

**Decreasing Radiation Dose for Complex Electrophysiology Procedures**  
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Radiation exposure related to medical imaging procedures is a concern for patients and practitioners alike. Due to the increased utilization of a large number of radiologic diagnostic and interventional procedures, patients are exposed to more radiation than ever before. Electrophysiology (EP) procedures, in particular, can last for several hours and result in substantial fluoroscopy times and radiation doses. The short term consequences of prolonged radiation exposure include hair loss and desquamation. The long term sequelae related to long procedures are unknown, but may include an increased risk of cancer. Currently, there is no industry standard or regulatory requirement for measuring, reporting or tracking a patient's radiation exposure over a lifetime. The EP lab at Lancaster General Hospital (LGH) in Lancaster, PA recently implemented a process improvement (PI) project designed to provide better tracking and documentation of patients' radiation dose, and ultimately decrease that dose.

In order to quantify patients' radiation exposure, we utilized Gafchromic XR3<sup>®</sup> dosimeter film for all complex procedures (EPS +/- RFA, biventricular PPG or ICD, lead/system extractions, PVI) to record the received dose. The film was electronically scanned and the dose determined by computer software. Although many facilities use this technology to track radiation therapy doses, the LGH EP lab is one of only a few institutions in the U.S. using the film to track doses received during fluoroscopic procedures.

In addition to using dosimeter film to record the radiation dose, the EP lab also implemented new departmental imaging guidelines, including

- x-ray controls set to low dose (in regards to beam intensity) for all procedures, unless the procedure requires images with higher resolution. This is in addition to using pulsed fluoro at 15/sec
- lowering the image intensifier as far as possible.
- collimating the image as much as possible.
- appointing two staff members to act as radiation officers for the EP lab, monitoring adherence to guidelines and making suggestions to improve practice and keep patients' doses low.

In addition to the technical and personnel changes, the EP lab also implemented a fluoroscopy "time out" at 30 minutes of accrued fluoro time and every 30 minutes thereafter. While only the physician can make the decision to stop or continue the procedure, the time out ensures that the physician and procedural staff are all aware of the radiation exposure, and if necessary, take steps to attenuate the patient's exposure.

EP staff members completed a Radiation Dose Data Form for all patients undergoing an EP procedure involving radiation exposure, documenting procedure type, the patient's height, weight, and BMI, and the procedure fluoro time (FT). Gafchromic XR3<sup>®</sup>

dosimeter film was utilized to record the radiation dose for all patients undergoing a potentially lengthy/complex procedure (diagnostic/interventional EP study, biventricular PPG or ICD, PVI, lead extraction, PPG/ICD revision). The dosimeter film was placed under the table pad beneath the patient's back and within the x-ray field. Following the procedure, the film was scanned and the dose determined by computer software. For this project, we arbitrarily designated a reportable dose as  $\geq 200$  cGy as determined by computer scanning.

We compared the average radiation dose and the percentage of cases with a scanned dose  $\geq 200$  cGy for 115 patients undergoing complex EP procedures before guideline implementation and 117 patients undergoing complex EP procedures after guideline implementation. Data analysis revealed a 52% decrease in mean radiation dose (289.6 (328.1) cGy to 139.5 (200.2) cGy), and a 61% decrease in the percentage of complex EP procedures with a dose  $\geq 200$  cGy (45.2% to 18.0%). See Table 1.

	<b>Pre IG</b>	<b>Post IG</b>	<b>P-value</b>
N	115	117	
Mean (95% CI) Dose in cGy	290 (228.9-350.2)	140 (102.9-176.2)	< 0.001
% (95% CI) Cases w/Dose $\geq 200$ cGy	45.2% (36.1%-54.3%)	18.0% (11.0%-24.9%)	< 0.001

In summary, we found that modification of fluoroscopy delivery via imaging guidelines resulted in a marked reduction in radiation dose without an appreciable decrease in image quality. Implementation of imaging guidelines resulted in a 52% reduction in mean radiation dose and a 61% reduction in complex radiation procedures with a radiation dose  $\geq 200$ cGy. The use of Gafchromic XR3<sup>®</sup> dosimeter film combined with electronic scanning and computerized dose determination accurately quantifies radiation dose for complex EP procedures.

We continue to adhere to imaging guidelines and to record, track and document radiation dose for all patients undergoing complex EP procedures. With a few exceptions, patients' radiation doses have remained low and data consistently mirrors the results of the PI project.