POINT/COUNTERPOINT

Suggestions for topics suitable for these Point/Counterpoint debates should be addressed to Habib Zaidi, Geneva University Hospital, Geneva, Switzerland: habib.zaidi@hcuge.ch; Jing Cai, The Hong Kong Polytechnic University, Hong Kong: jing.cai@polyu.edu.hk; and/or Gerald White, Colorado Associates in Medical Physics: gerald.white@mindspring.com. Persons participating in Point/Counterpoint discussions are selected for their knowledge and communicative skill. Their positions for or against a proposition may or may not reflect their personal opinions or the positions of their employers.

Gonadal shielding should be discontinued for most diagnostic imaging exams

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OVERVIEW

Radiation protection of patients and staff during diagnostic imaging procedures is an important aspect of the medical physics profession. Despite the large number of reports and guidelines published by specialized radiation protection organizations and professional societies, there are still some controversies regarding the utility and efficiency of some practices in terms of reducing the dose to patients during typical radiological imaging procedures. It is the role of medical physicists providing physics support to diagnostic imaging facilities and involved in clinical routine activities to debate important issues related to the design of optimal dose reduction strategies with the aims of protecting the patient from unnecessary exposure to ionizing radiation and limiting medically necessary exposure to the minimum required to answer the specific clinical question at hand. Among many other issues, the role of gonadal shielding to protect the patient's reproductive organs in radiology has long been debated without reaching a consensus, resulting in contradictory guidelines on their relevance in clinical practice. Regardless of the contradictions in the scientific literature on the importance of gonadal shielding, one might argue that the patients feel that gonadal shielding is often employed to protect them from ionizing radiation and that they are put at an increased risk in its absence. This is the topic addressed in this month's Point/Counterpoint debate.

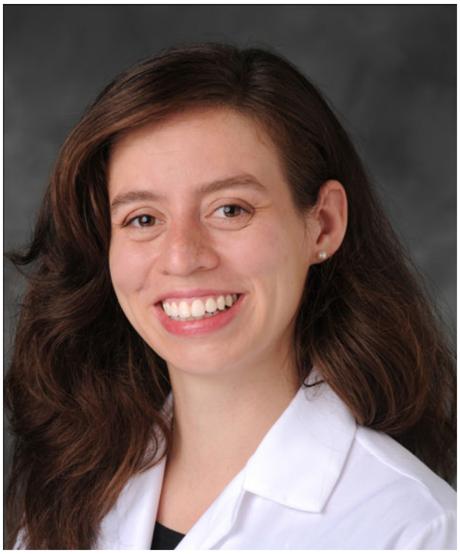
Arguing for the proposition is Sarah McKenney, PhD. Dr. McKenney is a Medical Physicist within the Department of Health Physics and an Associate Professor within the Department of Radiology at the University of California, Davis (UCD) Medical Center in Sacramento, CA. Dr. McKenney received a BS and BA in Physics and Studio Art from the University of Maryland, College Park then worked several years at the National Institute of Standards and Technology Center for Neutron Research. She obtained her PhD in Biomedical Engineering from UCD and completed her medical physics residency at Henry Ford Hospital. Before joining UCD as a medical physicist, Dr. McKenney served at Children's National in Washington DC. Dr. McKenney is Vice-Chair of the Pediatric Imaging Subcommittee within the AAPM and she is a steering committee member of Image Gently. Her research interests include imaging quality and dose optimization, particularly for pediatric populations.

Arguing against the Proposition is Eric Gingold, PhD. Dr. Gingold is Associate Professor of Radiology at the Sidney Kimmel Medical College at Thomas Jefferson University. He received his PhD under Dr Bruce Hasegawa of the UC Berkeley/UCSF Graduate Group in Bioengineering and then completed a medical physics postdoctoral fellowship/residency at the University of Alabama at Birmingham where he specialized in mammography spectral simulation and dosimetry. Dr. Gingold developed exam-specific image processing algorithms for digital radiography at Sterling Diagnostic Imaging and Hologic before joining the faculty at Thomas Jefferson University in 2004 as chief of diagnostic medical physics. He is a fellow of the AAPM and is the current chair of the AAPM's Imaging Physics Committee.

FOR THE PROPOSITION: SARAH MCKENNEY, PH.D

Opening statement

The clinical practice of gonadal shielding has not evolved with medical imaging technology and our understanding of



radiation biology. Clinicians rely on medical physicists to use our expertise and understanding to evaluate radiation protection measures. The physics does not support the practice. It is time to shelve gonadal shields and to adopt more effective technologies.

Historically, the gonads are considered radiosensitive with a specific concern for heritable effects, but ICRP report 103[1] now states that the risk is much less than originally assumed. The original 1990 risk estimate was based on extrapolations of germ cell mutations observed in primarily mice studies; the new estimate curtails these extrapolations and includes updated findings on the basic mechanisms of genetic mutations. ICRP report 103 reduces the gonadal tissue weighting factor from 0.2 to 0.08, a 6- to 8-fold reduction in risk[1] relative to other organs in the abdomen pelvis with greater weighting factors, indicating that technique-based radiation reduction efforts are more effective.[2]

Evidence suggests that gonadal shielding is consistently employed incorrectly. Often, efforts to reduce patient dose using gonadal shields actually increase dose because inadequate coverage of the gonads[3] or the obscuration of critical anatomy[4] may result in a repeated x ray. Even if the shield is correctly placed on the anatomy, the automatic exposure control phototiming cells may be covered, leading to increased radiation output of 63% for pediatrics to 147% for adults.[5]

Poor shielding placement is observed in 85% of female patients,[3] where it is challenging to predict the location of the ovaries. Additionally, shielding does not protect the patient from internally scattered radiation. Depending on the patient size, scattered radiation can substantially contribute of the radiation dose delivered to the ovaries.[5] While we strive for equality in healthcare, gonadal shielding is nothing more than good intentions for the female population. Instead, we must strive for personalized healthcare.

Gonadal shielding was introduced with film radiography in the mid 20th century.[6] Since then, digital imaging receptors have evolved to be more efficient, resulting in shift toward harder beams and an overall radiation output reduction in 2.7 between film and digital radiography.[7] Essentially, the percent dose reduction achieved with gonadal shielding is now achieved by employing digital x-ray systems. Digital imaging provides dose reductions while obviating shielding placement errors.

How do we evaluate risk? With the linear-no-threshold model, the additional risk of radiation-induced cancer from a pelvic x-ray examination ranges from 0.01% to 0.001%.[8] There is a risk of shielding failure, resulting from poor placement, in the range of 53% in males and 85% in females.[3] A repeated exposure doubles the dose, and the associated radiation risks, to the unshielded anatomy in the imaging field of view. The math makes sense; medical physicists must advocate for true patient safety.

AGAINST THE PROPOSITION: ERIC GINGOLD, PH.D

Opening statement

Radiation protection, a fundamental tenet of good radiological practice, demands that exposures be kept to levels that are as low as reasonably achievable (ALARA), economic and social factors being taken into account.[9] This idea is among the first things taught to anyone working with ionizing radiation. The principle of ALARA is so ingrained among radiation professionals that any action or activity perceived to violate the principle is likely to elicit a visceral response. The ALARA principle was intended for occupational exposures; for medical exposures, the idea of radiation dose optimization is favored. This is because workers do not receive a direct benefit from radiation exposure, but patients do. For medical exposures, justification of procedures and optimization of radiation protection are the operative principles.[1] ICRP recommends “management of the patient dose commensurate with the medical

task" and "appropriate mechanisms to avoid unnecessary or unproductive radiation exposure."

For avoidance of unnecessary or unproductive radiation exposure to patients, it is difficult to imagine any activity more effective and economical than simply placing a lead sheet over any radiosensitive anatomy. This practice is taught in all radiologic training programs and is considered a core competency for radiographers. According to Merrill's (a popular textbook in radiography training programs), "When practical, gonad shielding should always be used to protect the patient" and the detailed instructions for positioning of each body part includes a Radiation Protection statement that "the patient is to be protected from unnecessary radiation by using proper collimation and placing lead shielding between the gonads and the radiation source, when necessary."[10] This statement is consistent with FDA regulations 21CFR 1000.50 "Recommendation for the use of specific area gonad shielding on patients during medical diagnostic x-ray procedures":[11]

- When the gonads lie within or close to (about 5 cm from) the primary x-ray field despite proper beam limitation;
- When the clinical objective of the examination is not compromised;
- When the patient has a reasonable reproductive potential.

An important factor that should not be overlooked when considering the use of contact shields to protect radiosensitive anatomy from unnecessary radiation exposure is the psychological benefit. Radiophobia is prevalent in our society because of many factors including nuclear weapons, accidents at nuclear power plants, and news reports about iatrogenic effects following CT brain perfusion scanning.[12] As a result, patients expect gonadal (or other) shielding during radiologic examinations. The perception that it is important to shield low-dose exposures is confirmed when technologists stand behind lead barriers during exposures. The public is aware that radiation dose reduction has become a major goal of the medical imaging industry, and that screening tests like mammography and DEXA should not be performed too frequently. These observations reinforce the public's understanding that even low radiation exposures should be controlled. Given this situation, contact shielding during radiography is a perfectly logical and reasonable expectation and is consistent with optimization. Anecdotal evidence suggests that patients feel more secure and less anxious about their imaging examination when they are shielded, and it is a demonstration that the healthcare provider is concerned for their safety. This can lead to better patient cooperation and improved imaging performance. Discontinuation of gonadal shielding may produce the opposite effect.

Rebuttal: Sarah McKenney, Ph.D

If gonadal shielding was as simple as "placing a lead sheet over any radiosensitive anatomy," investigators would not be reporting such numbers of misplaced shielding.[3] While gonadal shielding may be a core competency, how is this competency evaluated? These statistics reflect inconsistent training or a priority for other elements of patient care, such as a fast throughput. Unless shielding placement can be dramatically improved such that a negligible portion of patients (<5%) receive improperly placed shields, the practice should be discontinued.

Much of the FDA's Title 21 reflects the state-of-the-art circa 1976. Few prescriptive regulations withstand the test of time. These regulations were created when hereditary effects were thought to be particularly vulnerable to radiation. It is now known that the risk of hereditary effects is much less than originally assumed; in fact, it has not yet been directly observed in humans.[1] To ensure patient safety, 21 CFR 1000.50 includes the statement that "The clinical objectives of the examination will not be compromised." Given the high repeat rates associated with examinations that employ gonadal shielding, we now know that gonadal shields compromise x-ray examinations. 21 CFR 1000.50 allows for the discontinuation of gonadal shielding.

While shielding reassures patients, this perpetuates misinformation and only adds to confusion. The onus is on the medical community to educate and reassure patients using interpretations of the most current data. It is condescending to misinform patients in order to obtain cooperation. Efforts to reduce radiation anxiety should be transparent and include a discussion and demonstration of scientifically justified efforts to reduce radiation dose, such as collimation, size-specific technique and beam filtration. Trust must continually be nurtured between patients and the medical community. It starts with medical staff practicing the safest techniques not by maintaining a legacy.

Rebuttal: Eric Gingold, Ph.D

Medical physicists absolutely need to adapt with the times and integrate new information into the policies that we are responsible for within the imaging practices that we serve. I agree with my colleague Dr. McKenney about the evidence that gonadal shields are often placed incorrectly, and when automatic exposure is used, these errors have to potential to drive up radiation dose. Repeated imaging caused by poor shield positioning also leads to unnecessary dose, defeating the original intent of the shield. We in the medical physics community should promote the sensible use of radiation protective shields to reduce unnecessary radiation exposure. We must also emphasize to our clinical colleagues that in striking a balance between image quality and radiation exposure, obtaining a diagnostic quality image is paramount. Gonadal (and other) shielding intended to control unnecessary radiation exposure must never interfere with that objective.

While the tissue weighting factor for the gonads was reduced in ICRP Report No. 103[1] in response to data on radiation-induced genetic mutations,[1] the public has largely not received this message and the ubiquitous fear of radiation exposure to the reproductive organs has not abated. Since there is often no harm when using gonadal shields, and there may be considerable benefit in the form of anxiety control and enhanced patient cooperation, gonadal shielding will likely continue to be used in radiography. As medical professionals, we must leverage our respected positions in imaging departments to counsel our technologist colleagues on the most effective ways to obtain high-quality images while simultaneously demonstrating concern for patient safety. This should involve continuing to employ shields to protect radiosensitive anatomy during imaging procedures, focusing on the most radiosensitive organs (red bone marrow, colon, lung, stomach, breast, followed by gonads), while concurrently educating the patient about what organs are being protected, and why. If there is a chance that a shield might intercept the primary beam in the area of interest, then one should not be used, and the patient should be informed as to the reason why. Current thinking about the proper use of shielding should be incorporated into technologist initial training and continuing education programs.

CONFLICTS OF INTEREST

Dr. Gingold and Dr. McKenney have no relevant conflicts of interest.

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