussions themselves. The trade-off in this case would be funding this person, vs the radiologist's time. In addition, it may be challenging to find someone with the appropriate understanding and expertise, and a fully informed discussion entails not only a discussion about the cancer risks, but also the benefits of imaging tailored to the individual patient's clinical scenario. However, if the patient's question is limited only to the matter of cancer risk, then a directed discussion could be carried out, while deferring the question of the potential benefits to others more familiar with the patient's clinical history.

At our institution, a dedicated emergency radiology division is situated within the ED, including 24/7 on-site attending presence. Residents and fellows are also available to consult on imaging studies at all times of the day. This permits for a collegial atmosphere whereby radiologists and ED physicians or specialists can discuss imaging findings. In cases where radiation risk becomes a concern for a patient, discussions occur with the ED practitioner or patient as warranted.

If staffing is not available to handle these types of discussions, written handouts may be useful, especially for patients and their families while they are awaiting a study. Institutional procedures can be developed to determine whether they are given to all patients awaiting a study or just to those who ask for more information. Resources from sites such as imagegently.org and imagewisely.org can also be relied upon to craft an effective radiation risk communication approach, tailored to the specifics of the practice setting.^{34,41} Web-based risk-calculation tools, although crude, may also be helpful for patients who have had multiple studies in the past.

CONCLUSION

Patients are increasingly aware that certain types of medical imaging are associated with cancer risks, and they often prefer to be informed of these risks. However, a number of theoretical and practical challenges, to general medical practice but also specific to the ED setting, make having these conversations difficult. Although an effective communication strategy depends greatly on the patient and the practice setting, a number of different approaches can be used to carry out these conversations.

If not everyone can be informed, then priority should be given to those most vulnerable, including children, pregnant females and young patients who have had or who may be at risk for having multiple CTs over time (e.g. patients with inflammatory bowel diseases or other recurrent conditions). In addition, communicating with the patient about a CT study entails not just talking about the radiation risks involved, but also the reasons why a CT is being sought, as well as the alternatives.⁴²

Both radiologists and emergency physicians have a role to play in these discussions. Although patients often prefer to talk about these matters with the provider with whom they are interacting most closely, that provider may not have the knowledge to effectively answer questions about radiation risk. The radiologist, or an appropriately trained assistant, can help if the patient or family members have concerns about the radiation risk from

a study. Discussing these matters also has to take into account the limitations of our risk models, and potential benefits, while making this information understandable to the patient.

There has been increasing emphasis towards a more patient-centred care approach in radiology. Campaigns led by the American College of Radiology and the Radiological Society of North America, such as Image Wisely® and Image Gently®, have brought increased attention to dose reduction and appropriateness of imaging studies. Although challenges and controversies still remain regarding the matter of discussing imaging-related cancer risk to patients, by collaborating with emergency physicians on this matter, we can help alleviate both patient and practitioner concerns while establishing greater clinical value as radiologists take on a much more robust and direct consultative role.

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