31 GIORNATE CARDIOLOGICHE TORINESI

TURIN
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2019

HOW TO REDUCE TIME, CONTRAST AND RADIATION DOSE IN CARDIOVASCULAR IMAGING AND PROCEDURES

How to optimize an endovascular procedure

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Disclosure Statement of Financial Interest

I, Maria Antonella Ruffino, DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation

Radiomachismo

"Increasingly, we have become causal regarding our exposure. We forget to wear the dosimeters. Not infrequently, there is a machismo disregard for radiation protection"

Rita Watson, Sayonara ALARA, Cath Cardiov Diagn, 1997

MISTAKEN ASSUMPTIONS

- Diagnostic radiation dose are relatively low
- No acute somatic injuries can occur with X-ray imaging
- The equipment is all automatic and the physician does not need to know anything about this operation
- Radiation badges are just a nuisance
- Parents can be in the procedure room for paediatric cases
- Staff can be used to hold uncooperative patients

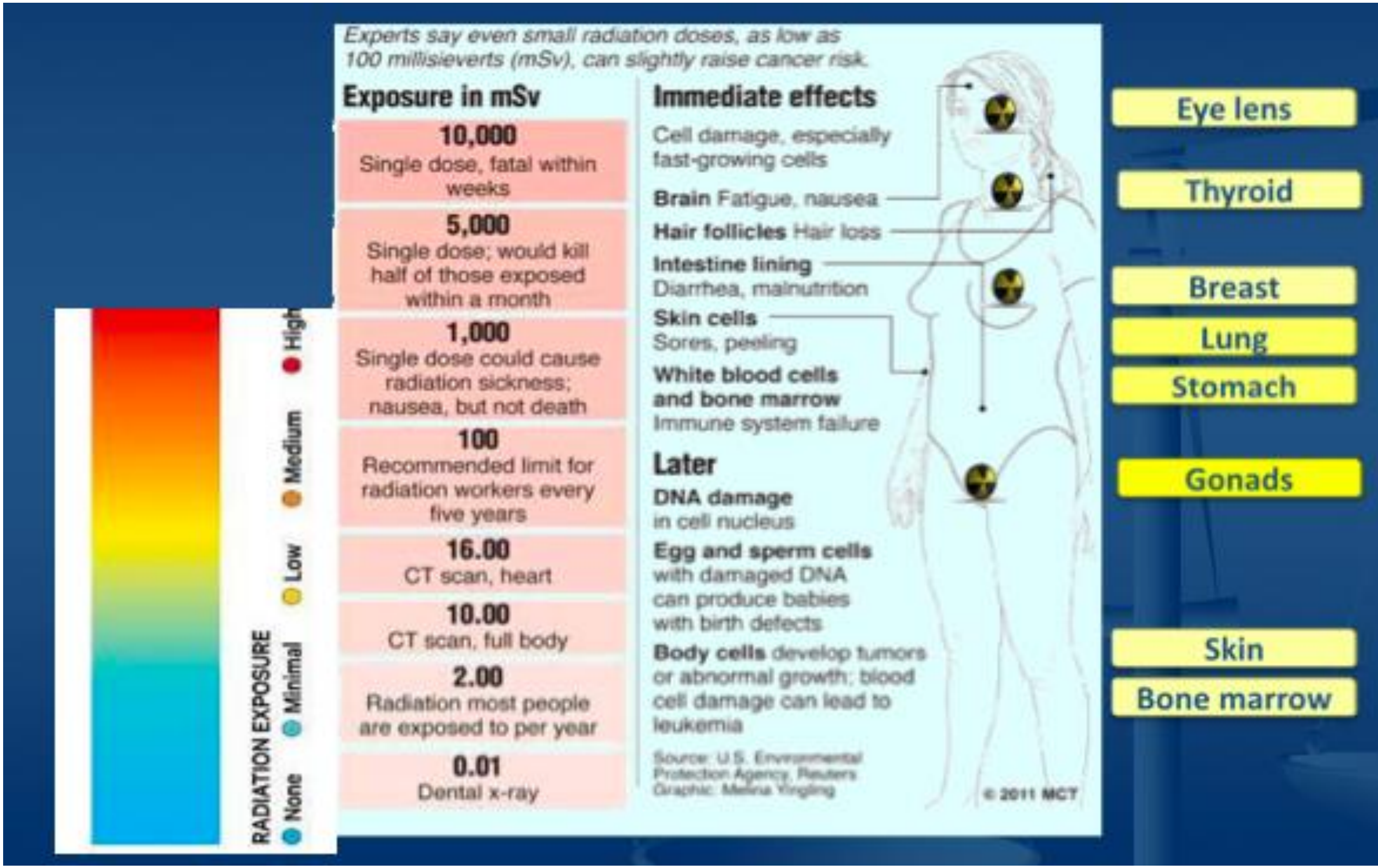
The radiation exposure during endovascular aortic procedure and lower extremity endovascular interventions exposes patients and staff to significant doses of ionizing radiation

DETERMINISTIC EFFECTS IN ENDOVASCULAR PROCEDURES

"Radiation injury is a potentially serious complication to fluoroscopically-guided complex interventions"

Ref. LK Wagner_biij, 2007

EFFECTS OF RADIATION EXPOSURE



LIFETIMES RISKS TO RADIOLOGISTS

- Assume 10 mGy Per year for 40 years
- “Effective dose” is <0.15 external badge reading
- Organ doses are much less assume uniform
- Fragmentation over time reduces bio-risks considerabily
- Cancer risk <10 mGy x 40 YRS x 0.15 x 0.00005 / mSv = 3,000 cases per million = radiologist lifetime = 0.3%

Insights Imaging
DOI 10.1007/s13244-014-0365-x

CARDIAC

Radiation awareness among radiology residents, technologists, fellows and staff: where do we stand?

Subramaniyan Ramanathan · John Ryan

Received: 31 July 2014 / Revised: 20 October 2014 / Accepted: 27 October 2014

Abstract
Objectives To investigate and compare the knowledge of radiation dose and risk incurred in common radiology examinations among radiology residents, fellows, staff radiologists and technologists.
Methods A questionnaire containing 17 multiple choice questions was administered to all residents, technologists, fellows and staff radiologists of the department of medical imaging through the hospital group mailing list.
Results A total of 92 responses was received. Mean score was 8.5 out of 17. Only 48 % of all participants scored more than 50 % correct answers. Only 23 % were aware of dose from both single-view and two-view chest X-ray; 50–70 % underestimated dose from common studies; 50–75 % underestimated the risk of fatal cancer. Awareness about radiation exposure in pregnancy is variable and particularly poor among technologists. A statistically significant comparative knowledge gap was found among technologists.
Conclusions Our results show a variable level of knowledge about radiation dose and risk among radiology residents, fellows, staff radiologists and technologists, but overall knowledge is inadequate in all groups. There is significant underestimation of dosage and cancer risk from common examinations, which could potentially lead to suboptimal risk assessment and excessive or unwarranted studies posing significant radiation hazard to the patient and radiology workers.
Main Messages
• *Knowledge of radiation dose and risk is poor among all radiology workers.*
• *Significant knowledge gap among technologists compared to residents, fellows and staff radiologists.*
• *Significant underestimation of radiation dose and cancer risk from common examinations.*

Keywords Radiation dose · Radiation risk · Residents · Technologists · Cancer risk · Questionnaire

Introduction

Radiology plays a prominent role in modern medicine. Many of the diagnostic and interventional radiology procedures involve exposure to ionising radiation. Although overall the benefits of imaging outweigh the associated risks of radiation, there is growing concern over the adverse biological effects of ionising radiation on living organisms. A 2009 National Council on Radiation Protection and Measurements publication, "Ionizing Radiation Exposure of the Population of the United States", reported a sevenfold increase in radiation exposure to the population of the United States from medical radiation since the early 1980s [1]. Stochastic effects of radiation, especially the cancer risk, is the most feared and least understood as it has no minimal threshold dosage and the adverse outcomes take at least 1–2 decades to manifest [2–4].

Review of the published scientific literature shows the knowledge of radiation dose and risk incurred in radiological examinations is very limited. Numerous studies have been performed, predominantly among physicians of different spe-

CONCLUSIONS:

the overall knowledge about radiation dose and risk is inadequate in all groups

SURVEY OF 92
CANADIAN RADIOLOGY LAB EMPLOYEES

Only 48% of all partecipants scored more than 50% correct answers
50-75% understimated the risk of fatal cancer

There is a significant understimation of dosage and cancer risk from common examinations
It could potentially lead to suboptimal risk assessment
Excessive or unwarranted studies pose significant radiation hazard to the patient and radiology workers

Call for Implementing a Radiation Protection Culture in Fluoroscopically Guided Interventional Procedures

Gabriel Bartal[1]
Ariel Roguin[2]
Graciano Paulo[3]

OBJECTIVE. The purpose of this article is to discuss the first prospective study published to date that followed a large cohort of radiologic technologists; the authors examined the risks of cancer incidence and mortality in U.S. radiologic technologists (radiographers) assisting in fluoroscopically guided interventional procedures.

CONCLUSION. There is an urgent need for implementing a radiation protection culture for medical procedures that use ionizing radiation.

The existing data of cancer cases resulting from ionizing radiation exposure is based mainly on extrapolations from the epidemiologic analysis of cancer in the Life Span Study of the Japanese atomic bomb survivors. Extrapolations, even for the large sample sizes, and statistical precision can still introduce bias, particularly in low-dose radiation exposure. The article by Rajaraman et al. in this issue of the *AJR* [1] is about the first prospective study published to date that followed a large cohort of radiologic technologists: 90,957. The authors examined the risks of cancer incidence and mortality in U.S. radiologic technologists (radiographers) assisting in fluoroscopically guided interventional procedures.

Fluoroscopic imaging creates radiation fields that are unevenly scattered throughout the interventional fluoroscopy room. It is well known that the radiation exposure of staff involved in fluoroscopically guided interventional procedures is higher than for

cer, and melanoma were elevated in technologists who performed fluoroscopically guided interventional procedures compared with those who did not perform fluoroscopically guided interventional procedures; however, they do not have supporting dosimetry data.

The most novel finding in this large prospective cohort of 90,957 radiologic technologists is the difference in mortality from brain tumors: There were 26 (0.12%) cases among 22,209 radiologic technologists who reported working with radiation as compared with 34 (0.05%) among 68,748 who reported never having been exposed to radiation [1]. These results are the first to show a statistically significant difference (hazard ratio = 2.55; 95% CI, 1.48–4.40) regarding the incidence of brain tumor deaths and exposure to low-dose radiation. Rajaraman et al. report death from brain tumors—thus, the real incidence of brain tumors—is even higher.

A major limitation of this study [1] was the lack of personnel radiation dose data, which

Keywords: brain, breast, cancer, fluoroscopically guided interventions, interventional radiology, radiation protection

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This article is a commentary on "Cancer Risks in U.S. Radiologic Technologists Working With Fluoroscopically Guided Interventional Procedures, 1994–2008" by Rajaraman et al. published in this issue of the *AJR*.

- AIM: to discuss the first prospective study that followed a large cohort of US technologists (radiographers) assisting in FGIP examining the risk of cancer incidence and mortality

CONCLUSIONS:

there is a urgent need for implementing a radiation protection culture for medical procedures that use ionizing radiation

RADIATION EXPOSURE RELATED OCCUPATIONAL RISK FOR INTERVENTIONAL LABORATORY STAFF

Brain and Neck Tumors Among Physicians Performing Interventional Procedures

Ariel Roguin, MD, PhD[a,*], Jacob Goldstein, MD[b], Olivier Bar, MD[c], and James A. Goldstein, MD[d]

Physicians performing interventional procedures are chronically exposed to ionizing radiation, which is known to pose increased cancer risks. We recently reported 9 cases of brain cancer in interventional cardiologists. Subsequently, we received 22 additional cases from around the world, comprising an expanded 31 case cohort. Data were transmitted to us during the past few months. For all cases, where possible, we endeavored to obtain the baseline data, including age, gender, tumor type, and side involved, specialty (cardiologist vs radiologist), and number of years in practice. These data were obtained from the medical records, interviews with patients, when possible, or with family members and/or colleagues. The present report documented brain and neck tumors occurring in 31 physicians: 23 interventional cardiologists, 2 electrophysiologists, and 6 interventional radiologists. All physicians had worked for prolonged periods (latency period 12 to 32 years, mean 23.5 ± 5.9) in active interventional practice with exposure to ionizing radiation in the catheterization laboratory. The tumors included 17 cases (55%) of glioblastoma multiforme (GBM), 2 astrocytomas (7%), and 5 meningiomas (16%). In 26 of 31 cases, data were available regarding the side of the brain involved. The malignancy was left sided in 22 (85%), midline in 1, and right sided in 3 operators. In conclusion, these results raise additional concerns regarding brain cancer developing in physicians performing interventional procedures. Given that the brain is relatively unprotected and the left side of the head is known to be more exposed to radiation than the right, these findings of disproportionate reports of left-sided tumors suggest the possibility of a causal relation to occupational radiation exposure. (Am J Cardiol 2013;111:1368–1372)

	Country	Year Diagnosed	Age at Diagnosis (yrs)	Gender	Radiation Exposure (Latency Period) (yrs)	Tumor Type	Side Involved	Occupation	Prognosis	Age at Death (yrs)	Survival After Diagnosis	Reference
1	Toronto, Canada	1997	62	M	20	GBM	Left side	IC	Died in 1999	64	2 yrs	13,15
2	Toronto, Canada	1997	53	M	20	GBM	Left side	IC	Died in 1999	55	4 yrs	13,15
3	Haifa, Israel	1998	48	M	12	Meningioma	Left temporal	IC	Alive			15
4	Paris, France	2001	56	M	25	GBM	Left temporal	IC	Died in 2005	59	4 yrs	15
5	Paris, France	2005	49	M	22	GBM	Left temporo-occipital	IC	died in 2006	50	16 mo	15
6	Haifa, Israel	2009	62	M	32	GBM	Left frontal	IC	Died in 2010	63	11 mo	15
7	Sweden	NA		M	20	Acoustic neurinoma	NA	IR				14,15
8	Sweden	NA		M	28	Meningioma	NA	IR				14,15
9	Sweden	NA		M	31	Oligodendroma	NA	IR				14,15
10	London, UK	2009	62	M	27	Parotids	Left	IC				16
11	Zürich, Switzerland	2009	53	M	20	GBM	Left frontal	Pediatric EP	Died in 2010	54	14 mo	16
12	Virginia	2009	67	M	29	GBM	Left	EP	Alive			16
13	Dundee, Scotland	2007	59	M	29	Astrocytoma	Left	IC	Died in 2009	61	2 yrs	16
14	Kentucky	2008	54	M	22	GBM	Left	IC	Died in 2010	56	2 yrs	16
15	Illinois	2003	65	M	32	GBM	Midline	IC	Died in 2005	67	2 yrs	16
16	Gainesville, Florida	1990s	~40	M	~10	GBM	Left occipital lobe	IC		NA		16
17	West of Scotland	2008	52	Female	NA	GBM	Left frontal	Radiologist	Died in 2009	53	1 yr	16 + new data
18	West of Scotland	2011	NA	M	NA	GBM	Left temporal	IR	Alive			16 + new data
19	Leipzig, Germany	2005	55	M	20	GBM	Right	IC		56	1 yr	New
20	Homburg, Germany	2010	54	M	25	Astrocytoma (grade II)	Left	IC	Alive			New
21	Linköping, Sweden	2009	49	M	12	GBM	Left frontal lobe	IC	Died in 2011	49	2 yrs	New
22	Santa Monica, California	2006	52	M	21	GBM	Left	IC	Died in 2007	53	2 yrs	New
23	California	2008	71	M	22	Glioma	Left temporal	IC	Alive			New
24	Maryland	2012	57	M	26	Meningioma	Right	IR	Alive			New
25	Belgium	1990s	NA	M	NA	GBM	NA	IC	Died	NA		New
26	Belgium	1990s	NA	M	NA	GBM	NA	IC	Died	NA		New
27	Ireland	2011	55	M	31	Neck lymphoma	Left	IC	Alive			New
28	Israel	2012	62	M	32	Parotids	Right	IC	Alive			New
29	Germany	2003	49	M	19	Meningioma	Left	IC	Alive			New
30	Middle East	2009	62	M	30	Meningioma	Left	IC	Alive			New
31	Middle East	2009	52	M	19	Tonsillar tumor	Left	IC	Alive			New

EP = electrophysiologist; F = female; GBM = glioblastoma multiforme; IC = invasive cardiologist; IR = invasive radiologist; M = male; NA = not available.

A striking finding was the disproportionate occurrence of tumors on the left side of the brain **85%!!!**

JOURNAL CLUB:

Cancer Risks in U.S. Radiologic Technologists Working With Fluoroscopically Guided Interventional Procedures, 1994–2008

AJR JOURNAL CLUB

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Keywords: brain, breast, cancer, fluoroscopically guided interventional procedures, interventional radiology, radiologic procedures

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OBJECTIVE. The purpose of this study was to examine risks of cancer incidence and mortality among U.S. radiation technologists performing or assisting with fluoroscopically guided interventional procedures.

SUBJECTS AND METHODS. A nationwide prospective cohort of 90,957 radiologic technologists, who responded to a 1994–1998 survey that collected information on whether they had ever worked with fluoroscopically guided interventional procedures, was followed through completion of a subsequent cohort survey during 2003–2005 (for cancer incidence) or December 31, 2008 (for cancer mortality). Sex-adjusted hazard ratios (HRs) and 95% CIs were calculated by use of Cox proportional hazards models for incidence and mortality from all cancers other than nonmelanoma skin cancer and for specific cancer outcomes in participants who reported ever performing fluoroscopically guided interventional procedures compared with technologists who never performed these procedures.

RESULTS. The analysis showed an approximately twofold increased risk of brain cancer mortality (HR, 2.55; 95% CI, 1.48–4.40) and modest elevations in incidence of melanoma (HR, 1.30; 95% CI, 1.05–1.61) and in breast cancer incidence (HR, 1.16; 95% CI, 1.02–1.32) but not mortality (HR, 1.07; 95% CI, 0.69–1.66) among technologists who performed fluoroscopically guided interventional procedures compared with those who never performed these procedures. Although there was a small suggestive increase in incidence of all cancers combined, excluding nonmelanoma skin cancers (HR, 1.08; 95% CI, 1.00–1.17), mortality from all cancers combined, excluding nonmelanoma skin cancers, was not elevated (HR, 1.00; 95% CI, 0.88–1.14). We similarly observed no elevated risk of cancers of the thyroid, skin other than melanoma, prostate, lung, or colon and rectum or of leukemia that was not chronic lymphocytic leukemia among workers who performed fluoroscopically guided interventional procedures.

CONCLUSION. We observed elevated risks of brain cancer, breast cancer, and melanoma among technologists who performed fluoroscopically guided interventional procedures. Although exposure to low-dose radiation is one possible explanation for these increased risks, these results may also be due to chance or unmeasured confounding by nonradiation risk factors. Our results must be confirmed in other studies, preferably with individual radiation dose data.

RESULTS:

- in workers who performed FGIP :
  - ≈ 2-fold increase risk for brain cancer mortality (HR=2.55, 95% CI 1.48-4.40)
  - modest elevations for incidence of breast cancer (HR=1.16, 95% CI 1.02-1.32)
  - observed no elevated risk for cancer of the: thyroid, non-melanoma skin, prostate, lung, colon-rectum, or non CLL or leukemia

CONCLUSIONS:

elevated risks for brain cancer, breast cancer, and melanoma in technologists who performed FGIP

Cardiac Catheterization

Occupational Health Risks in Cardiac Catheterization Laboratory Workers

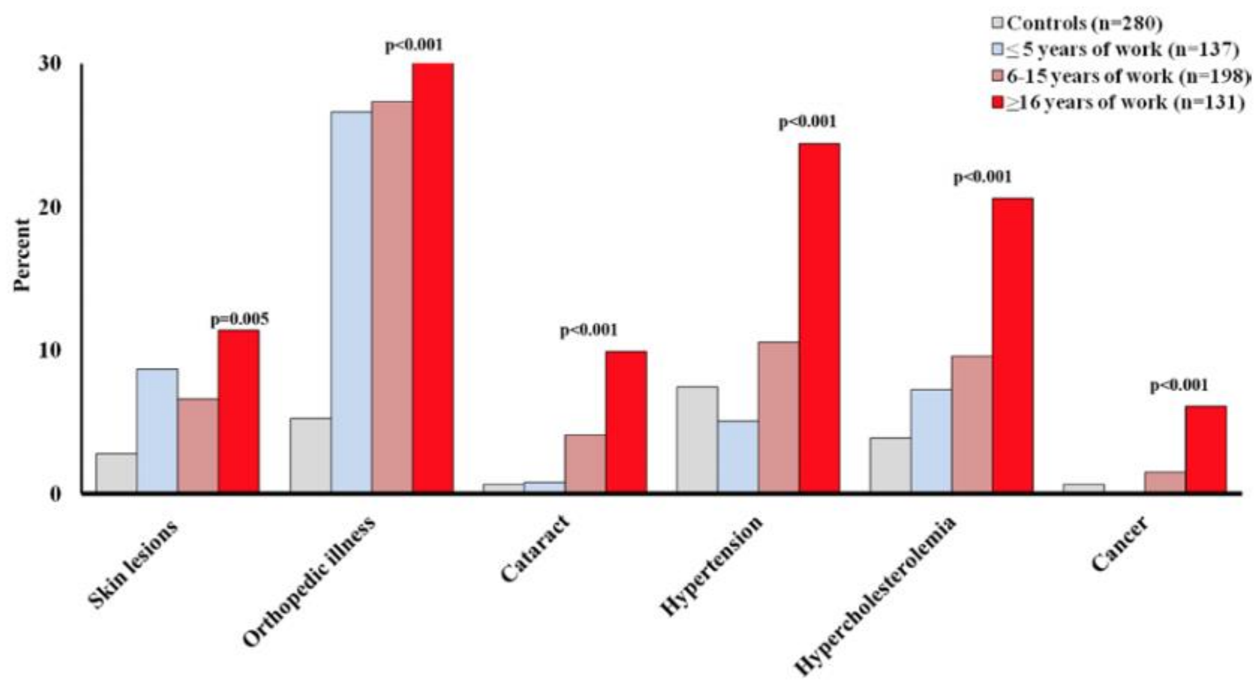
Maria Grazia Andreassi, MSc, PhD; Emanuela Piccaluga, MD; Giulio Guagliumi, MD;
Maurizio Del Greco, MD; Fiorenzo Gaita, MD, PhD; Eugenio Picano, MD, PhD;
on behalf of the Healthy Cath Lab Study Group*

Background**—**Orthopedic strain and radiation exposure are recognized risk factors in personnel staff performing fluoroscopically guided cardiovascular procedures. However, the potential occupational health effects are still unclear. The purpose of this study was to examine the prevalence of health problems among personnel staff working in interventional cardiology/cardiac electrophysiology and correlate them with the length of occupational radiation exposure.

Methods and Results**—**We used a self-administered questionnaire to collect demographic information, work-related information, lifestyle-confounding factors, all current medications, and health status. A total number of 746 questionnaires were properly filled comprising 466 exposed staff (281 males; 44±9 years) and 280 unexposed subjects (179 males; 43±7years). Exposed personnel included 218 interventional cardiologists and electrophysiologists (168 males; 46±9 years); 191 nurses (76 males; 42±7 years), and 57 technicians (37 males; 40±12 years) working for a median of 10 years (quartiles: 5–24 years). Skin lesions (P=0.002), orthopedic illness (P<0.001), cataract (P=0.003), hypertension (P=0.02), and hypercholesterolemia (P<0.001) were all significantly higher in exposed versus nonexposed group, with a clear gradient unfavorable for physicians over technicians and nurses and for longer history of work (>16 years). In highly exposed physicians, adjusted odds ratio ranged from 1.7 for hypertension (95% confidence interval: 1–3; P=0.05), 2.9 for hypercholesterolemia (95% confidence interval: 1–5; P=0.004), 4.5 for cancer (95% confidence interval: 0.9–25; P=0.06), to 9 for cataract (95% confidence interval: 2–41; P=0.004).

Conclusions**—**Health problems are more frequently observed in workers performing fluoroscopically guided cardiovascular procedures than in unexposed controls, raising the need to spread the culture of safety in the cath laboratory.
(*Circ Cardiovasc Interv*. 2016;9:e003273. DOI: 10.1161/CIRCINTERVENTIONS.115.003273.)

There is an increased rate of health problems across the years of work, especially ater 16 years



2015

Eur J Vasc Endovasc Surg. 2015 Apr;49(4):396-402. doi: 10.1016/j.ejvs.2014.12.032. Epub 2015 Feb 2.

Editor's choice--Angulation of the C-arm during complex endovascular aortic procedures increases radiation exposure to the head.

Albayati MA[1], Kelly S[1], Gallagher D[2], Dourado R[3], Patel AS[1], Saha P[1], Bajwa A[1], El-Sayed T[1], Salter R[3], Gkoutzios P, Carrell T[1], Abisi S[1], Modarai B[4].

Over lead dose 83 micro SV

2017

Circulation. 2017 Dec 19;136(25):2406-2416. doi: 10.1161/CIRCULATIONAHA.117.029550. Epub 2017 Oct 20.

Radiation-Induced DNA Damage in Operators Performing Endovascular Aortic Repair.

El-Sayed T[1], Patel AS[1], Cho JS[1], Kelly JA[1], Ludwinski FE[1], Saha P[1], Lyons OT[1], Smith A[1], Modarai B[2]; Guy's and St Thomas' Cardiovascular Research Collaborative.

Over lead dose 27 micro SV

Circulation. 2017 Oct 20. pii: CIRCULATIONAHA.117.029550. doi: 10.1161/CIRCULATIONAHA.117.029550. [Epub ahead of print]

Radiation Induced DNA Damage in Operators Performing Endovascular Aortic Repair.

El-Sayed T[1], Patel AS[1], Cho JS[1], Kelly JA[1], Ludwinski FE[1], Saha P[1], Lyons OT[1], Smith A[1], Modarai B[2]; Guy's and St Thomas' Research Collaborative.

⊕ Author information

Abstract

Background -Radiation exposure during fluoroscopically-guided interventions such as endovascular aortic repair (EVAR) is a growing concern for operators. This study aimed to measure DNA damage/repair markers in operators perfoming EVAR. ***Methods*** -Expression of the DNA damage/repair marker, gamma-H2AX (γ-H2AX) and DNA damage response (DDR) marker, phosphorylated ataxia telangiectasia mutated (pATM), were quantified in circulating lymphocytes in operators during the peri-operative period of endovascular (infra-renal [IEVAR], branched [BEVAR] and fenestrated [FEVAR]) and open aortic repair using flow cytometry. These markers were separately measured in the same operators but this time wearing leg lead shielding in addition to upper body protection and compared with those operating with unprotected legs. Susceptibility to radiation damage was determined by irradiating operators' blood *in vitro****Results*** -γ-H2AX and pATM levels increased significantly in operators immediately after BEVAR/FEVAR (*P*<0.0003 for both). Only pATM levels increased after IEVAR (*P*<0.04). Expression of both markers fell to baseline in operators after 24hrs (*P*<0.003 for both). There was no change in γ-H2AX or pATM expression after open repair. Leg protection abrogated γ-H2AX and pATM response after BEVAR/FEVAR. The expression of γ-H2AX varied significantly when operators' blood was exposed to the same radiation dose *in vitro* (*P*<0.0001). ***Conclusions*** -This is the first study to detect an acute DNA damage response in operators performing fluoroscopically-guided aortic procedures and highlights the protective effect of leg shielding. Defining the relationship between this response and cancer risk may better inform safe levels of chronic low dose radiation exposure.

"There is, rightly so, a significant focus currently on reducing the patients' exposure to radiation but mounting evidence suggests that recurrent low dose exposure to the practitioner is equally as important"

A population-based cohort study examining the risk of abdominal cancer after endovascular abdominal aortic aneurysm repair

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Hugh Mackenzie, PhD, MRCS,[a] George B. Hanna, PhD, FRCS,[a] Matt Thompson, PhD, FRCS,[b]
Peter Holt, PhD, FRCS,[b] Jesper Lagergren, PhD, MD,[d,e] *and* Alan Karthikesalingam, PhD, MA, MSc, MRCS,[a,b,c]
London, United Kingdom; and Stockholm, Sweden

ABSTRACT

Objective: Endovascular aneurysm repair (EVAR) has increasingly been used as the primary treatment approach for abdominal aortic aneurysm (AAA). This study examined the hypothesis that EVAR leads to an increased risk of abdominal cancer within the radiation field compared with open AAA repair.

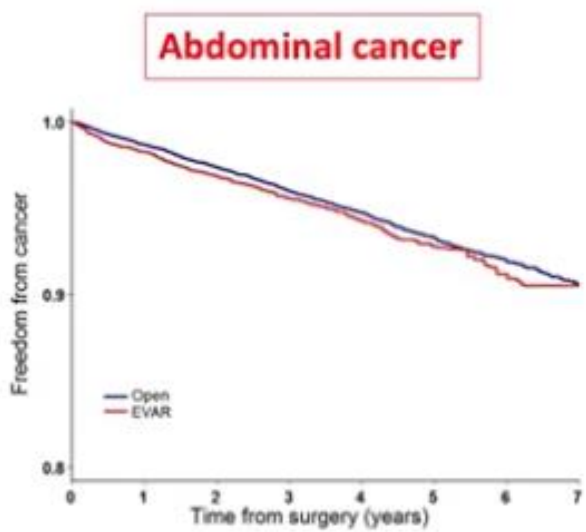
Methods: The nationwide English Hospital Episode Statistics database was used to identify all patients older than 50 years who received an AAA repair in 2005 to 2013. EVAR and open AAA repair groups were compared for the incidence of post-operative cancer using inverse probability weights and G-computation formula to adjust for selection bias and confounding.

Results: Among 14,150 patients who underwent EVAR and 24,645 patients who underwent open AAA repair, follow-up was up to 7 years. EVAR was associated with an increased risk of postoperative abdominal cancer (hazard ratio [HR], 1.14; 95% confidence interval [CI], 1.03-1.27) and all cancers (HR, 1.09; 95% CI, 1.02-1.17). However, there was no difference between the groups in the risk of lung cancer (HR, 1.04; 95% CI, 0.92-1.18) or obesity-related nonabdominal cancer (HR, 1.12; 95% CI, 0.69-1.83). Within the EVAR group, use of computed tomography surveillance was not associated with any increased risk of abdominal cancer (HR, 0.94; 95% CI, 0.71-1.23) or all cancers (HR, 0.97; 95% CI, 0.81-1.17).

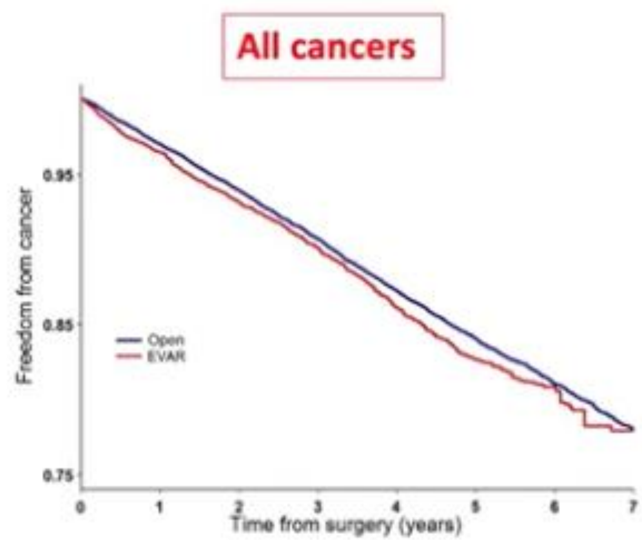
Conclusions: This study suggests an increased risk of abdominal cancer after EVAR compared with open AAA repair. The differential cancer risk should be further explored in alternative national populations, and radiation exposure during EVAR should be measured as a quality metric in the assessment of EVAR centers. (J Vasc Surg 2018;■:1-10.)

CONCLUSIONS

This large and population-based cohort study indicates that patients who underwent EVAR compared with open AAA repair were at a greater risk for development of later abdominal cancer, although causation cannot be inferred from the available nonrandomized and observational data. DNA damage observed from radiation exposure during EVAR provides a possible mechanistic explanation for the observed association, and exploration of this phenomenon in late follow-up of the available randomized trial data would be prudent.



HR 1.14 (CI 1.03-1.27, P=0.02)



HR 1.09 (CI 1.02-1.16, P=0.02)

Insights Imaging (2015) 6:411–417
DOI 10.1007/s13244-015-0410-4

REPORT

Summary of the European Directive 2013/59/Euratom: essentials for health professionals in radiology

European Society of Radiology (ESR)

Abstract The aspects of the new European Directive 2013/59/Euratom most relevant to diagnostic imaging and intervention are summarised. The Directive, laying down basic safety standards for protection against the dangers from exposure to ionising radiation, emphasises the need for justification of medical exposure (including asymptomatic individuals), introduces requirements concerning patient information and strengthens those for recording and reporting doses from radiological procedures, the use of diagnostic reference levels, the availability of dose-indicating devices and the improved role and support of the Medical Physics Experts in imaging. Relevant changes include new definitions, a new dose limit for the eye lens, non-medical imaging exposures, procedures in asymptomatic individuals, the use and regular review of diagnostic reference levels (including interventional procedures), dosimetric information in imaging systems and its transfer to the examination report, new requirements on responsibilities, the registry and analysis of accidental or unintended exposure and population dose evaluation (based on age and gender distribution). These changes will require Member States, the radiology community and the industry to adapt regulations, practices and equipment for a high standard of radiation safety. By 6 February 2018, the Directive has to be transposed into the national legislation of the Member States of the European Union.

Main messages

- *The new European Basic Safety Standards Directive impacts radiology departments*
- *Changes in justification, patient information, responsibilities and dose reporting are most significant*

- Dosimetric information must be transfer into examination report
- **By February 2018**, the Directive has to be transposed into national legislation of the Member States of the European Union

REDUCING RADIATION DOSE ACCORDING TO THE PRINCIPLE OF AS LOW AS REASONABLY ACHIEVABLE (ALARA)

- **REDUCE FLUOROSCOPY PULSE AND FLUOROGRAPHY FRAME SETTING**

  (at 7.5 pulses/s, 75% reduction in radiation dose compare to continuous fluoroscopy)

- **REDUCE FLUOROSCOPY TIME** (Note the number of 5-minutes fluoroscopy notification alarm)
- **AVOID REDUNDANT VIEWS**
- **RESPECT THE DISTANCES**
  - increase table-height: patient distant from the source
  - decrease patient-detector distance
  - mantain operator's distance as far as possible from the point of entrance of X-ray into the patient
- **MINIMIZE MAGNIFICATION**
- **USE COLLIMATION** (antiscatter grids)
- **CHANGE POINT OF X-RAY ENTRY**
- **AVOID STEEPLY ANGLED OBLIQUE VIEWS**
- **USE UP TO DATE EQUIPMENT**

AJR 2012; 198:200–206

Image Optimization During Endovascular Aneurysm Repair

T. Gregory Walker[1]
Sanjeeva P. Kalva
Suvranu Ganguli
Rahmi Öklü
Gloria M. Salazar
Arthur C. Waltman
Stephan Wicky

OBJECTIVE. The purposes of this review are to examine various properties of the fluoroscopic imaging equipment used during endovascular aneurysm repair (EVAR) that can be modified to reduce radiation dose while optimizing image acquisition and display, to detail geometric aspects of EVAR intraprocedural imaging used to achieve consistently optimal EVAR results, and to describe acquisition parameters and strategies for minimizing contrast-induced nephropathy.

CONCLUSION. The outcome of EVAR is strongly linked to image acquisition and interpretation, including the preprocedural, intraprocedural, and postprocedural display of relevant vascular anatomy, positions and configurations of the endograft components, and documentation of successful aneurysm exclusion. Operator familiarity with the imaging equipment, radiation and contrast dose reduction strategies, and image optimization techniques strongly influence the outcome of EVAR.

NEW ADVANCED AND SOPHISTICATED TECHNICAL INNOVATION

for reducing the entrance dose, while maintaining or even enhancing image quality

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Significant Radiation Dose Reduction in the Hybrid Operating Room Using a Novel X-ray Imaging Technology

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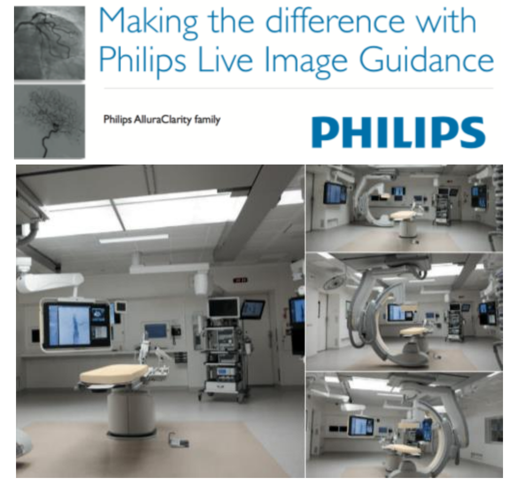
WHAT THIS PAPER ADDS
The considerable increase of endovascular procedures to treat aneurysmal and occlusive vascular disease over the last few years has led to increased radiation exposure in patients and staff. This study shows that a new imaging technology in the hybrid operating room suite can significantly reduce radiation dose for both patients and staff, without changing standard ways of working.

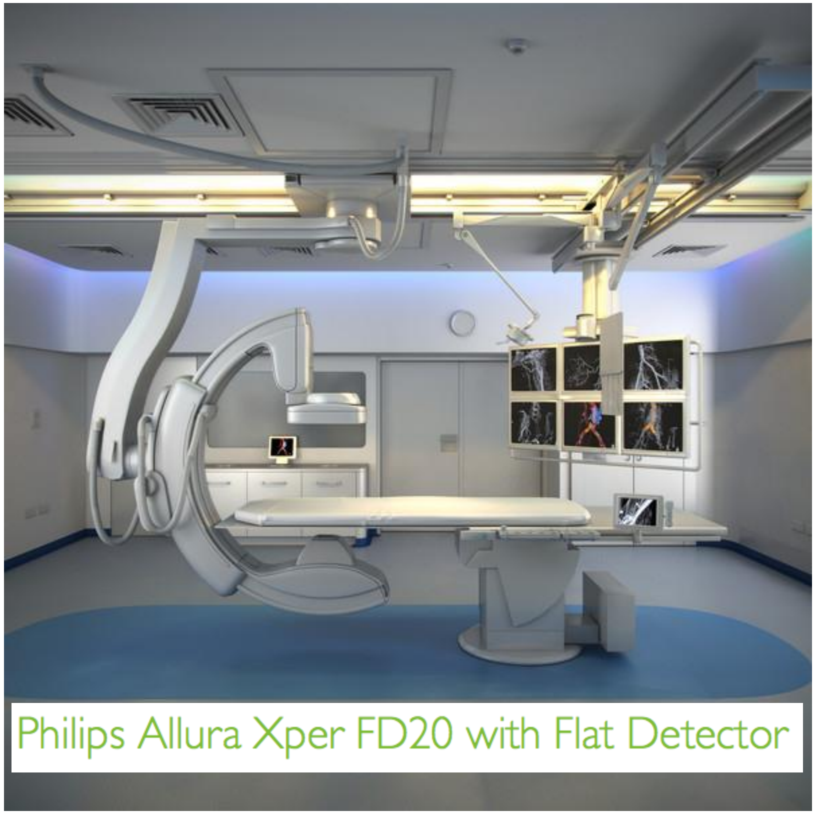
Objective/Background: To prospectively quantify radiation dose change in aortoiliac endovascular procedures in the hybrid operating room (OR) for patients and medical staff with a novel X-ray imaging technology (ClarityIQ technology), and to assess whether procedure or fluoroscopy time or dose of iodinated contrast was affected.
Methods: A prospective study including 138 patients was performed to compare radiation dose before and after installation of a novel X-ray imaging technology. Endovascular aneurysm repair (EVAR) was performed in 37 patients and an endovascular procedure for aortoiliac occlusive disease (AIOD) in 101. Patient radiation dose in air kerma (AK) and dose area product (DAP), patient demographics, and procedural data were recorded. Staff radiation dose was measured with real time personal dosimetry measurements. In both the EVAR and AIOD groups the reference system, ALX (AlluraXper FD20; Philips Healthcare, Best, the Netherlands), was compared with the upgraded X-ray system, CIQ (AlluraClarity FD20; Philips Healthcare). Procedure time, fluoroscopy time, and iodinated contrast dose were recorded.
Results: Patient radiation dose reduction in the EVAR group, in median AK, was 56% (ALX = 1,262.5 mGy; CIQ = 556.0 mGy [$p < .01$]); and in median DAP it was 57% (ALX = 224.4 $Gycm^2$ and CIQ = 95.8 $Gycm^2$ [$p < .01$]). Patient radiation dose reduction in the AIOD group, in median AK, was 76% (ALX = 1,011.0 mGy; CIQ = 248.0 mGy [$p < .01$]); and in median DAP it was 73% (ALX = 138.1 $Gycm^2$; CIQ = 38.0 $Gycm^2$ [$p < .01$]). Staff dose reduction in the EVAR group was 16% (ALX = 70.1 µSv; CIQ = 59.2 µSv [$p = .43$]) and in the AIOD group it was 69% (ALX = 96.2 µSv; CIQ = 30.1 µSv [$p < .01$]). There was no statistically significant difference between patient demographics, procedure time, fluoroscopy time, and iodinated contrast medium use in the two treatment groups before and after installation.
Conclusion: A novel X-ray imaging technology in the hybrid OR suite resulted in a significant reduction of patient and staff radiation dose without affecting procedure length, fluoroscopy time, or use of contrast.

Article history: Received 8 December 2014, Accepted 17 June 2015, Available online 15 August 2015
Keywords: Aneurysm repair, Dosimetry, Endovascular, Radiation, Radiation exposure



The drawback is their **high cost which limits its adoption only by the major centers**

…IMPROVE WHAT WE GOT!



Philips Allura Xper FD20 with Flat Detector

La radiologia medica
https://doi.org/10.1007/s11547-018-0924-1

RADIOBIOLOGY AND SAFETY

Radiation dose during endovascular aneurysm repair (EVAR): upgrade of an angiographic system from standard to Eco mode

Maria Antonella Ruffino[1] · Marco Fronda[2] · Andrea Discalzi[1] · Paola Isoardi[3] · Laura Bergamasco[4] · Roberto Ropolo[3] · Dorico Righi[1] · Paolo Fonio[2]

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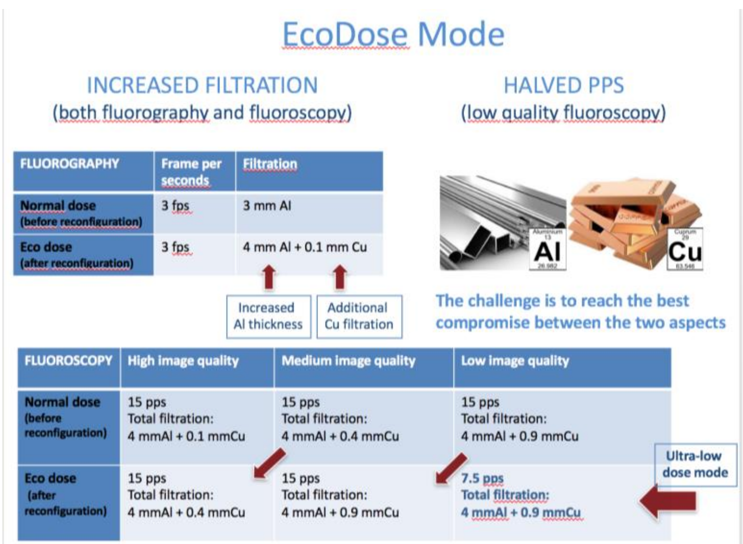
Abstract

Purpose To evaluate the radiation dose reduction during endovascular aneurysm repair (EVAR) after the reconfiguration of a Philips AlluraXper FD20 X-ray system.

Methods Between 2013 and 2015, we implemented a low-dose protocol (Eco dose) increasing the filtration with 1 mm of Al and 0.1 of Cu on both fluoroscopy and fluorography and halving the frames per second in fluoroscopy. The switch was complemented by hybrid operating room staff education and training in radiation protection. We compared two samples of 50 patients treated before the switch (normal dose) with 50 patients treated after the switch (Eco dose). Procedures were categorized into two different grades of complexity, standard and complex, intended as fenestrated/chimney/snorkel and EVAR plus additional embolization to prevent endoleak type II. We evaluated patient demographics, Air Kerma (AK), dose area product (DAP), and procedural data (fluoroscopy time, number of fluorographies, and iodinated contrast). Staff radiation dose was measured with film badge dosimeter on C-arm.

Results The Eco-dose protocol witnessed a DAP reduction of 53% in standard EVARs and of 57% in complex EVARs and an AK reduction of 45% in standard and 57% in complex EVAR. The image quality in 2016 was perceived acceptable, as proven by the fact that fluoroscopy time, number of fluorographies, and contrast medium volumes did not have to be increased. We achieved a reduction in staff dose of 25.6%.

Conclusions Optimized angiographic system setting significantly reduced the radiation dose both to the patients and to the staff assuring safe EVAR procedures.



The ambient dose equivalent went from 333 mSv/1000 procedures to 248 mSv/1000 procedures with a reduction of 25%.

Fig. 1 Box plot of AK (**a**) and DAP (**b**) for standard (normal and Eco protocol) and complex (normal and Eco protocol) EVAR procedures. The bottom and top hinges of the boxes are the first (Q1) and third (Q3) quartiles; the blue band inside the box is the second quartile (median), and the red line is the sample mean

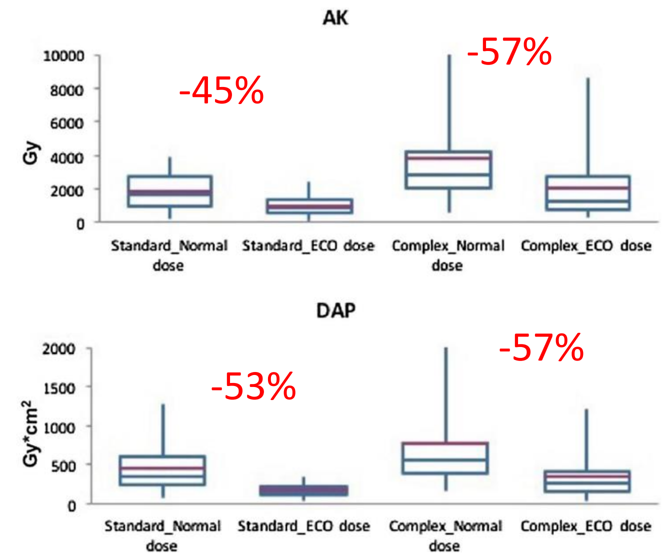
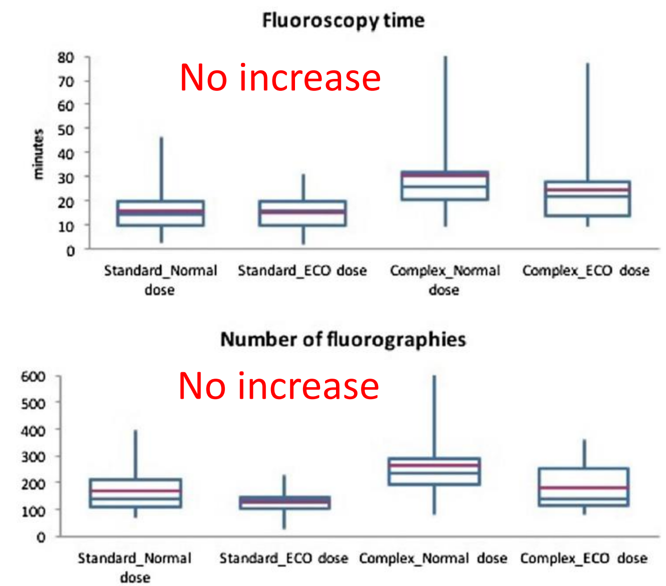


Fig. 2 Box plot of the fluoroscopy time (**a**) and of the number of fluorographies (**b**) for standard (normal and Eco protocol) and complex (normal and Eco protocol) EVAR procedures. The bottom and top hinges of the boxes are the first (Q1) and third (Q3) quartiles; the blue band inside the box is the second quartile (median), and the red line is the sample mean



Intra-operative guidance using fusion imaging

JVS, 2018

From the Society for Vascular Surgery

A prospective observational trial of fusion imaging in infrarenal aneurysms

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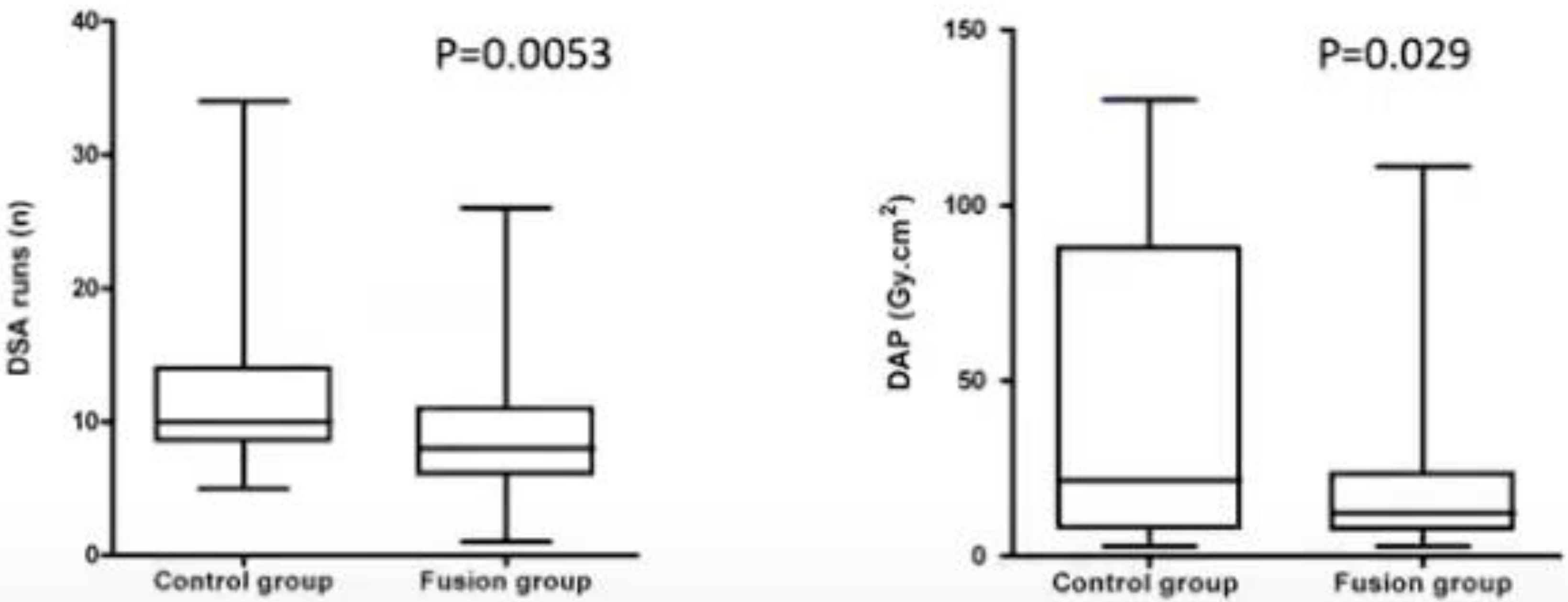
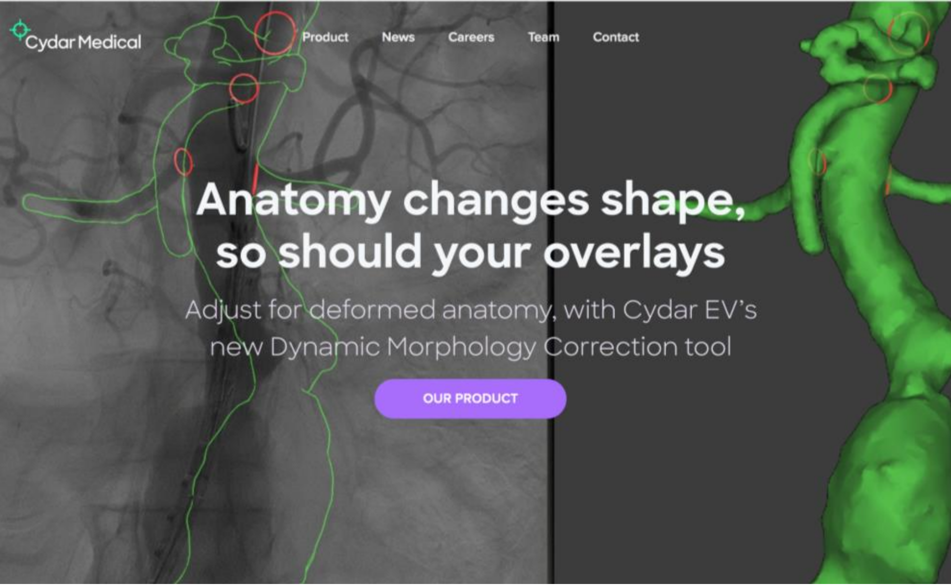
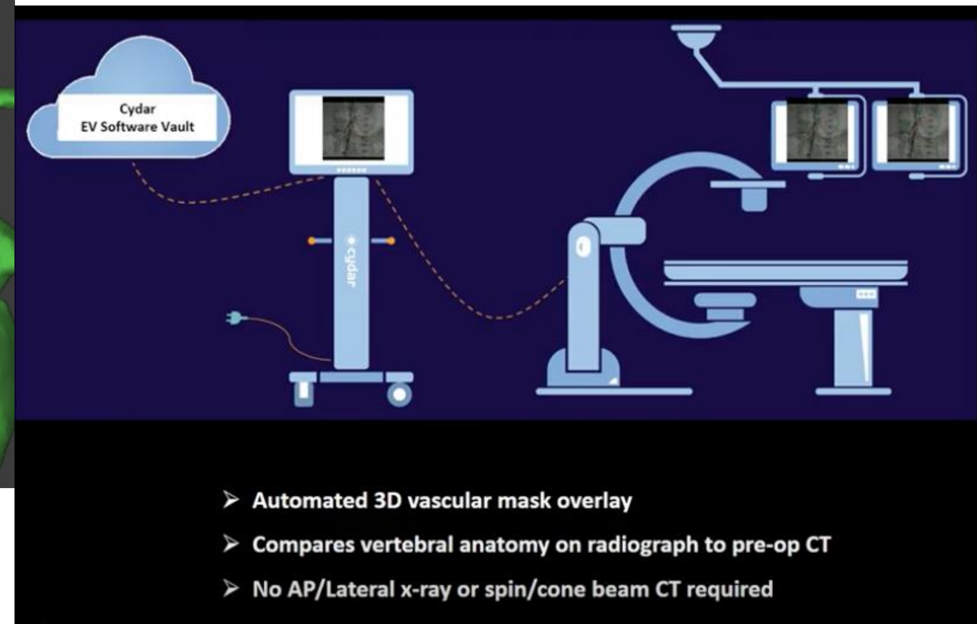
Blandine Maurel, MD, PhD,[a,b] Teresa Martin-Gonzalez, MD, PhD,[a] Debra Chong, MD,[a] Andrew Irwin, MD,[a] Guillaume Guimbretière, MD,[b] Meryl Davis, MD,[a] and Tara M. Mastracci, MD, MSc, FRCSC, FACS, FRCS,[a]
London, United Kingdom, and Nantes, France







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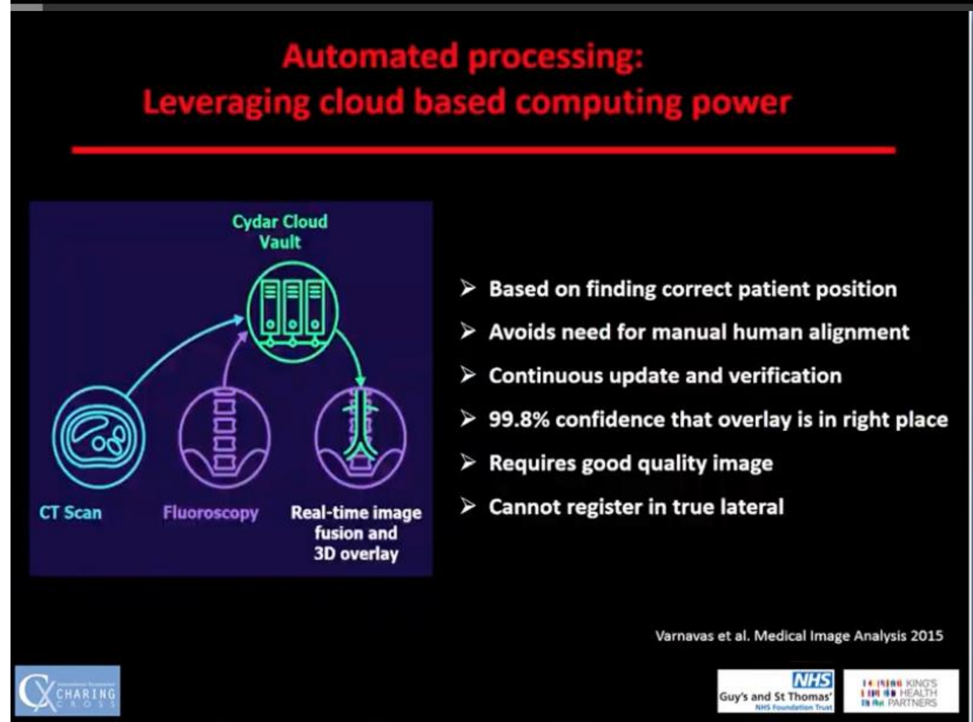
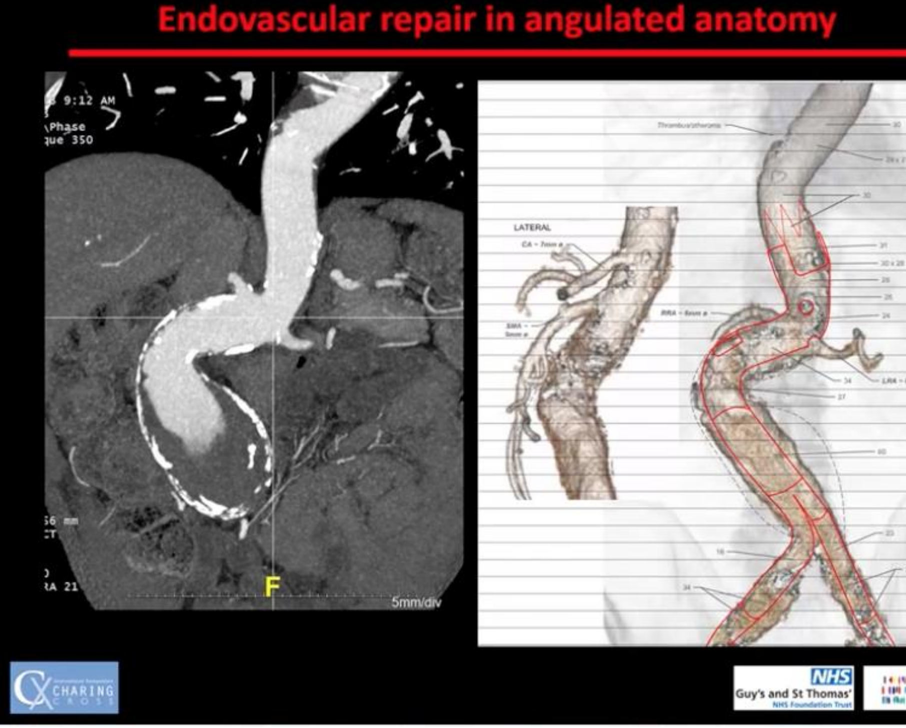
- GPU parallel processing
- Up to 1 Petaflop
- More powerful than most powerful supercomputer in 2012




Endovascular repair in angulated anatomy
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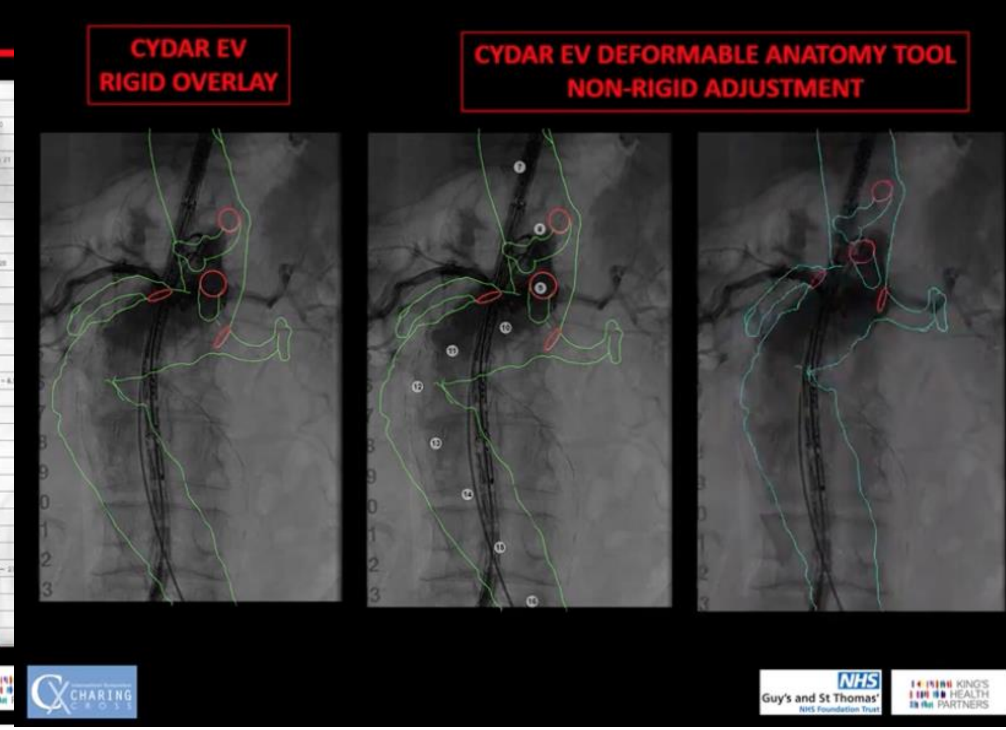
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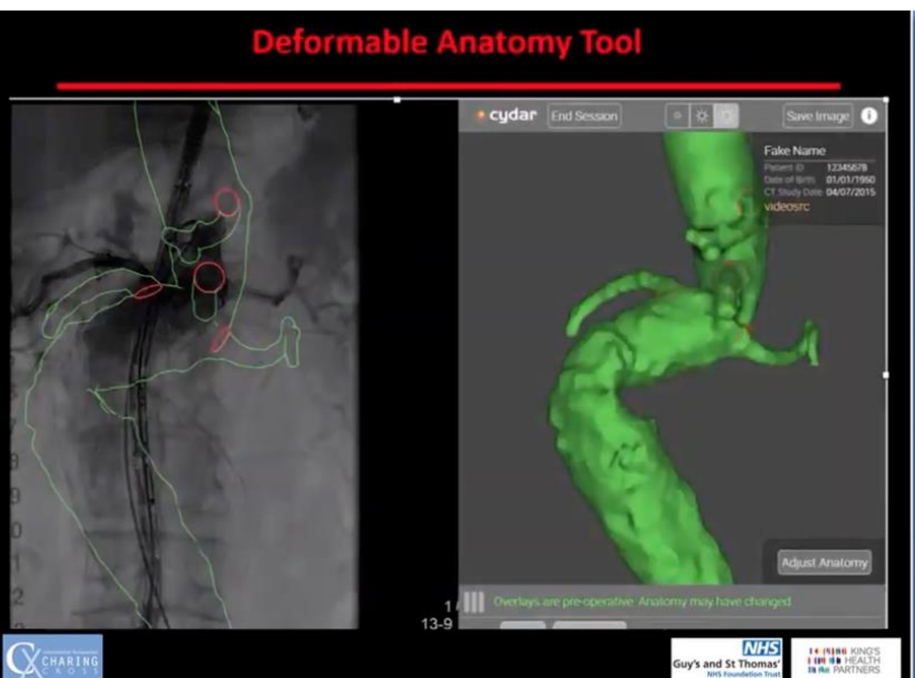
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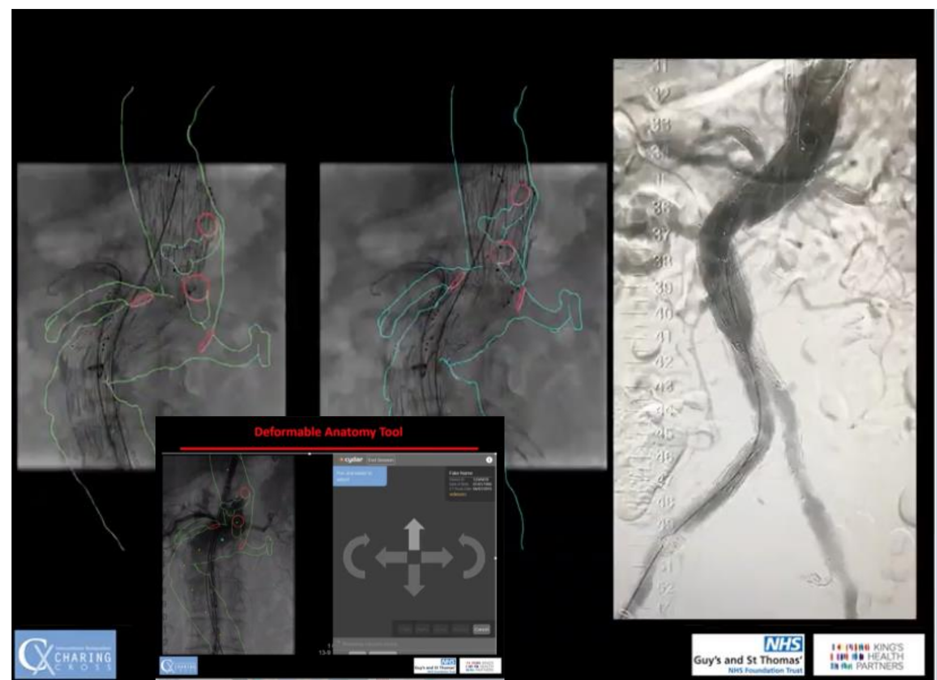
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CONCLUSIONS

• Robust and appropriate standardized operating procedures ("radiation protection culture") have to be in place to prevent unintentional overexposures

•Employees who work with FGIP and patients who undergo these procedures need to be informed on real potential risks and how these risks can be minimized

•The improvement of available resources, by optimizing the angiographic system settings and training in radiation protection the hybrid operating room staff, allowed to significantly reduce the radiation dose, thereby ensuring safer EVAR and peripheral procedures both for patients and staff

•New tools and technologies that can help in reducing the dose and consequently the risks should be introduced in common practice ASAP