Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

ARPANSA's Response to the ICRP's Dose to the Eye Recommendation

Blake Orr

Australian Radiation Protection and Nuclear Safety Agency (APRANSA)

ARPANSA History

- ARPANS Act of 1998
- ARPANSA was formed in 1999
- *Combination of 2 agencies:*
  - *Nuclear Safety Bureau (Sydney)*
  - *Australian Radiation Laboratory (Melbourne)*
- Federal Government Agency
- Currently approx. 130 employees
  - Melbourne ~105
  - Sydney ~25

ARPANSA

- Our Mission
  - *To assure the protection of people and the environment from the harmful effects of radiation*
- Achieved by
  - Regulator of Commonwealth use of radioactive material
  - Maintenance of National Radiation Standards
  - Harmonisation across states and territories

Australian Regulatory System

- Australia is a Commonwealth made up of six States and two Territories
- Each of the nine jurisdictions (State, Territory & Commonwealth) are responsible for their own radiation regulation and compliance
- ARPANSA regulates radiation protection and nuclear safety for Commonwealth entities

Advisory Bodies

- The ARPANS Act establishes several bodies that advise the CEO of ARPANSA. These bodies include the Radiation Health and Safety Advisory Council, the Radiation Health Committee and the Nuclear Safety Committee. The ARPANS Act also specifies the categories of membership for the Council and Committees.
- ARPANSA Codes and Guides are published through the Radiation Health Committee (RHC). With the aim of national uniformity and harmonsation.
- https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications

International best practice

- ARPANSA looks to implement international best practice in radiation protection. In particular in considering codes, standards, recommendations and guides by international organisations, namely:
  - UNSCEAR
  - IAEA
  - ICRP
  - ICNIRP
  - WHO
  - NEA
- https://www.arpansa.gov.au/regulation-and-licensing/regulation/international-best-practice

ICRP statement

- April 2011 - Lens of the eye
  - Threshold now considered to be 0.5 Gy
  - For occupational exposure, in planned exposure situations, recommended:
    - Equivalent dose limit of 20 mSv in a year
    - Averaged over 5 year periods, with
    - No single year exceeding 50 mSv
- Included in ICRP 118 (2012)

RHC statement


RHC statements

From time to time, the Radiation Health Committee issues statements that provide details on the Committee's position on a range of topics relating to radiation health.

Statements prepared by the Radiation Health Committee.

- Statement on eye dose (2011)
  - *The RHC recommends that relevant radiation users, such as interventional radiologists and cardiologists, should be aware of the changed occupational dose limit for the lens of the eye and that it will be included in the revision of RPS 1 and will in time become mandatory.*
  - *The Radiation Health Committee recommends that where practicable, radiation users commence implementing the new dose value as soon as possible. The RHC would also appreciate being informed of implementation issues with a significant economic or other impact.*
- https://www.arpansa.gov.au/sites/g/files/net3086/f/rhc-statement-occupational-dose-limit-for-eye.pdf

Formalisation of limits (ARPANSA)

- The new dose limits were formalised in 2016
  - Code for Radiation Protection in Planned Exposure Situations RPS C-1 (ARPANSA Code)
  - Codes are mandatory for commonwealth licensees
  - Input from other jurisdictions through RHC
  - Supersedes other guides/codes with old dose limits
  - https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rpsc-1

The occupational dose limits for ionising radiation are as follows:

Type of limit	Limit[1]
Effective dose	20 mSv per year, averaged over a period of five consecutive years[2]
Annual **equivalent dose** to:	
the lens of the eye	20 mSv per year, averaged over a period of five consecutive years[3]
the skin[4]	500 mSv
the hands and feet	500 mSv

Other jurisdictions

Jurisdiction	Occupational Limit	Link
Victoria	20 mSv per year, averaged over 5 years. The dose in a single year is not to exceed 50 mSv.	https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/eye-dose-limit-for-workers
New South Wales	20 mSv per year averaged over a period of 5 consecutive calendar years[4, 5, 6]	https://www.epa.nsw.gov.au/your-environment/radiation/management-licence/info-radiation-management/monitoring/pmd-monitoring
Australian Capital Territory (ACT)	20 mSv per year, averaged over 5 years. The dose in a single year is not to exceed 50 mSv.	Adopted ARPANSA Codes in legislation
Queensland	the equivalent dose for each lens of the person's eyes must not be more than 150mSv per year	https://www.legislation.qld.gov.au/view/whole/html/inforce/current/sl-2010-0240
Western Australia	Dose limit not specifically mentioned	http://www.radiologicalcouncil.wa.gov.au/Pages/prms.html
Tasmania	an average of 20 millisieverts per year over a 5-year period; or (ii) 50 millisieverts in any one year;	https://www.legislation.tas.gov.au/view/html/inforce/2017-01-01/sr-2016-032
South Australia	150 millisievert in the lens of the eye in a calendar year	https://www.legislation.sa.gov.au/LZ/C/R/RADIATION%20PROTECTION%20AND%20CONTROL%20%28IONISING%20RADIATION%29%20REGULATIONS%202015.aspx
Northern Territory	20 mSv per year, averaged over 5 years. The dose in a single year is not to exceed 50 mSv.	Adopted ARPANSA Codes in legislation

ARPANSA Guidance advice

- Available on the ARPANSA web-site
- Guidance - Improving eye safety in Image Guided Interventional Procedures (IGIP)
  - Reason for dose limit change
  - Recommendations
    - Increased training
    - Use of dosimeters, double dosimetry, real-time dosimeters
    - PPE such as glasses, shielding
    - National Dose register should include eye dose
- https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/eye-safety-image-guided-interventional-procedures

Eye dose programs

- At ARPANSA
  - ARPANSA personal monitoring service is currently investigating different badge types to measure Hp(3).
- Commonwealth licensees
  - ANSTO only commonwealth agency reporting eye dose
  - ANSTO have their own dosimetry service. Filter on dosimeter to calculate Hp(3). Doses generally inferred from torso badge, but are also worn close to the eye .
  - More work to be done in the future
- State jurisdictions
  - Tasmania recently undertook some informal studies to observe the use of PPE for interventional radiography and cardiac procedures. Shielding a PPE not always used.
  - Tasmanian regulator is purchasing a number of dosimeters for Hp(3).
  - In early 2019, they will undertake a study of eye doses, in particular for interventional radiologists.
  - In 2016, ACT published a study on eye doses during various procedures.

ACT Study

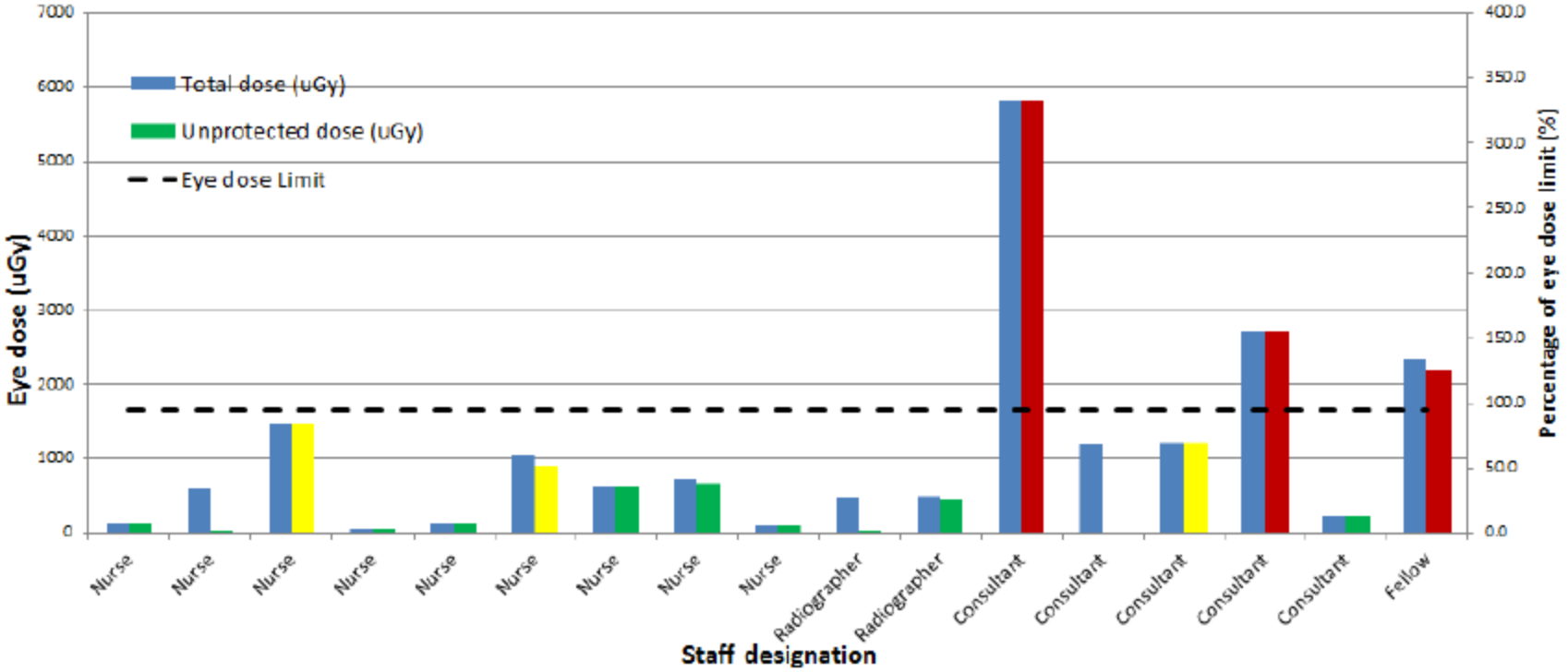
- ‘Eye dose to staff involved in interventional and procedural fluoroscopy’ - McLean *et al* 2016 *J. Phys.: Conf. Ser.* **694** 012054
- Used TLD badges designed for Hp(3)

Clinical situation	No. staff involved	procedures
Cardiac laboratory	17	192
Angiography Suite	18	93
ERCP procedures	14	34

-

	Cardiology		Angiography		ERCP	
	medical	nurse	medical	nurse	medical	nurse
minimum	0.68	0.49	2.40	0.65	0.21	0.17
1st quartile	1.41	0.78	12.16	1.13	0.30	0.18
median	1.54	1.32	18.05	6.06	0.37	0.21
3rd quartile	4.45	2.59	**26.55**	7.39	1.00	0.35
maximum	9.64	3.09	**59.01**	14.88	2.77	0.46

ACT Study


Total dose (uGy)
Unprotected dose (uGy)
Eye dose Limit
Eye dose (uGy)
Percentage of eye dose limit (%)
7000
6000
5000
4000
3000
2000
1000
0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Nurse
Nurse
Nurse
Nurse
Nurse
Nurse
Nurse
Nurse
Nurse
Radiographer
Radiographer
Consultant
Consultant
Consultant
Consultant
Consultant
Fellow
Staff designation

ACT Study

- Main findings/conclusions
  - Before audits, the use of protective glasses and shielding screens was not thought of as a high priority.
  - After audits the use of shielding increased
  - Changes to procedural techniques to reduce eye doses
  - Nursing staff can also have reasonably high eye doses, and need to be considered in eye dose reporting

Modelling eye dose using VARSKIN

- ARPANSA asked to model a Mo-99 and F-18 to a potential spill on the eye, and compare to skin dose
- Thanks to David for some useful advice on settings
- Table below, 70um (Skin) dose, F-18, dose area 1cm^2

Source description	Source type	Source area	Electron (per Bq) mGy/h	Photon (per Bq) mGy/h	Skin dose rate conversion factor ((mGy/h)/(kBq/cm^2))
Droplet (50 uL) Spread over area 1 cm^2 with height 0.5 mm	Cylinder (droplet)	1 cm^2	7.3E-4	1.9E-5	0.75
Entire vial 1.27 mL spread over height 0.5 mm. (Area 25.4 cm^2)	Cylinder (droplet)	25.4 cm^2	3.07E-5	1.18E-6	0.8
Infinitely thin Spread over area 1 cm^2	Disk (infinite)	1 cm^2	1.51E-3	1.95E-5	1.5
Infinitely thin Spread over area 10 cm^2	Disk (infinite)	10 cm^2	1.56E-4	2.66E-6	1.6
Entire vial 1.27 mL Infinitely thin (Area 25.4 cm^2)	Disk (infinite)	25.4 cm^2	6.15E-5	1.1E-6	1.6

Modelling eye dose using VARSKIN

- Table below shows infinitely thin disk source spread over area 10 cm2, comparing F-18 and Mo-99. Doses are calculated over an area of 1 cm^2

Depth (µm)	F-18		Mo-99	
	Electron (per Bq) mGy/h	Photon (per Bq) mGy/h	Electron (per Bq) mGy/h	Photon (per Bq) mGy/h
70 (skin)	1.6E-4	2.7E-6	1.5E-4	4.0E-7
140	1.1E-4	2.9E-6	1.2E-4	4.1E-7
220	8.4E-5	2.9E-6	9.3E-5	4.1E-7
370	5.1E-5	2.9E-6	6.9E-5	4.1E-7
750	1.4E-5	2.6E-6	3.8E-5	3.8E-7
1500	4.9E-7	2.2E-6	1.4E-5	3.2E-7
3000 (eye)	<1E-8	1.6E-6	9.6E-7	2.4E-7

- VARSKIN predicts dose to the eye is much smaller than dose to the skin.
- Much less penetration from electrons at 3mm.

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

THANK YOU

CONTACT ARPANSA

Email: blake.orr@arpansa.gov.au
Website: www.arpansa.gov.au
Telephone: +61 3 9433 2211
Freecall 1800 022 333
General Fax: +61 3 9432 1835