

Bismuth Shielding – To Use or Not To Use?

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CT Doses

- From our data the approximate Median Effective Doses are:

Brain – 2.3 mSv

Sinuses – 0.3 mSv

CTA Cerebrals – 4.6 mSv

HRCT – 5 mSv

CTPA – 9 mSv

Abdomen – 8.4 mSv

CTU – 8 mSv

L-Spine – 14 mSv

Organ Doses

- Measured in mGy
- Important to be aware of organ doses
- Typical doses reported by Shrimpton et al (1991):
 - Brain Scan – Lens => 50 mGy
 - Chest Scan – Breasts => 21 mGy
 - Abdomen – Uterus => 26 mGy, Ovaries => 23 mGy, Testes => 1.7 mGy

Organ Doses

- Calculated from the absorbed dose and tissue weighting factors (mSv)

	ICRP 26 (1977)	ICRP 60 (1990)	ICRP 103 (2008)
Gonads	0.25	0.20	0.08
Breast	0.15	0.05	0.12
Red Bone Marrow	0.12	0.12	0.12
Lung	0.12	0.12	0.12
Thyroid	0.03	0.05	0.04
Colon/Stomach		0.12	0.12
Bladder		0.05	0.04

Organ Doses - Breast

- Breast Tissue is radiosensitive
- Breast tissue of adolescents and young adult women are especially susceptible
- Stochastic risks are variable depending on source of Data => Atomic Bomb Survivors vs BEIR VII Report
- Average sized woman for conventional CT Scan of Chest, Breasts receive 20-50 mGy (Hooper et al 1997), and 40-60mGy for CTPA studies (Hurwitz et al 2006)

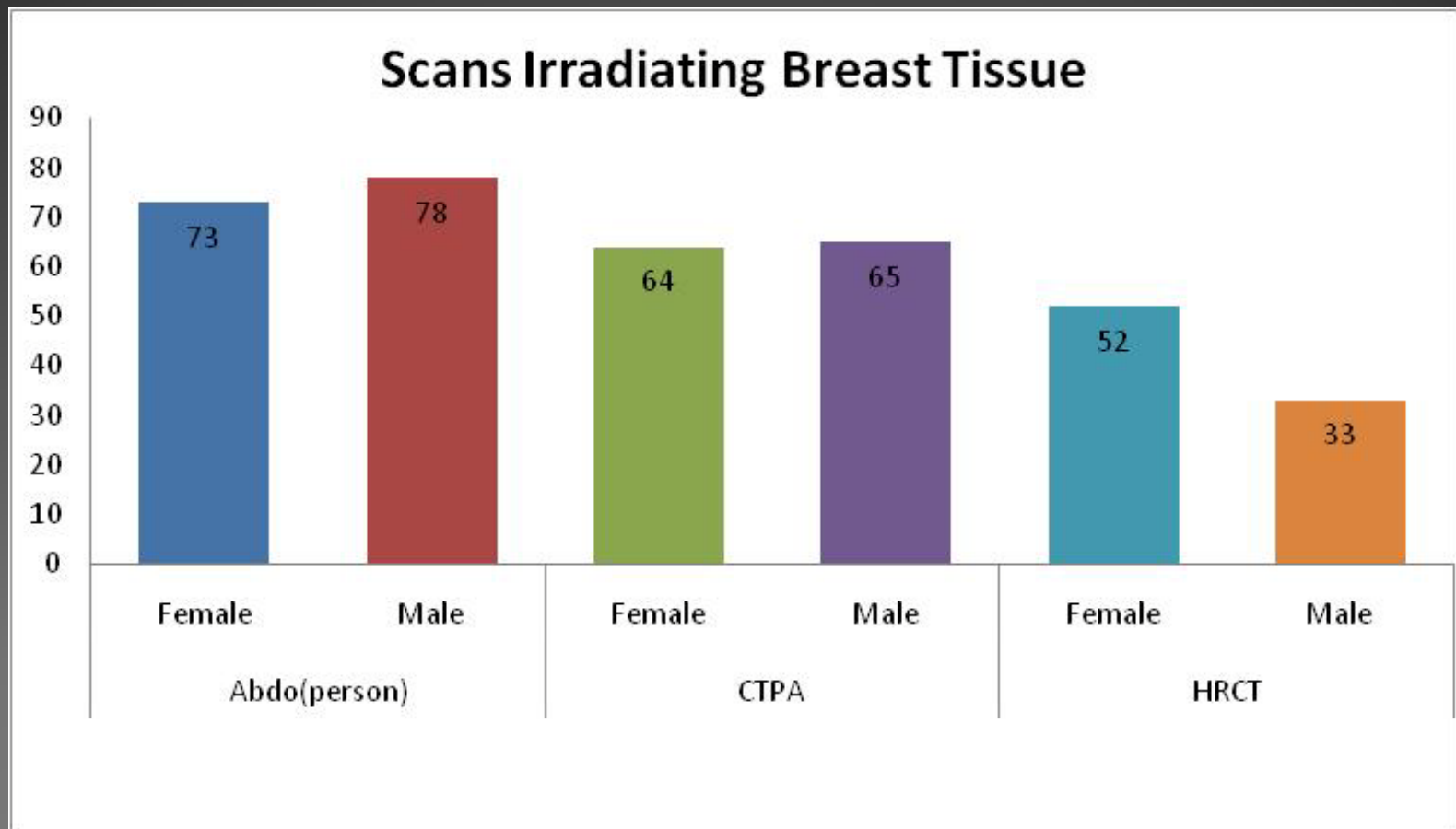
Organ Doses - Breast

- Breast Organ dose depends on
 - kVp & mAs => larger settings = Increased Dose
 - Slice Thickness & Patient Size => smaller = Increased Dose
 - Patients position in gantry
- Breasts also receive dose from CT Abdomen exams
 - 10-20mGy to inferior/lateral aspects of breasts (Hurwitz et al 2006)

Breast Doses

- Approximate doses for Victorian Project
 - CTPA – 3-50 mGy
 - HRCT – 2.3-66 mGy
 - Abdomen - <0.2-2.4 mGy

Females Having CT Chest Scans



Organ Doses - Eyes

- One of the most radiosensitive organs
- Threshold for inducing cataracts 0.5-2Gy (Mukundan et al 2006)
- Children's threshold is less than $\frac{1}{2}$ of this dose (Mukundan et al 2006)

Organ Doses - Gonads

- In the scanning field of a high dose scan
- Generally not all the testes are in the primary beam
- Testes receive dose due to Overscanning (~10mGy)

Bismuth Shielding

- Garments that cover radiosensitive organs – Eyes, Thyroid, Breasts and Gonads.
- Reduce doses to organs by 40% - 60% according to manufacturer (Attenurad).
- Multiple studies performed to validate manufacturers claims.

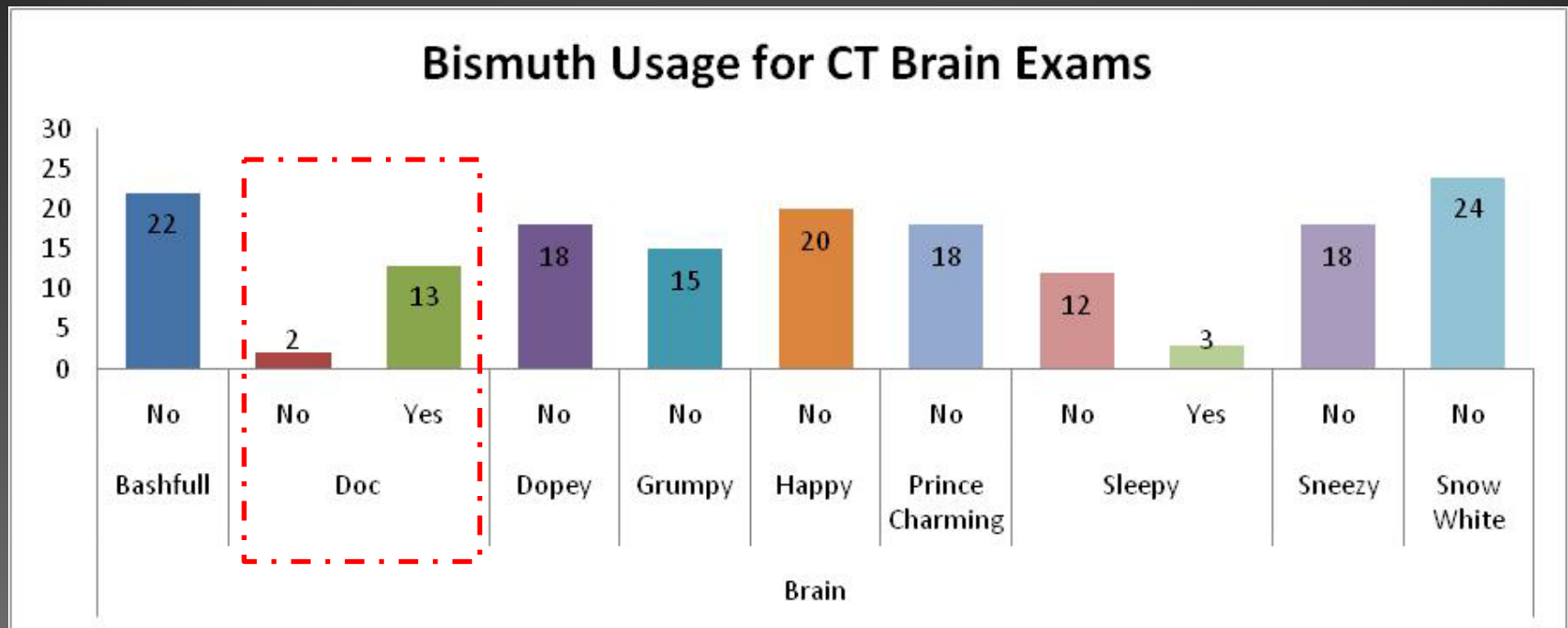
Bismuth Shielding Studies

Exam	AttenuRad	Hooper 1997	McLaughlin & Mooney 2003	Heaney & Norvill 2006	Fricke et al 2002 #	Mukundan et al 2006 #
Brain	50%	40%	20% *	48%^		42%
Chest						
Breast	57%	57%		23%	29%	
Thyroid			67%	47%		
Abdomen (Testes)		51%				

Usage

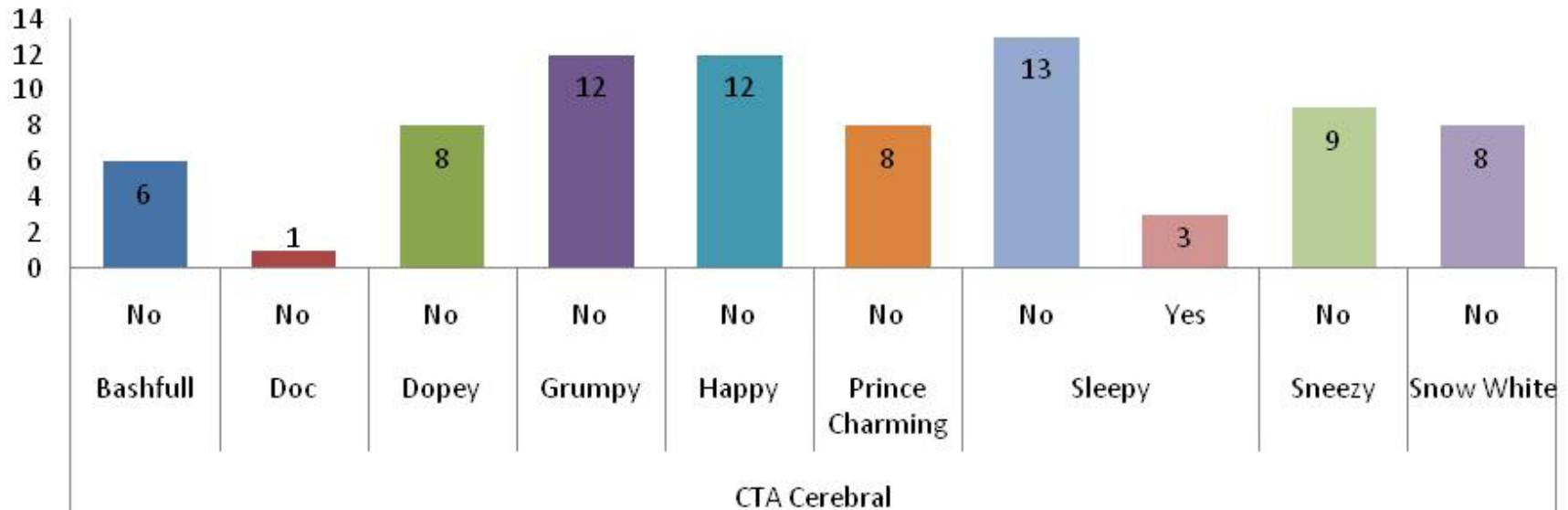
- In the Victorian CT Dose Optimisation Project only eye and breast shields were utilised.
- Usage widely variable.

CT Brain Usage



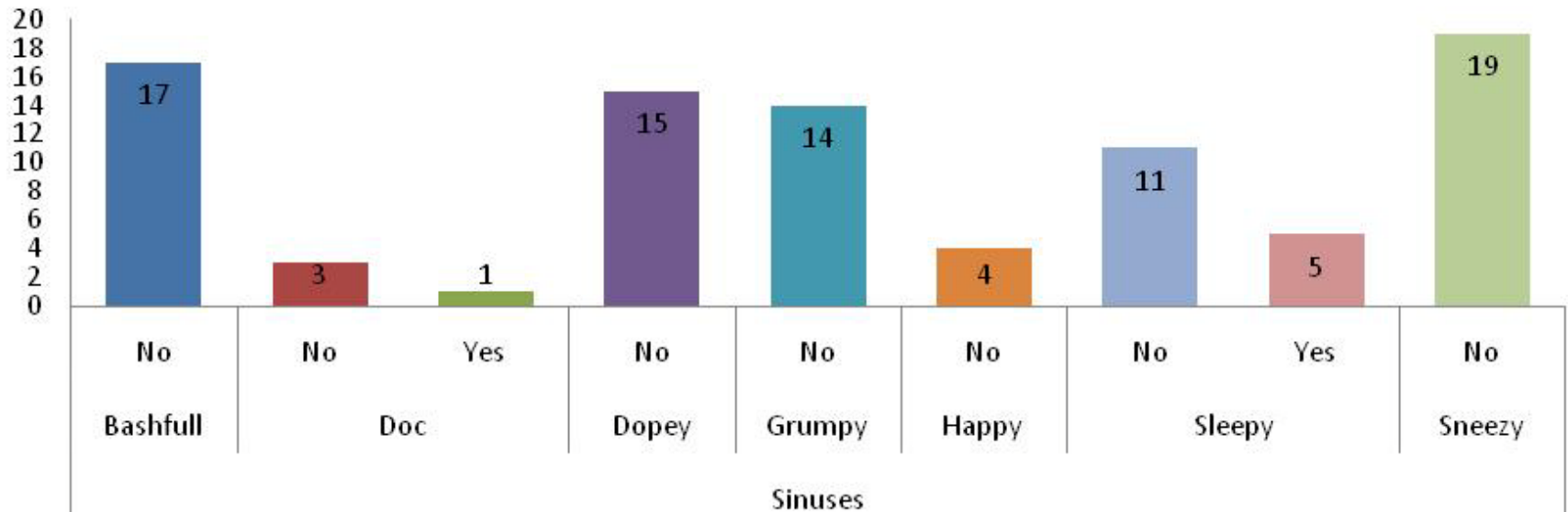
CTA Cerebral Usage

Bismuth Usage for CTA Cerebral Exams



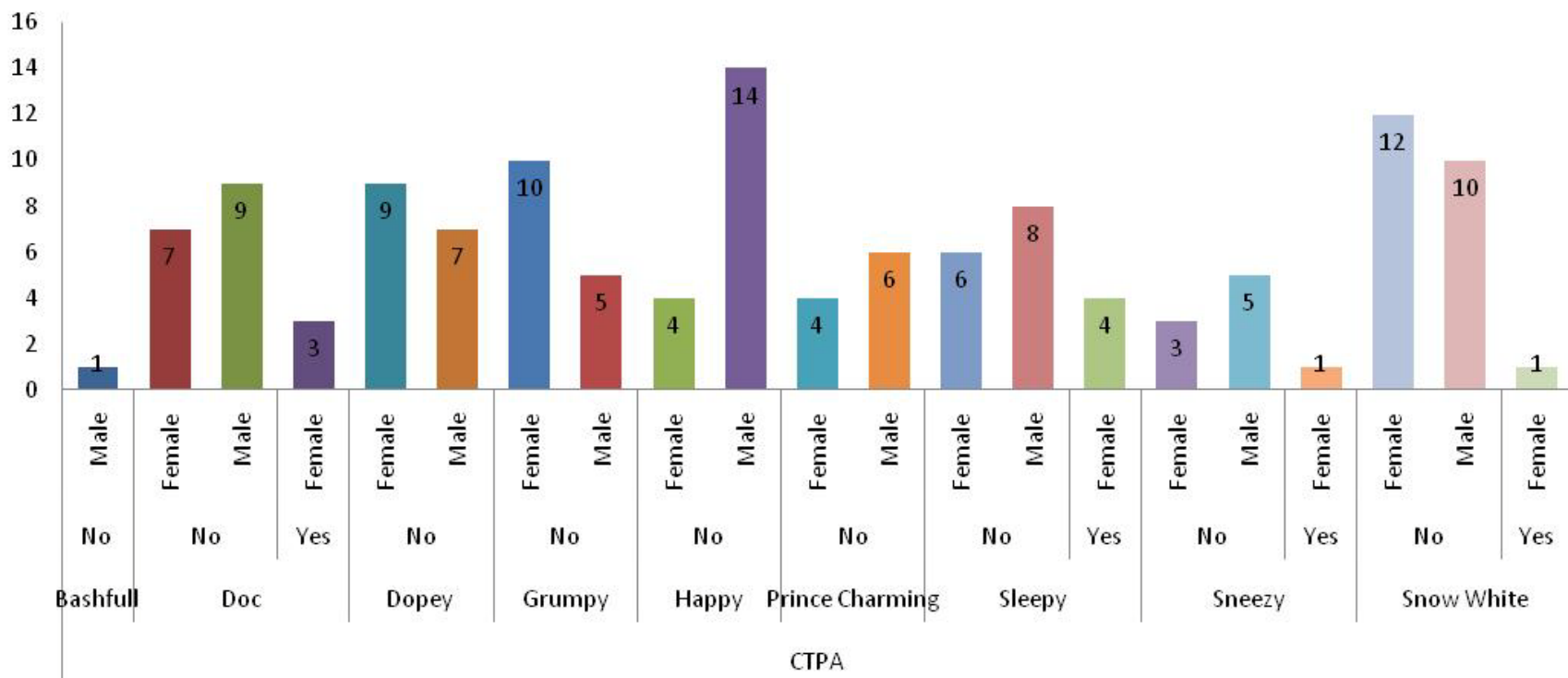
CT Sinuses Usage

Bismuth Usage for CT Sinus Exams



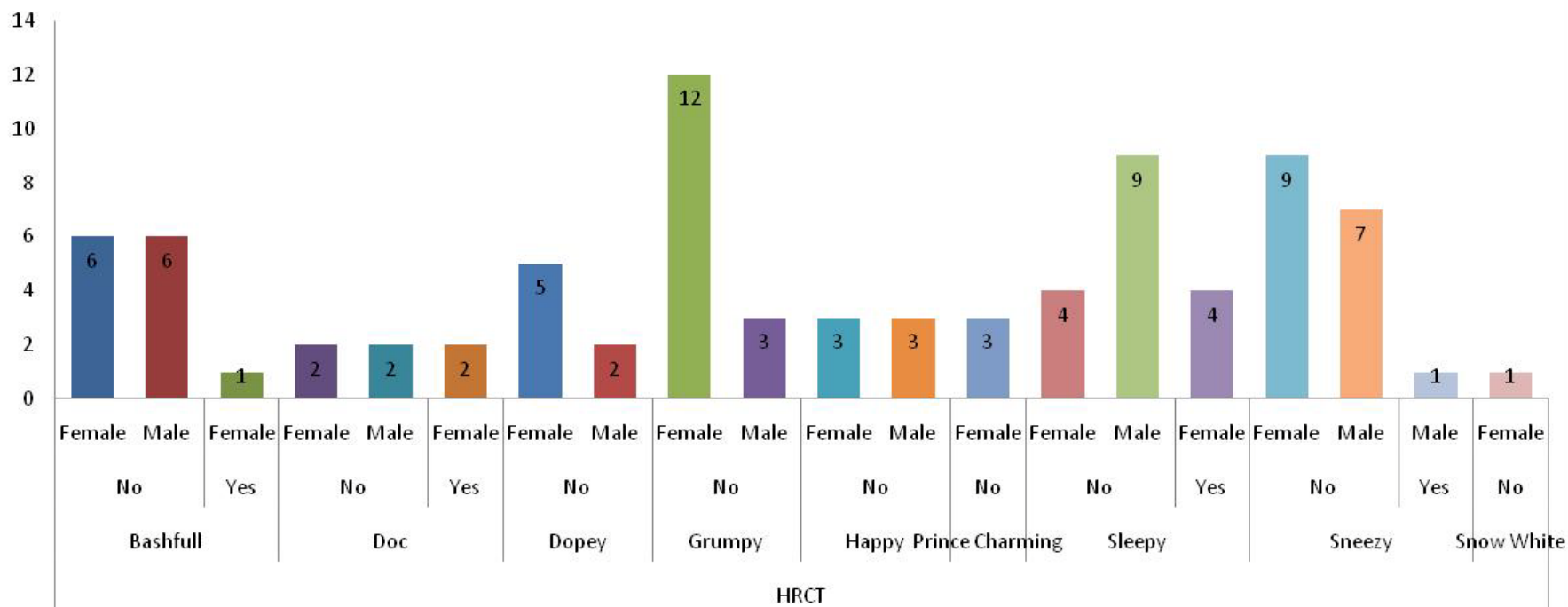
CTPA Usage

Bismuth Usage for CTPA Exams

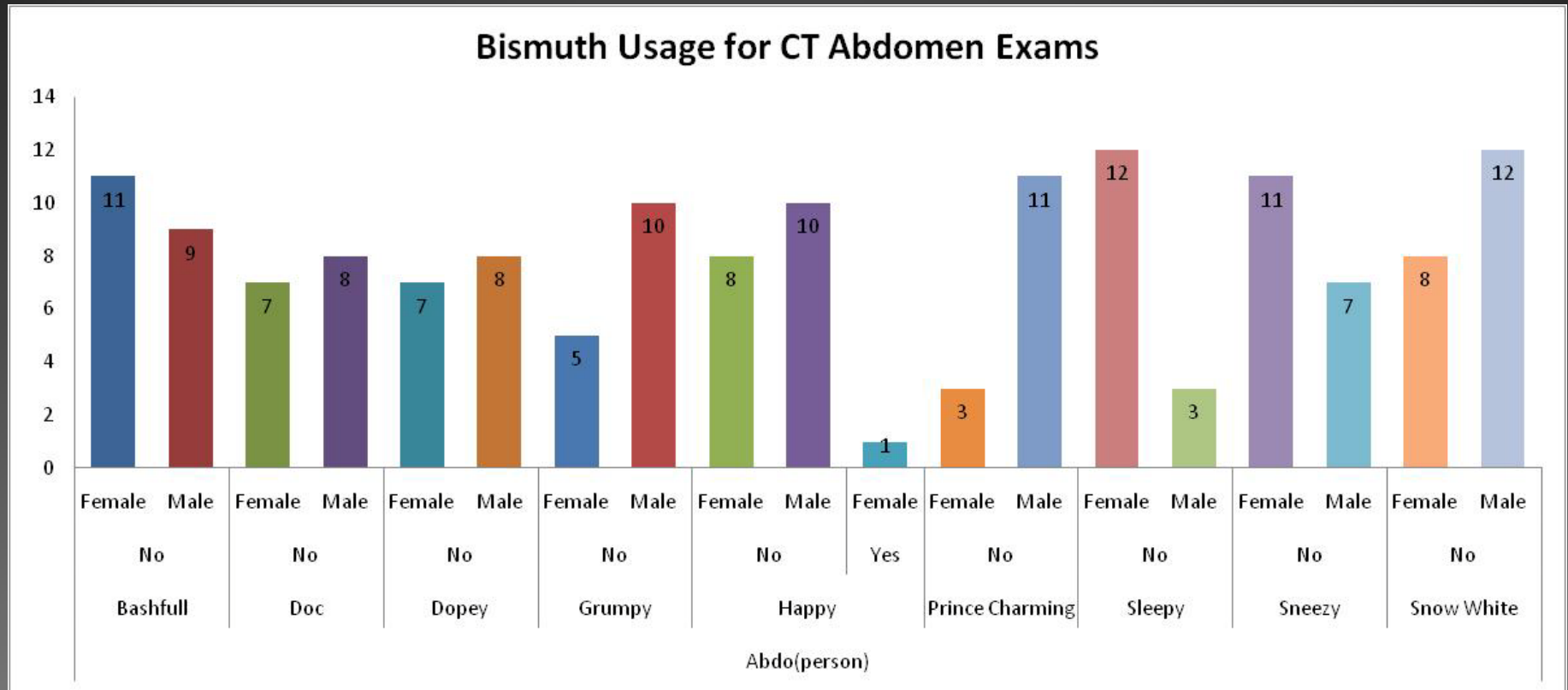


HRCT Usage

Bismuth Usage for HRCT Exams

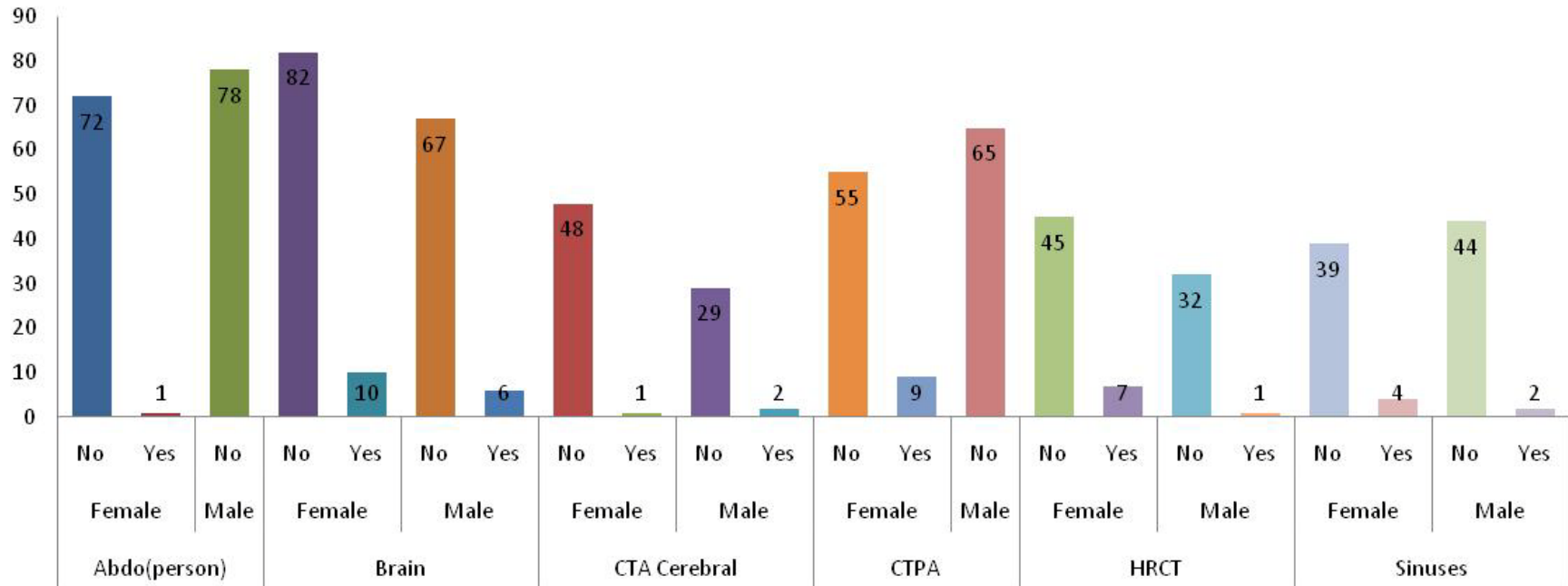


CT Abdomen Usage



Overall Usage

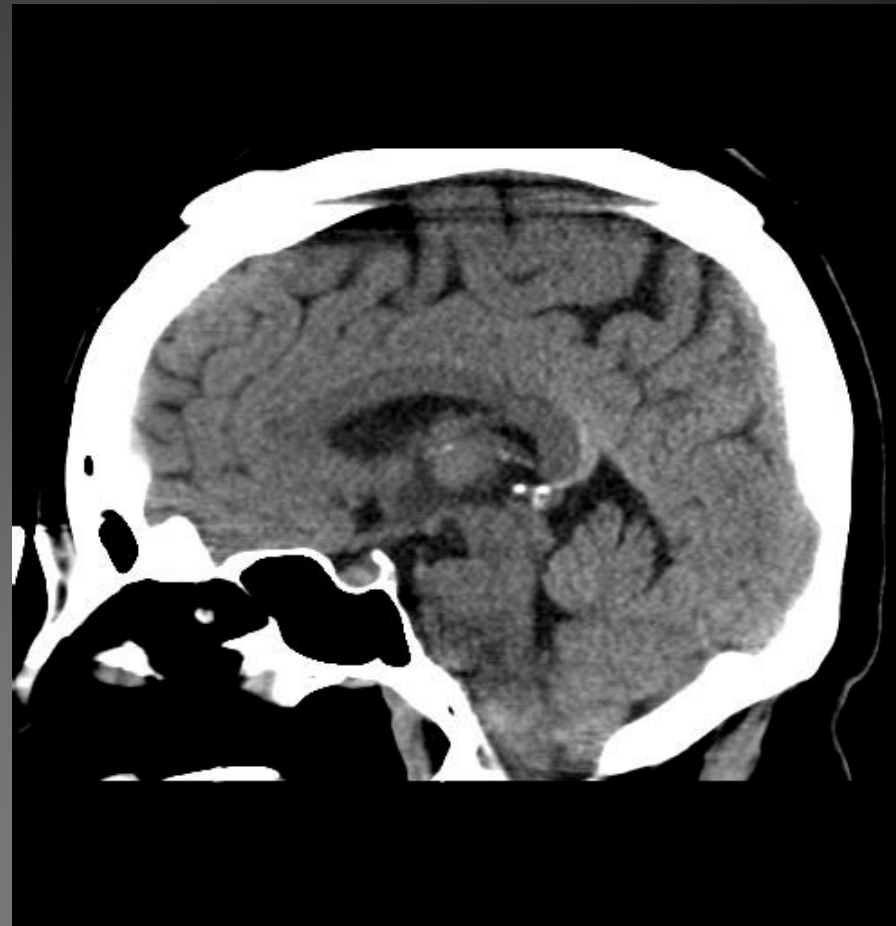
Overall Bismuth Usage



Artefacts

- Can get some beam hardening
- Placing a piece of paper towel between the patient & eye shield removes any artefact + keeps shield clean to use on multiple patients
- Breast Shields are supplied with foam pads to lift shields off patient

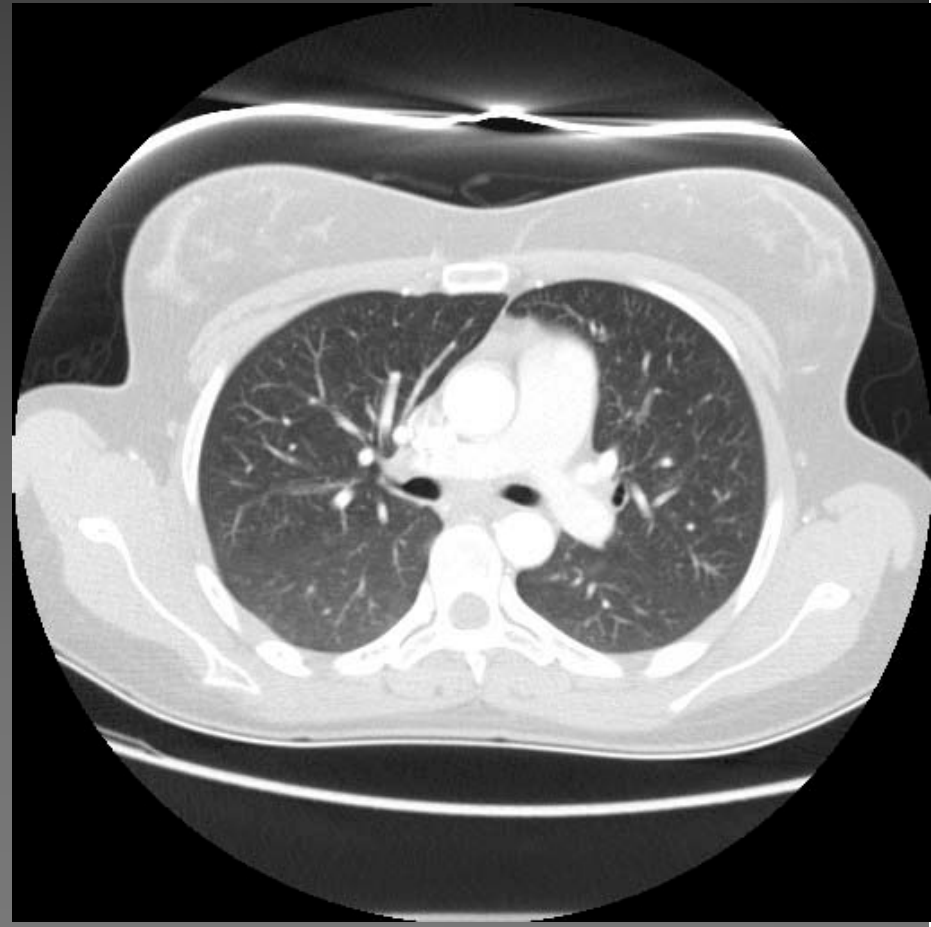
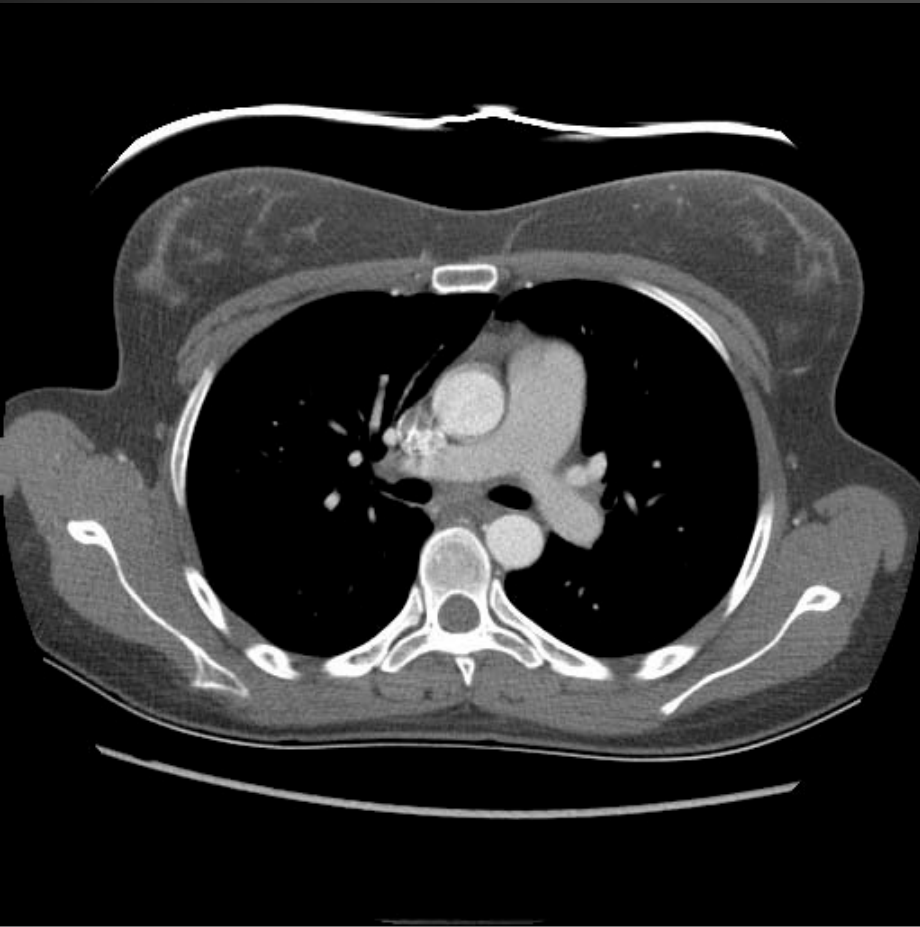
Bismuth for CT Brain Scans



Bismuth for CT Sinus Scans



Bismuth for CT Chest Scans



Should We Use Bismuth?

- Data says YES

BUT

- Not all scanners can incorporate Bismuth into their protocols without increasing the dose through the region
- Depends on how YOUR scanner performs Dose Modulation

GE Scanners

- Dose Modulation is determined from the scouts
- Bismuth can be used on all protocols – Dose Modulated and Manual mA
- Bismuth **MUST** be positioned after the Scout/Topogram

Toshiba Scanners

- Dose Modulation is determined from the scouts
- Bismuth can be used on all protocols – Dose Modulated and Manual mA
- Bismuth **MUST** be positioned after the Scout/Topogram

Philips Scanners

- Can be used on ALL Manual mA scans (Head)
- Multiple ways to calculate Dose Modulation
- Can be used on scans with ONLY Z-DOM and/or Z-DOM & ACS after the scout has been acquired
- Bismuth MUST be positioned after the Scout/Topogram
- Cannot be used on scans using D-DOM +/- ACS

Costs for AttenuRad Shields

- Eye Shields (20) - ~\$175
- Thyroid Shields (10) - ~\$205
- Breast Shields
 - Adult - ~\$150 (Each)
 - Paeds - ~\$210 (4-10/pack depending on size)

Take Home Messages

- Organ Doses are high for organs commonly in the scan field
- Links to Ca and doses from CT have been made
- Bismuth Shielding reduces organ doses 20-60% without any effect on image quality
- Know your CT Dose Modulation Systems
- Use Bismuth when your CT System allows you to
- ALWAYS position the Bismuth Shield AFTER the Scout/Topogram

Thankyou



Victorian CT Dose Optimisation Workshop July
2010