JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 71, NO. 11, 2018

Radiation Exposure of Operators Performing Transesophageal Echocardiography During Percutaneous Structural Cardiac Interventions

James A. Crowhurst, BSc (Hons),[a,b] Gregory M. Scalia, MBBS, MMedSci,[a,b] Mark Whitby, MSc, PhD,[c] Dale Murdoch, MBBS,[a,b] Brendan J. Robinson, BappSci,[a] Arianwen Turner, BappSci,[d] Liesie Johnston, BappSci,[d] Swaroop Margale, MBBS,[e] Sarvesh Natani, MBBS, MD,[e] Andrew Clarke, MBBS,[f] Darryl J. Burstow, MBBS,[a,b] Owen C. Raffel, MB,[a,b] Darren L. Walters, MBBS, MPhil[a,b]

JACC JOURNAL CME/MOC

This article has been selected as the month's *JACC* Journal CME/MOC activity, available online at http://www.acc.org/jacc-journals-cme by selecting the *JACC* Journals CME/MOC tab.

Accreditation and Designation Statement

The American College of Cardiology Foundation (ACCF) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

The ACCF designates this Journal-based CME/MOC activity for a maximum of 1 *AMA PRA Category 1 Credit(s)*. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Method of Participation and Receipt of CME/MOC Certificate

To obtain credit for *JACC* CME/MOC, you must:

1. Be an ACC member or *JACC* subscriber.
2. Carefully read the CME/MOC-designated article available online and in this issue of the journal.
3. Answer the post-test questions. At least 2 out of the 3 questions provided must be answered correctly to obtain CME/MOC credit.
4. Complete a brief evaluation.
5. Claim your CME/MOC credit and receive your certificate electronically by following the instructions given at the conclusion of the activity.

CME/MOC Objective for This Article: Upon completion of this activity, the learner should be able to: 1) state which staff members receive the highest radiation dose during percutaneous structural cardiac intervention procedures; 2) compare x-ray C-arm projections and their impact on operator radiation dose; and 3) explain why certain patient, procedural, and environmental factors may affect staff radiation exposure in the cardiac catheter laboratory.

CME/MOC Editor Disclosure: *JACC* CME/MOC Editor Ragavendra R. Baliga, MD, FACC, has reported that he has no financial relationships or interests to disclose.

Author Disclosures: The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Medium of Participation: Print (article only); online (article and quiz).

CME/MOC Term of Approval

Issue Date: March 20, 2018
Expiration Date: March 19, 2019

Listen to this manuscript's audio summary by *JACC* Editor-in-Chief Dr. Valentin Fuster.

From the [a]Cardiology Department, The Prince Charles Hospital, Chermside, Queensland, Australia; [b]University of Queensland, St. Lucia, Queensland, Australia; [c]Biomedical Technical Services, The Prince Charles Hospital, Chermside, Queensland, Australia; [d]Medical Imaging Department, The Prince Charles Hospital, Chermside, Queensland, Australia; [e]Department of Anaesthesia, The Prince Charles Hospital, Chermside, Queensland, Australia; and the [f]Department of Cardio-thoracic Surgery, The Prince Charles Hospital, Chermside, Queensland, Australia. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received August 22, 2017; revised manuscript received January 8, 2018, accepted January 11, 2018.

ISSN 0735-1097/$36.00 https://doi.org/10.1016/j.jacc.2018.01.024

Radiation Exposure of Operators Performing Transesophageal Echocardiography During Percutaneous Structural Cardiac Interventions

James A. Crowhurst, BSc (Hons),[a,b] Gregory M. Scalia, MBBS, MMedSci,[a,b] Mark Whitby, MSc, PhD,[c] Dale Murdoch, MBBS,[a,b] Brendan J. Robinson, BappSci,[a] Arianwen Turner, BappSci,[d] Liesie Johnston, BappSci,[d] Swaroop Margale, MBBS,[e] Sarvesh Natani, MBBS, MD,[e] Andrew Clarke, MBBS,[f] Darryl J. Burstow, MBBS,[a,b] Owen C. Raffel, MB,[a,b] Darren L. Walters, MBBS, MPhil[a,b]

ABSTRACT

BACKGROUND Transesophageal echocardiography operators (TEEOP) provide critical imaging support for percutaneous structural cardiac intervention procedures. They stand close to the patient and the associated scattered radiation.

OBJECTIVES This study sought to investigate TEEOP radiation dose during percutaneous structural cardiac intervention.

METHODS Key personnel (TEEOP, anesthetist, primary operator [OP1], and secondary operator) wore instantly downloadable personal dosimeters during procedures requiring TEE support. TEEOP effective dose (*E*) and *E* per unit Kerma area product (*E*/KAP) were calculated. *E*/KAP was compared with C-arm projections. Additional shielding for TEEOP was implemented, and doses were measured for a further 50 procedures. Multivariate linear regression was performed to investigate independent predictors of radiation dose reduction.

RESULTS In the initial 98 procedures, median TEEOP *E* was 2.62 μSv (interquartile range [IQR]: 0.95 to 4.76 μSv), similar to OP1 *E*: 1.91 μSv (IQR: 0.48 to 3.81 μSv) ($p = 0.101$), but significantly higher than secondary operator *E*: 0.48 μSv (IQR: 0.00 to 1.91 μSv) ($p < 0.001$) and anesthetist *E*: 0.48 μSv (IQR: 0.00 to 1.43 μSv) ($p < 0.001$). Procedures using predominantly right anterior oblique (RAO) and steep RAO projections were associated with high TEEOP *E*/KAP ($p = 0.041$). In a further 50 procedures, with additional TEEOP shielding, TEEOP *E* was reduced by 82% (2.62 μSv [IQR: 0.95 to 4.76] to 0.48 μSv [IQR: 0.00 to 1.43 μSv] [$p < 0.001$]). Multivariate regression demonstrated shielding, procedure type, and KAP as independent predictors of TEEOP dose.

CONCLUSION TEE operators are exposed to a radiation dose that is at least as high as that of OP1 during percutaneous cardiac intervention. Doses were higher with procedures using predominantly RAO projections. Radiation doses can be significantly reduced with the use of an additional ceiling-suspended lead shield. (J Am Coll Cardiol 2018;71:1246–54)

Percutaneous interventional procedures, guided by fluoroscopy for structural pathology of the heart, are now commonplace, and procedures such as transcatheter aortic valve replacement (TAVR) offer an alternative treatment option to open-heart surgery (1). These procedures and many others, including left atrial appendage occlusion and transcatheter mitral valve repair/implantations, require guidance with transesophageal echocardiography (TEE) in addition to fluoroscopy (2,3). This exposes the echocardiographer and/or echocardiologist who operate the TEE probe and console to the harmful effects of scattered ionizing radiation. Although recent publications have highlighted the risks of radiation to the staff performing fluoroscopically guided cardiac procedures (4–6), none of these studies were inclusive of radiation dose to TEE operators in this environment.

Primary operators, usually the cardiologist performing the procedure, have tableside and ceiling-suspended lead shields in place to protect them from the harmful effects of radiation. These are usually only in place on the right side of the procedure table, where the primary operator and their assistant stand. There is often no specific additional protection installed at the head end or left side of the procedure table where the TEE operator (TEEOP) would stand. Recent guidelines have highlighted the risks of radiation to TEEOP and the lack of evidence surrounding radiation dose to TEEOP (7). All staff working in this