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X-ray exposure hazards for physicians performing ablation procedures and device implantation: results of the European Heart Rhythm Association survey

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The purpose of the survey was to evaluate physician's and authorities policies and clinical practices when using occupational X-ray during ablation procedures and device implantation. This survey shows infrequent use of lead gloves, radiation absorbing pads, and lead glass cabins, but increasing use of three-dimensional mapping systems to decrease X-ray radiation hazards. Digital fluoroscopy with decreased frame rate is not used by approximately one-third of responding centres.

Keywords Catheter ablation • Pacing • Fluoroscopy • Radiation dose

Introduction

The number and complexity of electrophysiology procedures and cardiac rhythm device implantations are steadily increasing. Complex procedures are often characterized by prolonged fluoroscopy times and may have significant influence on the health status of the electrophysiology personnel and the patient. The purpose of this survey was to evaluate experience and practices of working with X-ray radiation during electrophysiology and implantation procedures in EHRA's EP Network centres.

Methods and results

Characteristics of centres

A multichoice questionnaire was constructed using SurveyMonkey® engine and emailed to the EHRA Research Network centres. Responses were collected from 53 centres. Some survey questions were dedicated to institutional policies and methods to reduce X-ray hazards for electrophysiology personnel and patients.

Centre contribution by nation in alphabetical order was: Armenia 1 centre, Austria 1, Belgium 1, Bulgaria 1, Denmark 4, France 3, Germany 3, Greece 2, Italy 11, Lithuania 2, Monaco 1, the Netherlands 5, Romania 1, Spain 9, Sweden 2, and United Kingdom 6 centres.

Responding centres are mostly characterized by high procedure numbers. In the year 2011, 56% of centres performed 200 or more catheter ablation procedures and 30% performed 50–199 procedures. A total of 61% of centres implanted 50–199 ICDs, 20% implanted 200 or more ICDs; 31% implanted 50–199 pacemakers, and 65% implanted 200 or more pacemakers. The types of hospitals were as follows: 69% of centres were university hospitals; 7% were private, and 24% other types of hospitals.

X-ray equipment used for electrophysiology procedures and device implantation

Limited data about the X-ray equipment manufacturer and device models were collected. Both for ablation and implantation procedures, Siemens products were used more often (in about one-half of responses), followed by Philips, General Electric, and Toshiba equipment. Only 19% of centres use biplane fluoroscopy for ablation, and only 4% indicated that biplane fluoroscopy is used sometimes during device implantation procedures.

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Policies and practices regarding X-ray exposure in electrophysiology personnel

To reduce X-ray exposure, most of the centres use lower fluoroscopy pulse rate [33% use 6 frames per second (fps), 20% use 3 fps, and 17% use 12 fps]. As a comparison, 17% of responding centres use 25–30 fps rate, and 13% of responders do not know which frame rate they use. Radiation doses are measured individually in most of the centres; only one centre indicated that individual doses are not measured. Yearly health check-ups are performed in 70% of responding centres. Regarding the monthly/yearly staff X-ray exposure limits, 39% reported not knowing about these limits, and 61% of responders indicated a yearly maximum dose of 50 mSv and monthly 3 mSv. For routine monitoring, operators use dosimeters above the lead apron (67% of responders), beneath the apron (59%), and finger dosimeters (35%). If the individual monthly or yearly X-ray burden exceeds the limits, more comprehensive personal radiation measurements are done (41% of responders), blood laboratory tests are scheduled (22%), or a person is limited to perform a certain number of procedures (67%).

The use of other safety measures and techniques has also been evaluated and is presented in *Table 1*. When asked about maximal limits of fluoroscopy times or procedure duration for cardiac resynchronization device implantation, 26% of responders indicated 60 min of fluoroscopy or 4 h of total procedure duration, and the rest 74% did not indicate any limits. For ablation procedure, 15% indicated a fluoroscopy time limit of 1 h, and the rest did not mentioned any limits, with several comments about never reaching such a limit.

Table 1 Use of various safety measures and techniques to decrease X-ray radiation during electrophysiology procedures

Safety measure or technique	Reported frequency of use, % of responders
Minimizing the tube-to-intensifier distance	98
Collimation of the X-ray beam (narrowing the diaphragm)	91
Verbal informing of reached fluoroscopy times	86
Lead apron	94
Lead thyroid shield	98
Lead glasses	89
Lead glass walls inside the lab	84
Lead screen below the table	71
Sterile radiation absorbing pads placed near (around) the device pocket incision	27
X-ray protecting sterile gloves	32
Mobile radiation protection cabine (e.g. CathPax)	19
Use of 3D mapping systems also in routine cases to minimize radiation	73
Use of robotic systems (Stereotaxis, Hansen) in order to minimize radiation	11

Two survey questions were dedicated to the responders' perception of illness of operators and patients resulting from X-ray use. The absolute majority of the responders had observed no possible health damage as a result of X-ray radiation. However, 2% mentioned radiation dermatitis observed in colleagues or themselves, and 11% mentioned radiation dermatitis in their patients. Four per cent of responders indicated that malignancy in electrophysiology colleagues could be possibly attributable to occupational X-ray radiation.

Discussion

X-ray radiation is one of the limiting factors both for electrophysiology staff and patients, and the steadily increased numbers and complexity of procedures may pose substantial risk for electrophysiology personnel. Numerous studies have addressed the burden of radiation for various types of procedures[1] and examined possible ways to decrease the dose of ionizing radiation.[2] One of the purposes of this survey was to check how often these safety measures are implemented into clinical practice across Europe. The results of this survey showed that selected European centres have adopted the standard use of individual lead aprons and shields, beam collimation, and others. The use of some other measures (as radiation absorbing sterile drapes[3] or gloves) is less homogeneous. In difficult cases of cardiac resynchronization therapy device implants, recommended procedure time limit is 4 h, or 60 min of X-ray exposure.[4] Responders did not indicate a frequent use of these limits, which is probably related to the fact that these limits are very rarely reached with the advent of modern left ventricular lead technologies and device programming capabilities. Pulsed fluoroscopy with lower frame rates (12–6–3 fps), despite well-demonstrated effectiveness,[2] is not used by up to one-third of responders. Three-dimensional mapping systems are often used to decrease fluoroscopy usage. Robotic systems are less frequently used to diminish the X-ray dosage, and the reason could be higher cost of the procedure or small number of such systems installed.

Conclusions

This survey on occupational X-ray hazards in electrophysiology shows infrequent use of lead gloves, radiation absorbing pads, and lead glass cabins, but increasing use of three-dimensional mapping systems to decrease X-ray radiation burden. Digital fluoroscopy with decreased frame rate is not used by approximately one-third of responding centres.

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