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Uw ziekenhuis.

Quality project : Radioprotection in the cathlab

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Background

- Medical radiological examinations are the most important source of radiation exposure for the average person in the Western world

- It is capital that the cardiologist aims for the best image quality at the lowest achievable radiation dose for the patient.

- Radiation in the cath lab can cause health problems for the patient and for the operator and paramedics through deterministic and stochastic effects.

News • Interventional
TCT 2018

Off Script: Opacity, Transparency, and Magic Buttons in the Cath Lab

We are so focused on ‘seeing’ in procedures, we sometimes fail to fully understand the implications of delivering ionizing radiation on this scale.

By Kwan S. Lee

September 24, 2018

2018 ACC/HRS/NASCI/SCAI/SCCT Expert Consensus Document on Optimal Use of Ionizing Radiation in Cardiovascular Imaging: Best Practices for Safety and Efficacy

PTCA procedures

10 0000 ?!

boek 1	10
Boek 2	425
Boek 3	337
Boek 4	435
Boek 5	364
boek 6	413
Boek 7	470
Boek 8	544
2003	419
2004	430
2005	413
2006	418
2007	330
2008	298
2009	245
2010	313
2011	270
2012	268
2013	286
2014	355
2015	334
2016	328
2017	310
2018	291

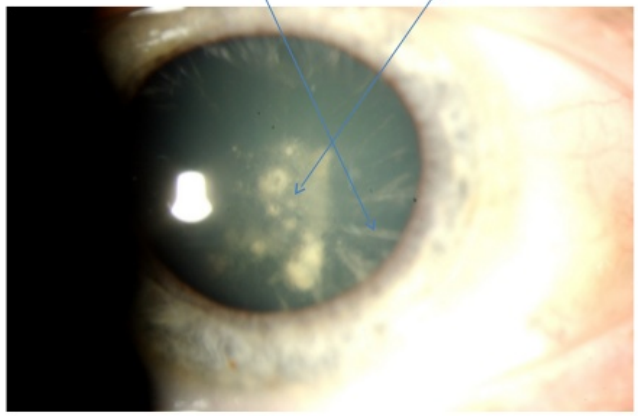
UZL-1991

Cataract

- = opacification of the lens
- Often associated with visual impairment
- Three main categories: nuclear, cortical, and posterior subcapsular

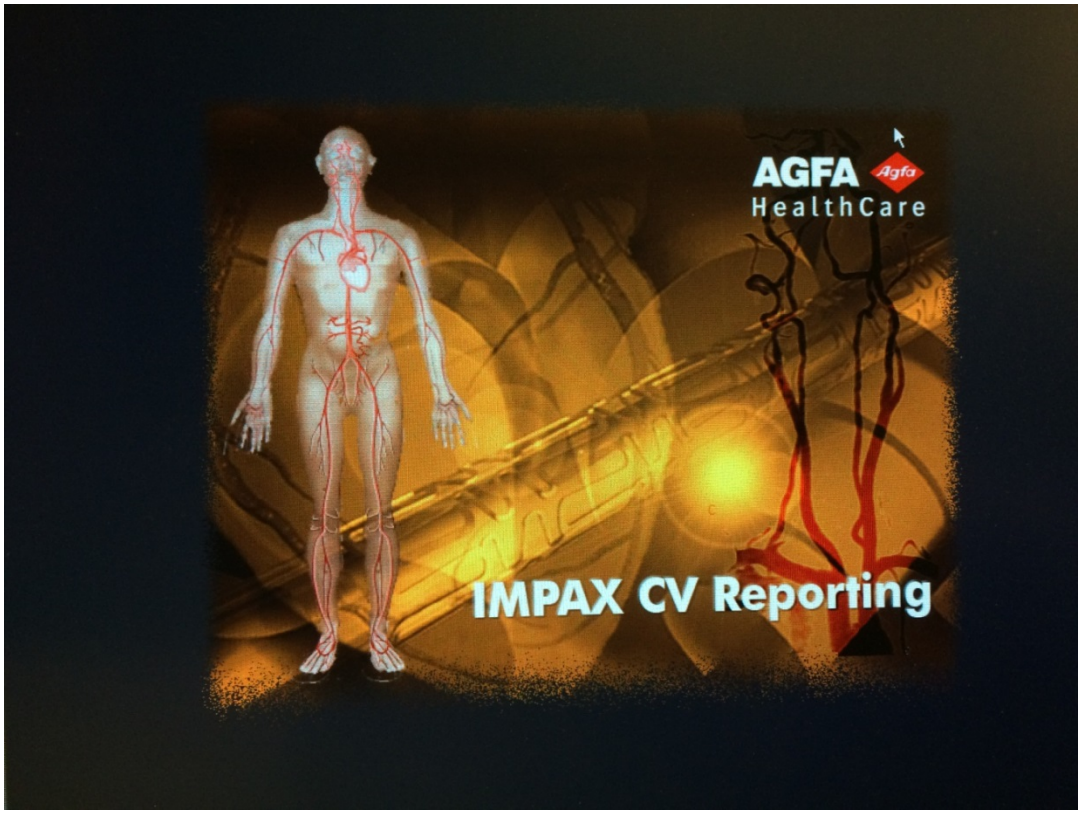
- Posterior subcapsular is the least common but most frequently associated with ionizing radiation exposure
- Because of their location along the lens' visual axis, relatively minor posterior subcapsular cataracts can have great impact on vision

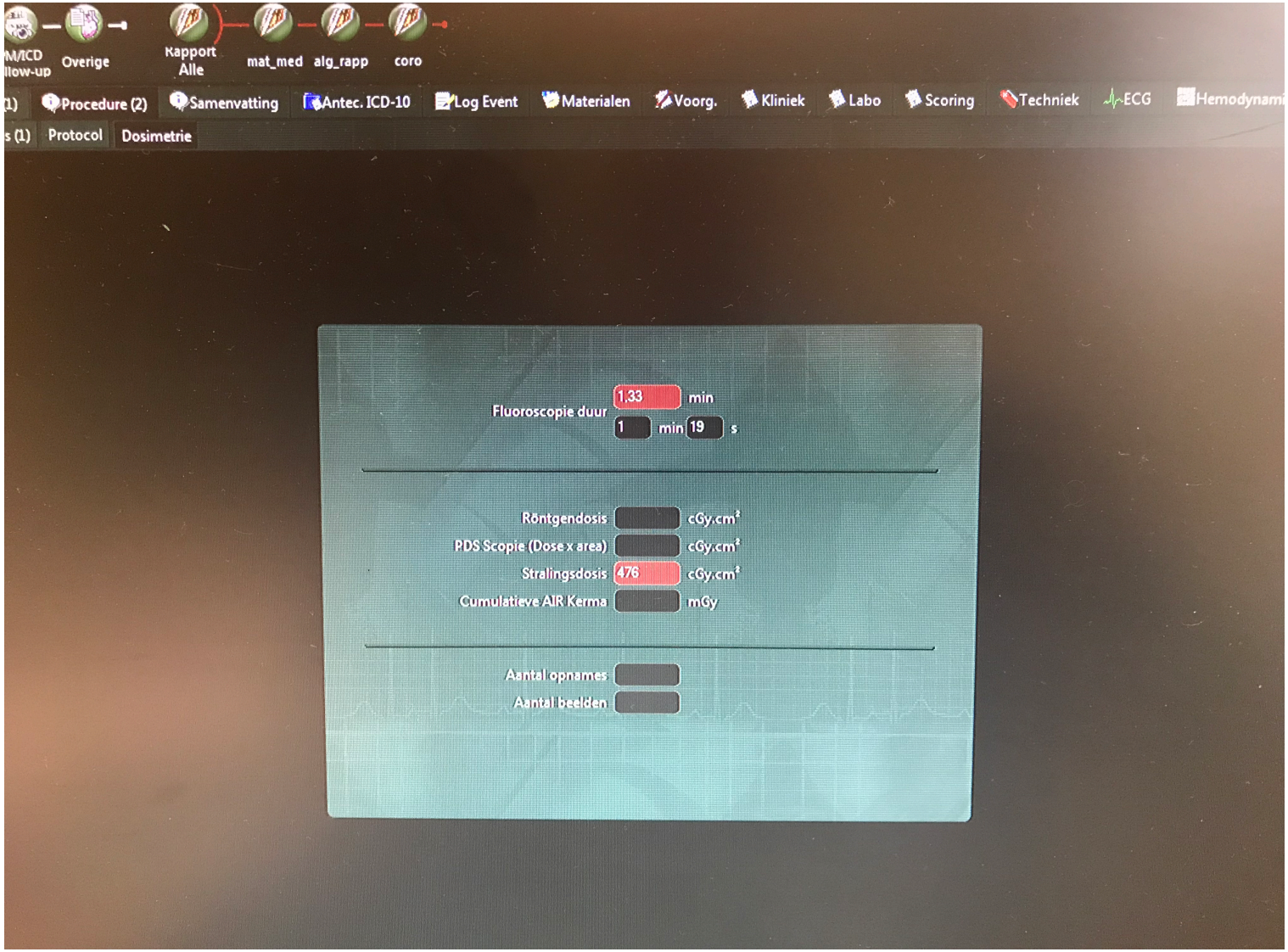
Cortical cataract and Posterior subcapsular cataract

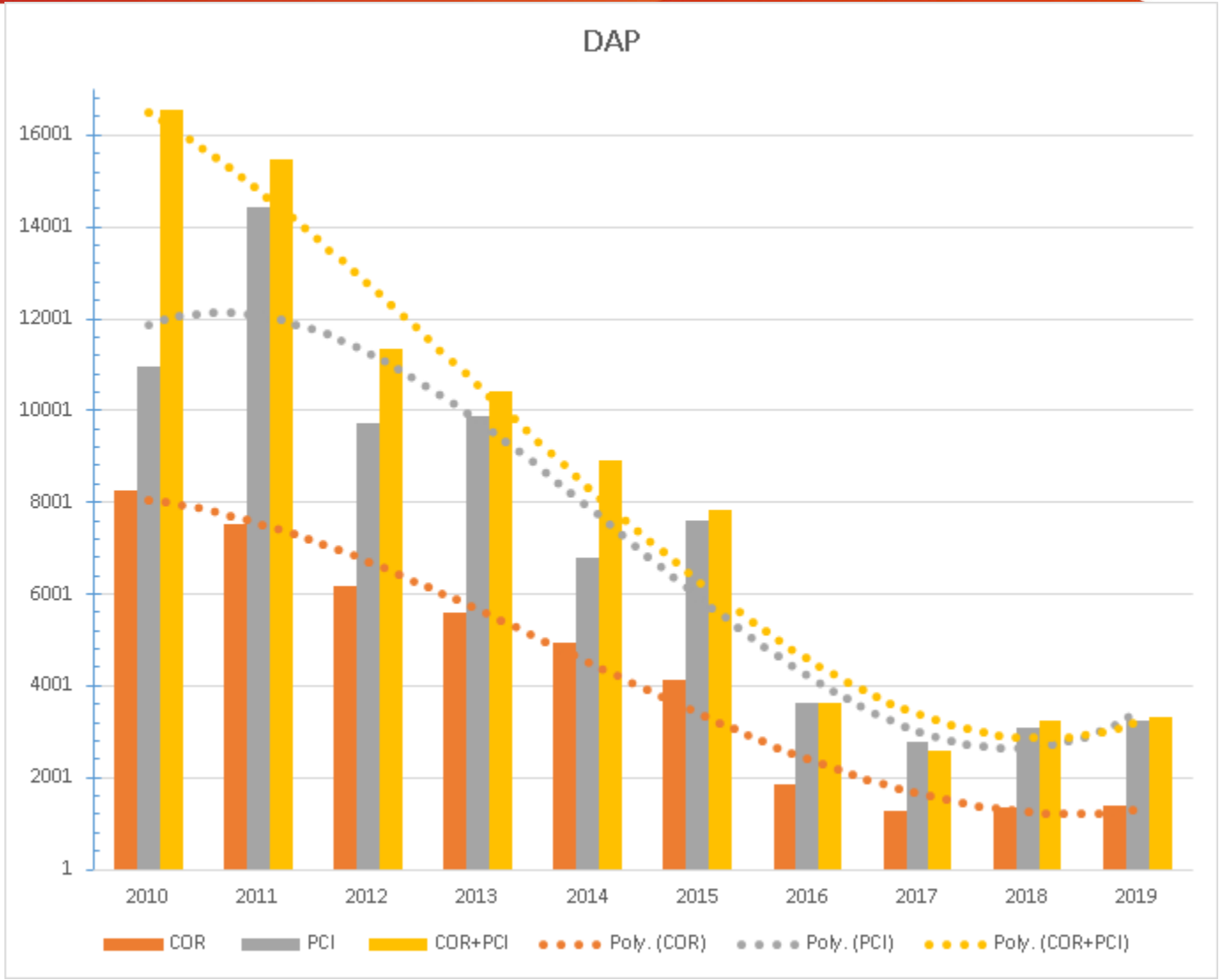


Belcolore

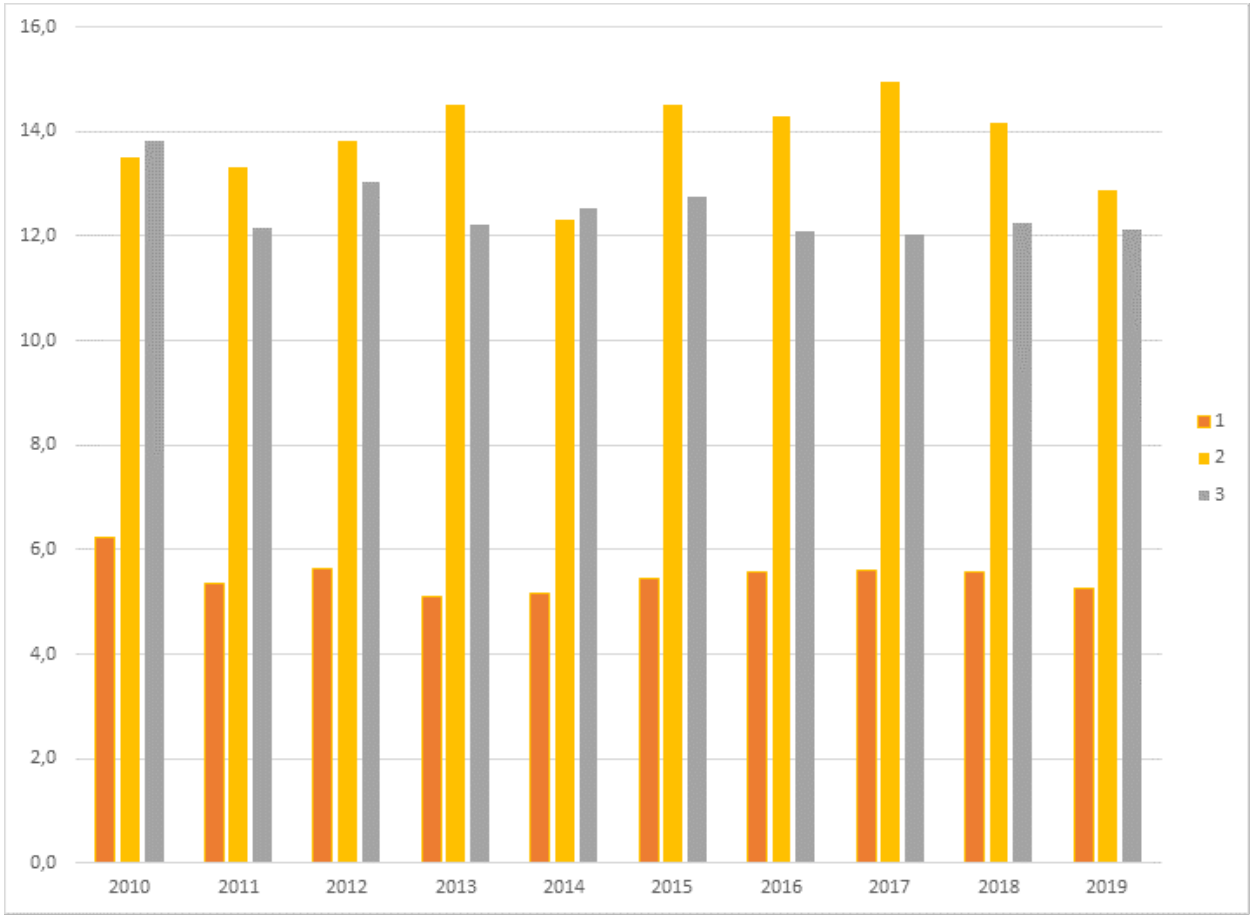
Belgian cohort of Interventional Cardiologists on radiation induced lens opacities and retrospective eye lens dosimetry


AGFA
HealthCare
IMPAX CV Reporting

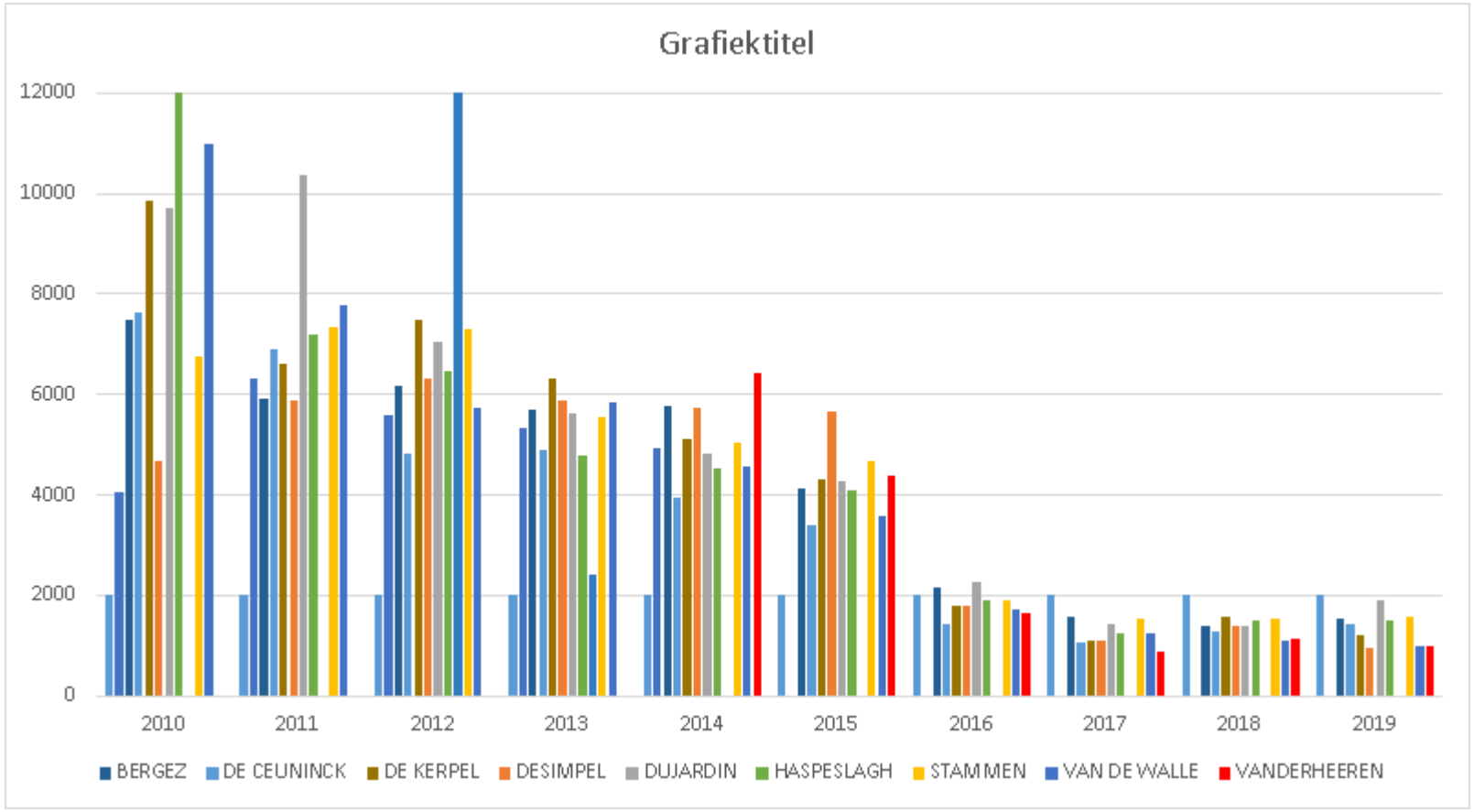

M/ICD
llow-up
Overige
Rapport
Alle
mat_med
alg_rapp
coro
(1)
Procedure (2)
Samenvatting
Antec. ICD-10
Log Event
Materialen
Voorg.
Kliniek
Labo
Scoring
Techniek
ECG
Hemodynami
s (1)
Protocol
Dosimetrie
Fluoroscopie duur
1,33
min
1
min
19
s
Röntgendosis
cGy.cm²
PDS Scopie (Dose x area)
cGy.cm²
Stralingsdosis
476
cGy.cm²
Cumulatieve AIR Kerma
mGy
Aantal opnames
Aantal beelden


DAP
16001
14001
12001
10001
8001
6001
4001
2001
1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
COR
PCI
COR+PCI
Poly. (COR)
Poly. (PCI)
Poly. (COR+PCI)

FLUOROSCOPY DURATION



1= coronaro
2= cor + PCI
3= PCI


Grafiektitel
12000
10000
8000
6000
4000
2000
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2010
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2012
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2016
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BERGEZ
DE CEUNINCK
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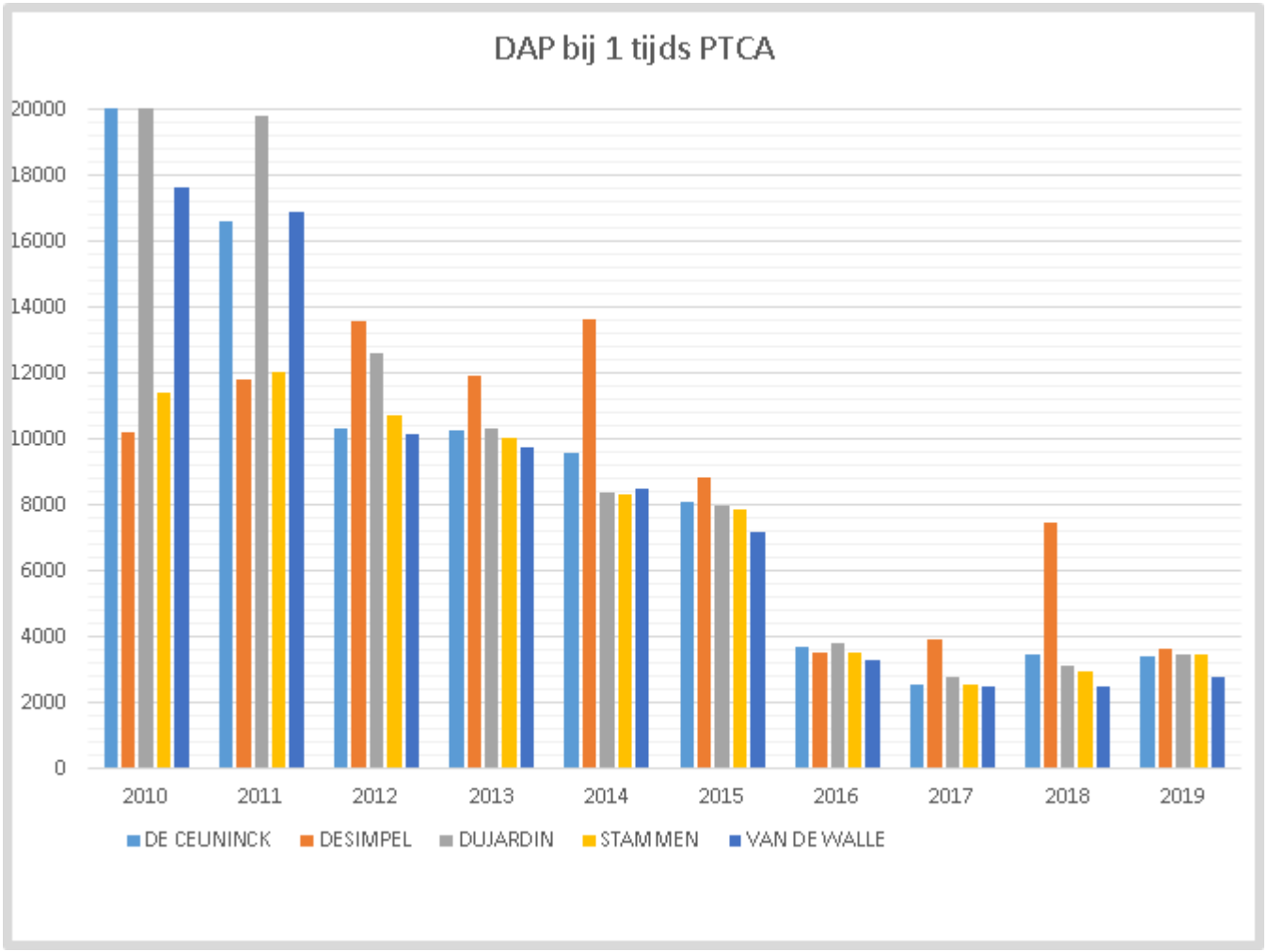
DESIMPEL
DUJARDIN
HASPESLAGH
STAMMEN
VAN DE WALLE
VANDERHEEREN


DAP bij 1 tijds PTCA
20000
18000
16000
14000
12000
10000
8000
6000
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2000
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2010
2011
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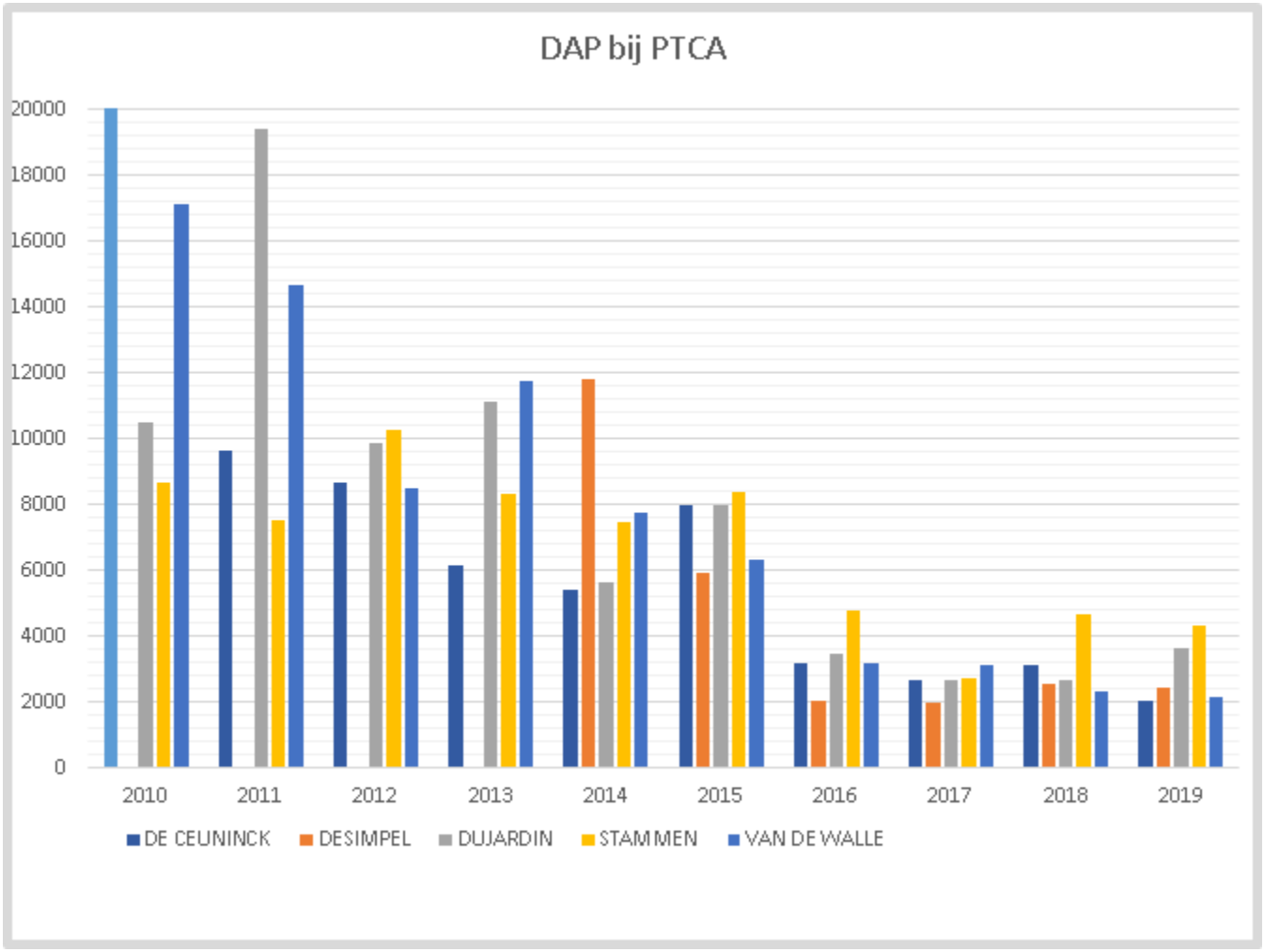
DE CEUNINCK
DESIMPEL
DUJARDIN
STAMMEN
VAN DE WALLE


DAP bij PTCA
20000
18000
16000
14000
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10000
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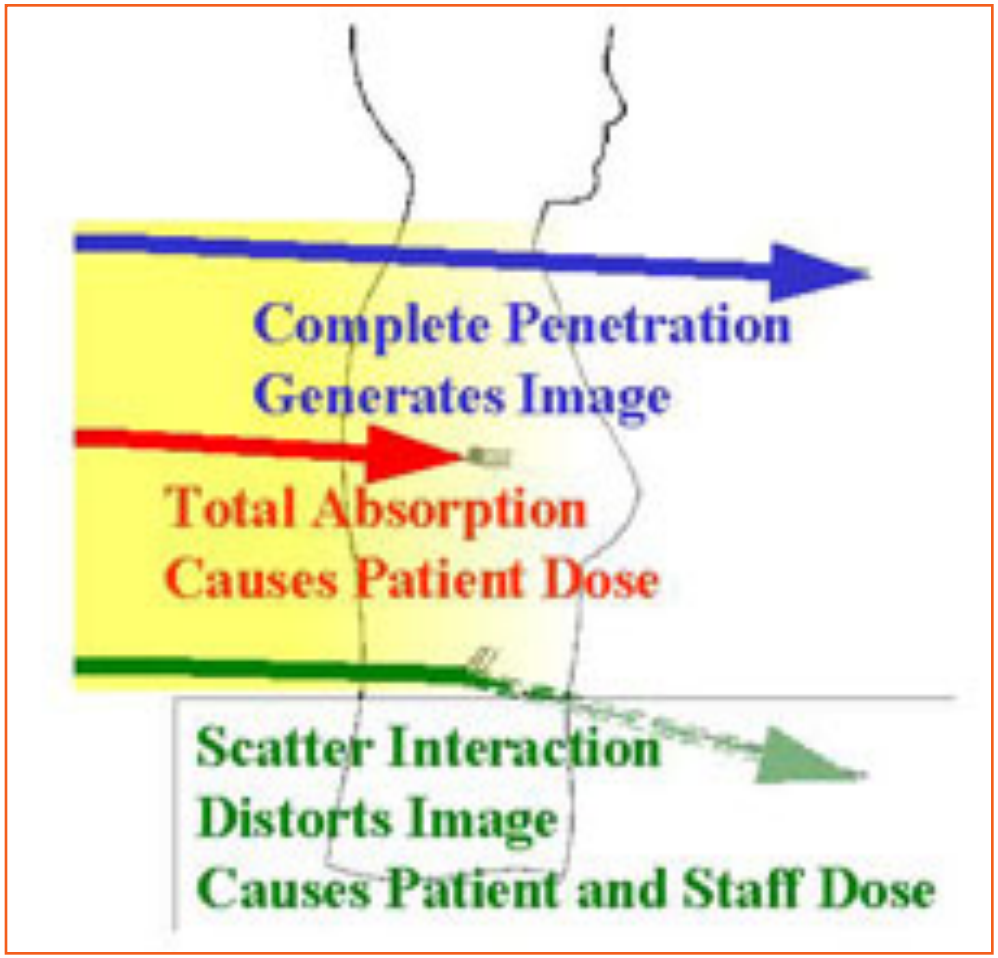
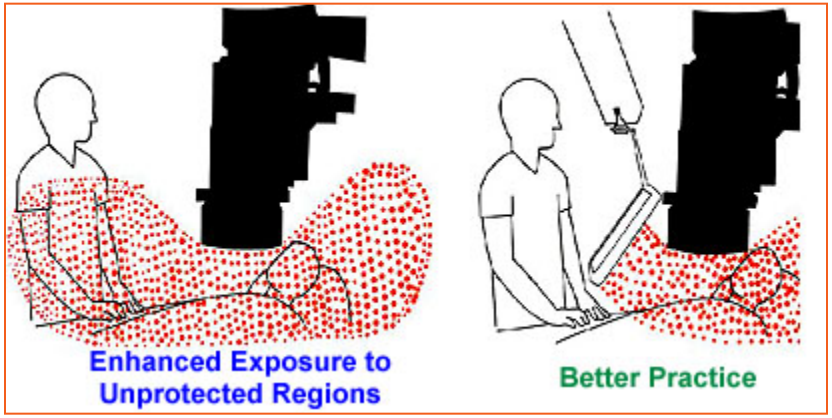
DESIMPEL
DUJARDIN
STAMMEN
VAN DE WALLE


Complete Penetration
Generates Image
Total Absorption
Causes Patient Dose
Scatter Interaction
Distorts Image
Causes Patient and Staff Dose

Reducing Radiation Exposure

- *Reduce Use Time*
- *Increase Operator Distance*
- *Minimize air gap between image receptor and patient*
- *Minimize Use of Magnification*
- *Minimize Use of Grid*
- *Collimate Primary Beam*
- *Use Alternate Projections*
- *Optimize X-ray Tube Voltage*
- *Use Radiation Shields*
- *Use Protective Equipment*



Quality project AZ Delta

1. The literature describes a radiation dose reduction up to 90% by the standard radioprotective measures. Most of these are already operative in our cath lab AZ Delta. Is a supplementary education in radioprotective measures for all cath lab operators and employees combined with adaptations in the standard hardware settings effective to give an additional radiation exposure reduction for patients and operators?

2. Are the current thermoluminescent dosimeters sensitive enough for the detection of a very low radiation exposure? Even a very low radiation exposure frequently received mounts up to a significant lifetime radiation exposure.

3. Does the use of a protective apron on the patient (‘pelvic shield’) lead to a significant radiation load reduction for the operator? Has this any effect on the patient’s radiation load?

Method

Study population

- 1353 examinations over a period of 24 weeks
- The radiation load for the patient is measured by the dose area product : DAP
  * = the multiplication of the absorbed dose and the radiated surface.
  * expressed in Gray.cm2.
  * reflects the radiation load for a determined BSA
- The radiation load data for the operators
  * 7 cardiologists and 16 nurses
  * These data are expressed in milliSievert (mSv).

SCK·CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE
http://www.dosimetrie.be

azdelta

Measurements

All DAP radiation measurement is derived from Quaelum Philips (Philips Allura Xper with Clarity software, Philips, Amsterdam, Netherlands).

The two dosimeters

- are both thermoluminescent detectors
- are delivered by and read out by the Belgian Study Center for Nuclear Energy (SCK-CEN).
- minimal detectable dose is 50 µSv.
- detect beta, gamma, and X-rays.
- They have three detectors: one for surface measurement (Hp 0.07), one for more deep measurement (Hp 10), and one for back-up.
- They measure 4.2 cm in diameter, the thickness is 10mm and the weight is 15 g.
- The price is 84.32 Euro per year.

Measurements

The Tracerco dosimeter (Tracerco, Billingham, UK)

- is more sensitive.
- detects radiation exposure below 1 uSv.
- exposure can be read out directly on the screen.
- The operator will be warned by an audio alarm during the procedure when a programmed threshold is exceeded.
- The price is 730 Euro.

Hardware configuration / timeline

- 15 fr/sec
- RCA 2 / LCA 6

- 7,5 fr/sec
- RCA 2 / LCA 4
- Default settings : lowest scopy/graphy
- Maximal use of lead protection shields

- Lead apron upon the patient

Period 1
8 weeks

Period 2
8 weeks

Period 3
8 weeks

Nov 2016

May 2017

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Data collection

1. Patient measurements:

a. The DAP radiation measurements are obtained for all patients that underwent a left heart cardiac catheterisation/coronarography/PCI

b. For period 2 and 3, a dosimeter is positioned at 20 cm above the centre point between the two knees of the patient. This dosimeter measures the radiation load of the patient. In period 3, this dosimeter is covered by the lead pelvic apron upon the patient.

2. Operator measurements:

a. The dosimeter measurements under and above the lead apron

b. One operator wears an additional Tracerco dosimeter beneath his apron. (for comparison with the thermoluminescent dosimeter)

Measurements : Examination distribution

The 1353 cath lab examinations are equally distributed between the three periods

Table 1. Procedure type. Distribution per period (%).

Type procedure	Period 1 ($n = 487$)	Period 2 ($n = 492$)	Period 3 ($n = 374$)	Total
Coronarography	59.8	58.1	60.4	59.4
Coronarography + PCI	30.4	30.7	28.1	29.9
Right heart catheterisation and coronarography	4.1	4.1	5.4	4.4
Elective PCI	5.3	5.9	5.6	5.6
Other	0.4	1.2	0.5	0.7

$Chi^2 = 4.33$, p value $= .826$.

Measurements : 1. Radiation exposure for the patient

	Period 1 ($n = 487$)	Period 2 ($n = 492$)	Period 3 ($n = 374$)	p
DAP				
Geometric mean ± SD	176.0 ± 2.2	111.4 ± 2.4	112.3 ± 2.5	<.001
% Reduction vs. period 1	–	−37%	−36%	–
Fluoroscopy time				
Geometric Mean ± SD	376.4 ± 2.3	343.6 ± 2.3	333.4 ± 2.4	.082
% Reduction vs. period 1	–	−9.0%	−11%	–
Dosimetry (mSv)*	–	9.02	10.76	NS

*Cumulated patient dose over 8 weeks, as measured by the thermoluminescent dosimeter (period 2 without pelvic shield and period 3 with pelvic shield).

- The average DAP per procedure decreases significantly between period 1 and 2, 3
- There is no significant change in average fluoro time (scopy and graphy) over the three periods.
- The mean radiation exposure measured by the thermoluminescent dosimeter (above the knees) does increase by 9% from period 2 to 3.

Measurements : 2. Radiation exposure for the operator

Table 4. Comparison radiation exposure 1st vs. 2nd operator.

Dosimeter above apron				
Non-parametric test	Median 1st	0.680	0.720	0.640
–	Median 2nd	0.275	0.260	0.130
–	Difference	0.405	0.460	0.510 ←
–	*p* value (K Wallis)	.004	.006	.036
Dosimeter under apron				
Non-parametric test	Median 1st	0.165	0.110	0.060
–	Median 2nd	0	0	0
–	Difference	0.165	0.110	0.060 ←
–	*p* value (K Wallis)	.023	.010	.010

- The radiation dose for cardiologists (1st operator) is significantly higher than for nurses (2nd operator)
- Both the radiation measured above and under the lead apron is significantly higher for cardiologists.

Measurements : 2. Cardiologist radiation exposure

	Unit	Period 1	Period 2	Period 3	*p*
Above the apron*	mSv, Hp (3)	1.61	1.43	0.76	.008
	%	–	−11	−53	–
Compared to DAP	%	–	+29	−37	–
Under the apron**	mSv, Hp (0.07)	0.147	0.117	0.073	.008
	%	–	−20	−50	–
Compared to DAP	%	–	+16	−34	–

*Cumulated dose over 8 weeks, as measured by the thermoluminescent dosimeter worn above the apron (at the level of the left thyroid region).
**Cumulated dose over 8 weeks, as measured by the thermoluminescent dosimeter worn under the apron (at the level of the left nipple).

- The cardiologist radiation dose measured above/under the apron (unprotected) decreases significantly over the three periods.
- The measured radiation dose, compared to the DAP (relative radiation dose), is the highest for period 2 (129%) and the lowest for period 3 (63%).

Measurements : 2. Cardiologist radiation exposure

Table 6. Comparison thermoluminescent dosimeter and Tracerco dosimeter, both worn under the apron.

Dosimeter	Unit	Period 1	Period 2	Period 3
Thermoluminescent	mSv	0	0	0
Tracerco	µSv	121.3	62.4	40
	%	–	−49	−67
Tracerco: calculated one year exposure	mSv	0.786	0.405	0.260

- There is a clear difference between the measurement of the Tracerco dosimeter and of the thermoluminescent dosimeter, both worn under the apron.
- The Tracerco dosimeter is much more sensitive than the thermoluminescent dosimeter.

Measurements : 3. Nurse radiation exposure

The results are similar to these from the cardiologist

- The radiation dose measured above the apron decreases significantly over the three consecutive periods : -29% for period 2 (p 0.11) and - 62% for period 3 (p 0.017).

- The radiation dose measured under the apron is barely measurable over the three periods, respectively : 0.00467, 0.00667, and 0.00333 mSv. The measured differences are non-significant.

Key messages

- Educational lectures for sensitisation of all operators, combined with structural measures, leads to a significant reduction in radiation dose of 37% for the patient.
- This goes together with a reduction in radiation exposure at the (un)protected area of the body for both the first and the second operator between 10 and 30%

- The dose reduction for the first and second operator by the **pelvic shield** is spectacular: the dose reduction for the cardiologist and for the nurse is >50%.

Key messages

The measured radiation dose is very different between the cardiologists :

The unprotected dosimeter during <u>period 1</u> measures a dose of **3.31 mSv** for one cardiologist and **0.55 mSv** for another (with similar cumulative DAP and the fluoro time)

=resp. calculated yearly load of ***20 mSv*** and ***6.5 mSv***

Lead protection shields !

<u>Period 3</u> : resp. **0.87 mSv** (yearly dose ***5.2 mSv***) and **0.41 mSv** (yearly dose ***2.4 mSv***).


RAYONS X

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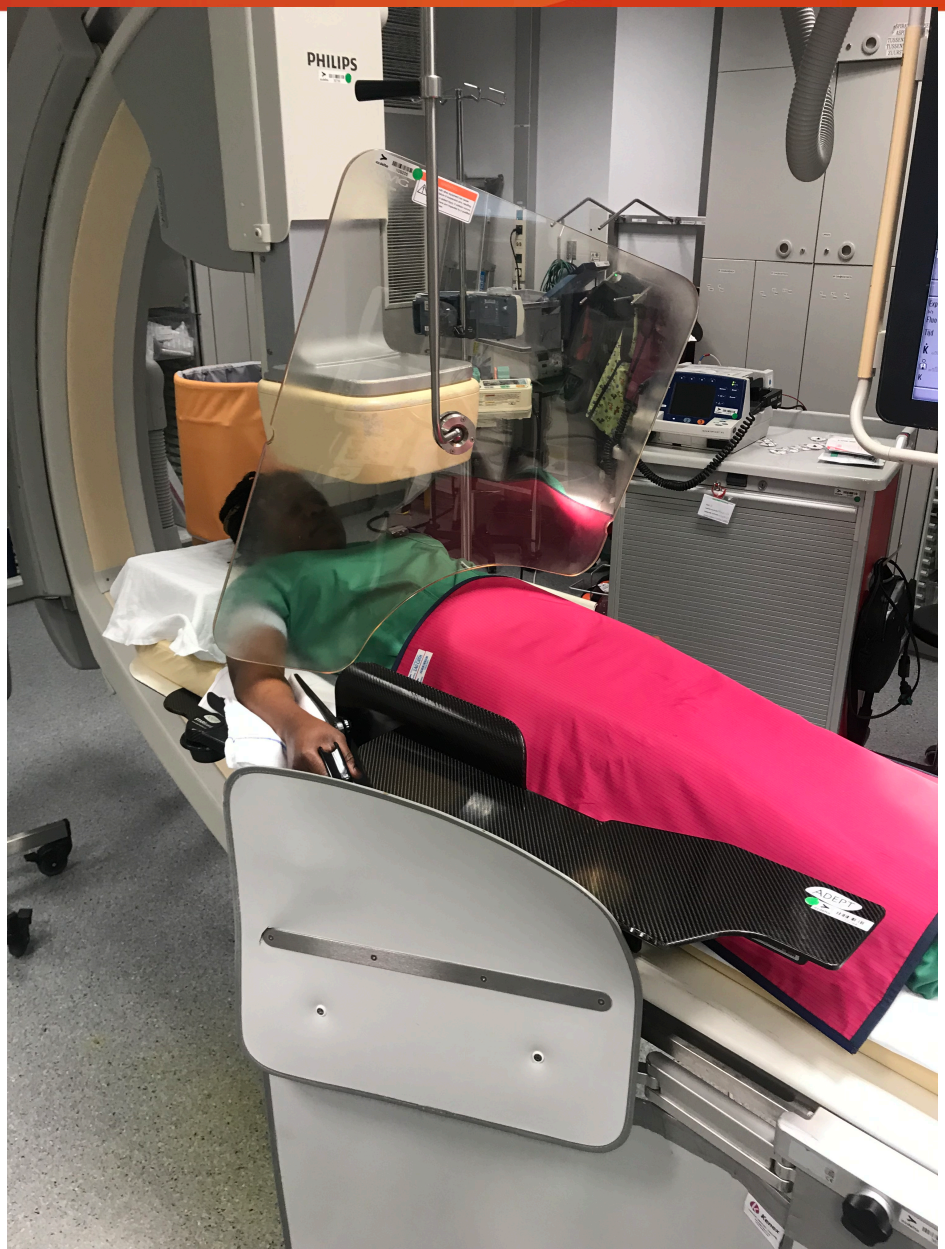
TERUMO

New Zealand company Adept Medical to make the revolutionary STARSystem for radial access


PHILIPS

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