Estimating Patient Dose SPECT/PET (& all of NM)

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Thanks to S. James Adelstein, S. Ted Treves, Keith Strauss, Matthew Palmer, Marilyn Goske, James Brink

Disclosures

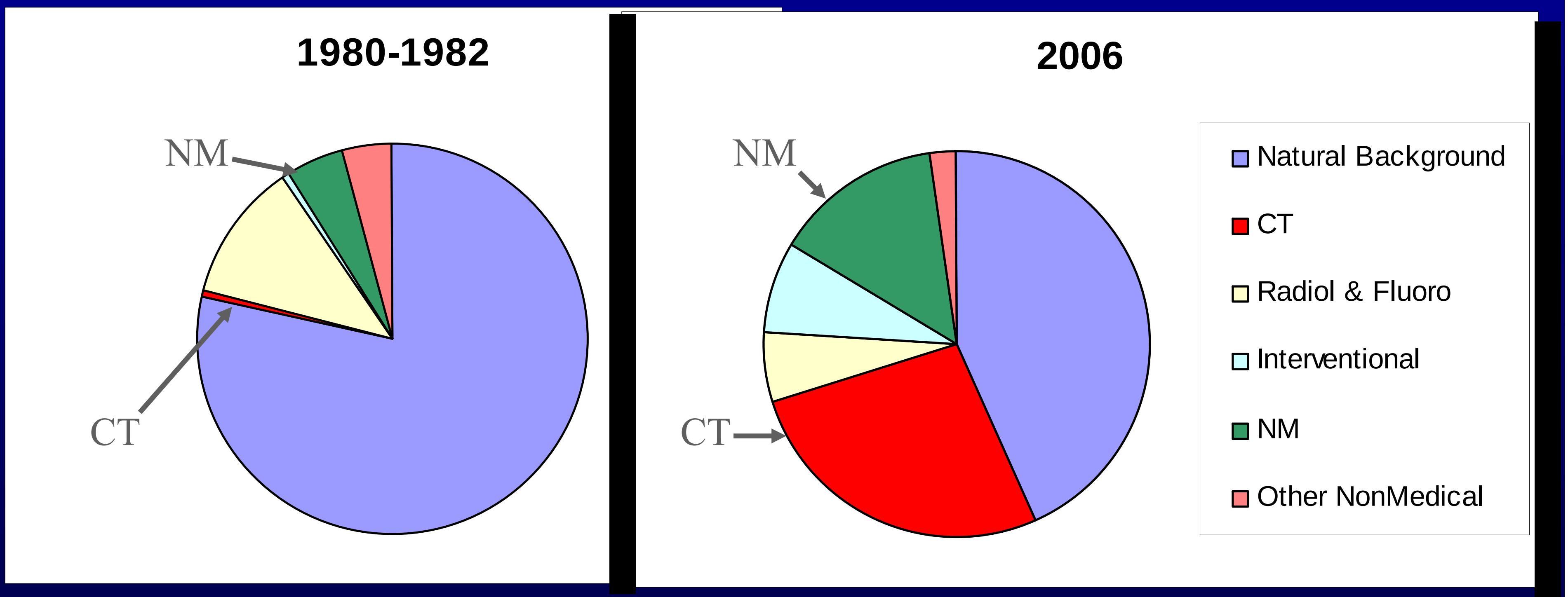
- Sadly, none that pay me any money! ☹
- SNM Dose Estimation Task Force
- Image Gently
- Image Wisely
- MITA Dose Reduction Task Force Advisory Board

Learning Objectives

After attending this lecture, participants will be able to:

- List 3 items that affect radiation dose from the administration of radiopharmaceuticals
- Describe 3 ways that body habitus can affect radiation dose from the administration of radiopharmaceuticals
- Define 3 approaches that may lead allow for a reduction in administered activity in nuclear medicine

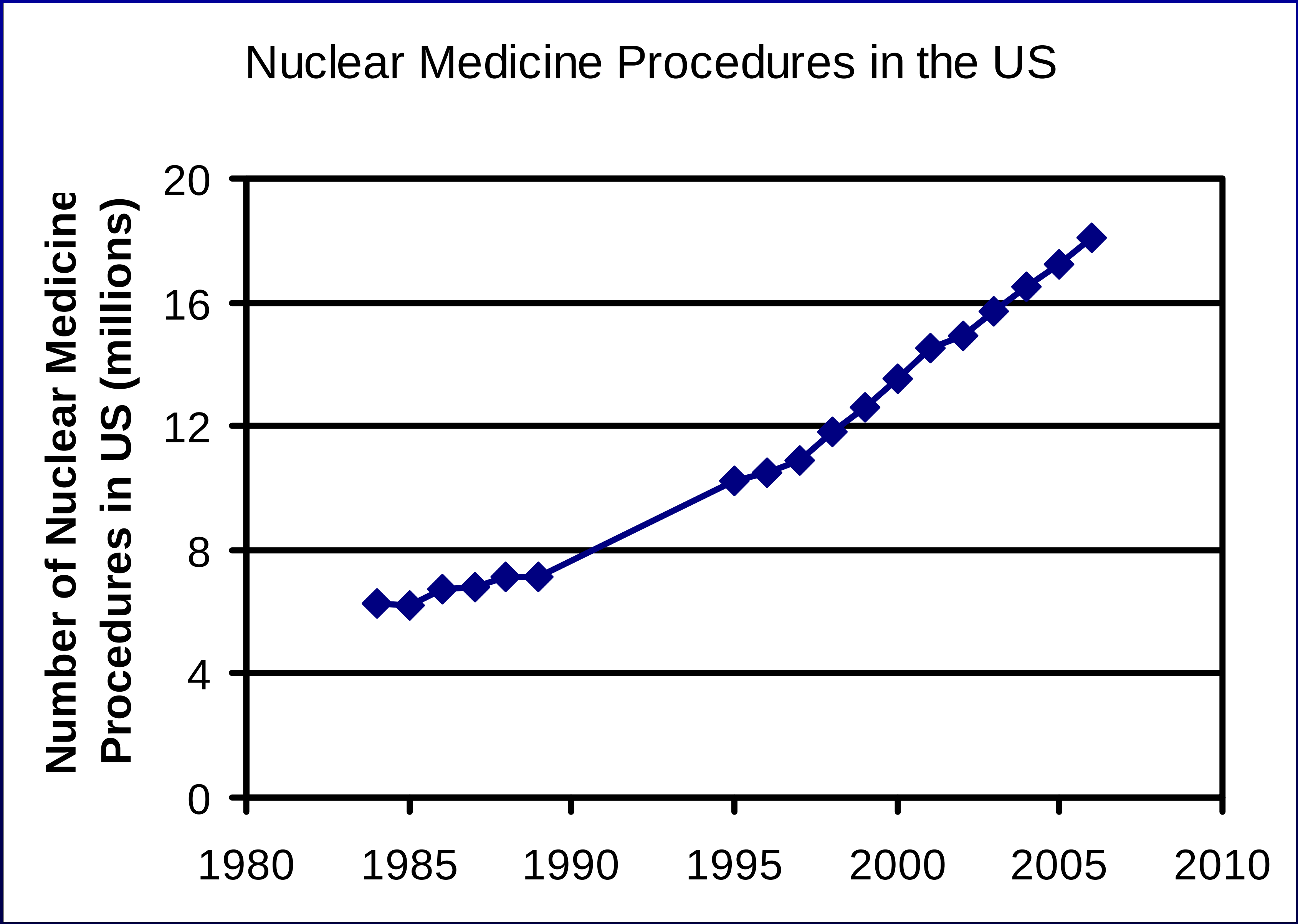
Estimated Annual Per Capita Adult Effective Dose in US



Medical 0.5 mSv
Total 3.1 mSv

Medical 3.0 mSv
Total 5.5 mSv

from NCRP 160


Nuclear Medicine Procedures in the US
Number of Nuclear Medicine Procedures in US (millions)
0
4
8
12
16
20
1980
1985
1990
1995
2000
2005
2010

NCRP 160

R. Fazel et al., Exposure to Low-Dose Ionizing Radiation from Medical Imaging Procedures. NEJM 2009; 361:841

- Studied insurance records of over 900,000 patients (18-65 YO) over 3 years
- 69% had at least 1 radiologic exam
- Annual effective dose
  - Mean 2.4 ± 6.0 mSv
  - Median 0.1 mSv (inter-quartile range 0.1-1.7 mSv)
  - 78.6% < 3 mSv; 19.4% 3-20 mSv
  - 1.9% 30-50 mSv; 0.2% >50 mSv

R. Fazel et al., NEJM 2009; 361:841

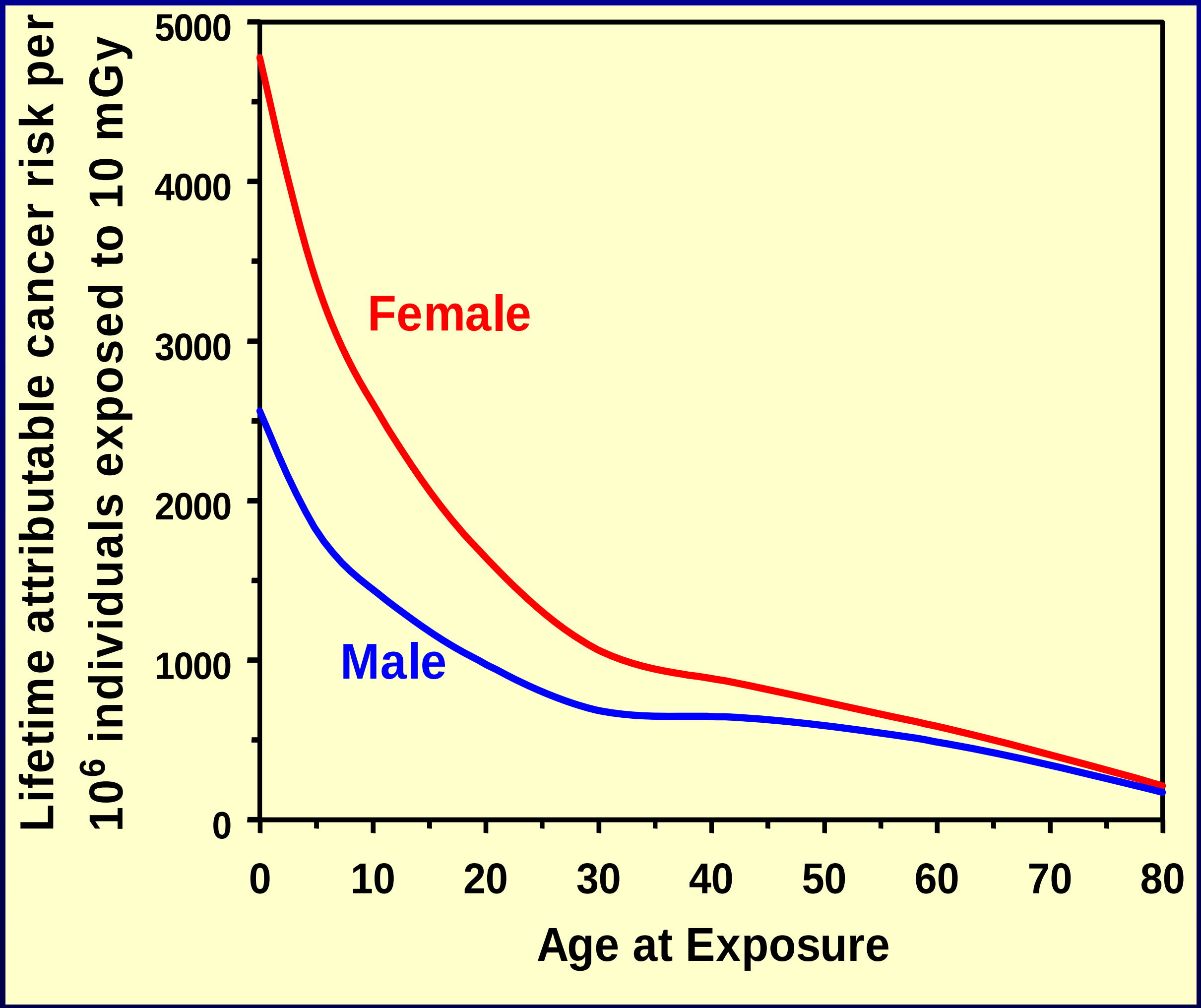
Procedure	Ave ED (mSv)	Ann'l ED per cap	% Total ED
1. Myo Perf Img	15.6	0.540	22.1
2. CT Abdomin	8	0.446	18.3
3. CT Pelvis	6	0.297	12.2
4. CT Chest	7	0.184	7.5
5. Dx Card Cath	7	0.113	4.6
6. Rad Lumbar	1.5	0.080	3.3
7. Mammo	0.4	0.076	3.1
8. CT Ang Chest	15	0.075	3.1
12. Bone Scan	6.3	0.035	1.4
17. Thyroid Uptk	1.9	0.016	0.7

Lifetime Attributable Risk 10 mGy in 100,000 exposed persons (BEIR VII Phase 2, 2006)

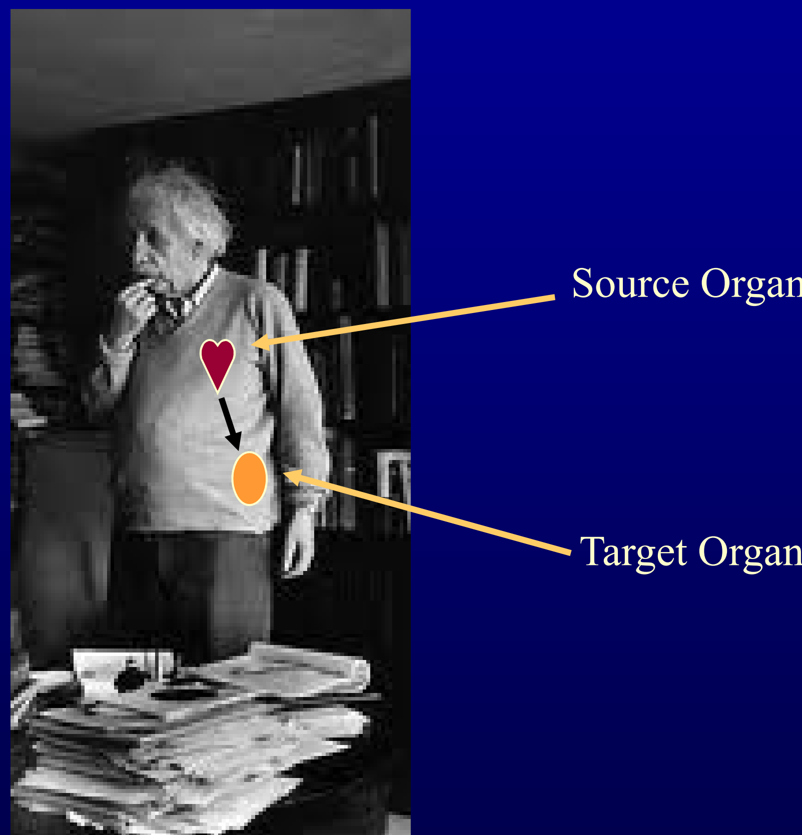
	All Solid Tumors		Leukemia	
	Male	Female	Male	Female
Excess Cases	80	130	10	7
Excess Deaths	41	61	7	5

Note: About 45% will contract cancer and 22% will die.

Lifetime Attributable Risk10 mGy in 1,000,000 exposed persons (BEIR VII Phase 2, 2006)



MIRD Equation



Medical Internal Radiation Dosimetry Committee of the SNM

MIRD Equation

MIRD Pamphlet 21. J Nucl Med 2009;50:477

$$D(r_T) = \sum_S \tilde{A}(r_S)\, S(r_T \leftarrow r_S)$$

- $D(r_T)$ is radiation dose to the target organ
- $\tilde{A}(r_S)$ is time integrated activity for the source organ
- "S" value is a radionuclide specific quantity which is the mean dose to the target organ per integrated activity in the source organ
- $\sum_S$ indicates that this is summed over all source organs

Time Integrated Activity (Ã)

- Units of activity-time (e.g. Bq-hr) & is total # of decays
- Depends on
  - Administered activity (A_o in Bq)
  - Fraction of activity that goes to source organ (F)
  - How long the activity stays there (T_{eff})

$$\tilde{A}(r_S) = A_o \, F \, T_{eff}$$

F depend on the particular radionuclide administered, and the specific uptake of the patient.

Effective Half-Life

- Combination of biological clearance and physical radioactive half-life (T_P)
- Biological clearance is often model as exponential (T_B) although there are exceptions (hopefully bladder)

$$T_{eff} = \frac{T_B * TP}{T_B + TP}$$

- Shorter of T_B and TP dominates

Time Integrated Activity (Ã)

- Ã is a physiologic parameter as it depends on both the uptake and the clearance of the radiopharmaceutical
- Ratio of Ã and administered activity A_o is sometimes referred to as "residence time" ($T_R = Ã/ A_o$) but this is a misnomer as it also depends on fractional uptake.
- Typically estimated using biokinetic data from either animals or humans
- Although these estimates may be reasonable in most cases, they may not apply to a specific patient!

S Factor

$$S(r_T \leftarrow r_S) = \sum_i \Delta_i \, \varphi_i / M_T$$

- Δ_i is the mean energy per nuclear transformation for the ith radiation emitted by the radiopharmaceutical
- φ_i is the fraction of energy emitted by the source organ that is absorbed by the target organ of the ith radiation which depends on the radiation and the size and anatomy of the patient
- M_T is the mass of the target organ
- $\sum_i$ Indicates that this is summed over all radiations

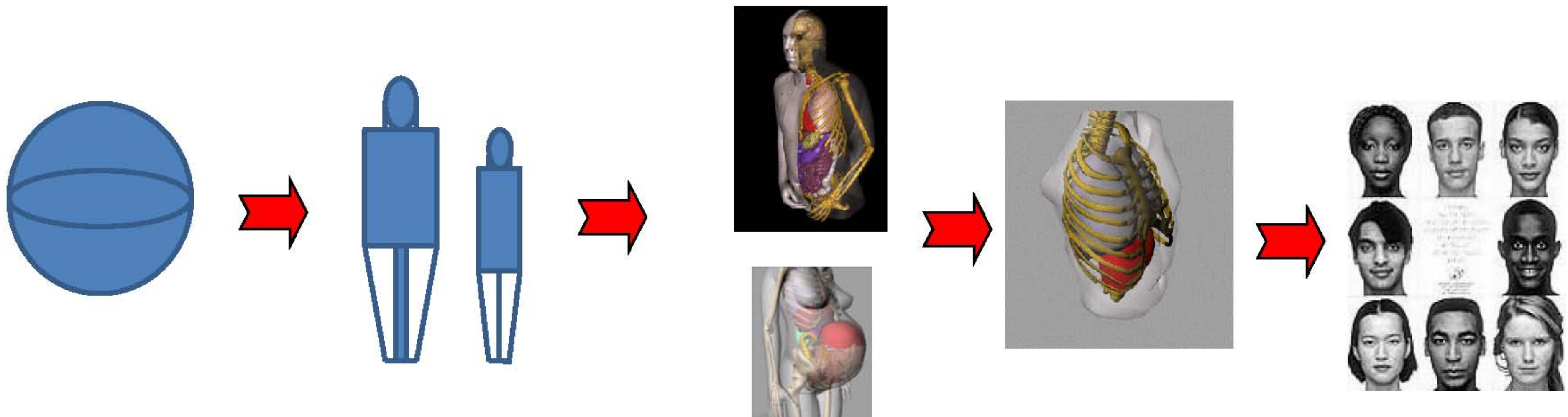
S Factor

- Physical parameter relying on the radionuclides decay scheme and orientation, size and spacing of organs within the patient
- Models for different types of patients (standard man, women (pregnant or not), and children
- φ_i is often considered to be 1.0 for non-penetrating radiation (e.g. beta particles including positrons) and less than unity for gamma and x-rays. Also, φ_i/M_T is referred to as the specific absorbed fraction (SAF).

Rensselaer
why not change the world?℠

Evolution of Computational Phantoms

- Simple to complex
- Homogeneous to heterogeneous
- Rigid to deformable
- Stationary to moving
- "Reference Man" to "reference library" or "person-specific" (?)



ICRU sphere 1960s

MIRD anthropomorphic models in 1980s

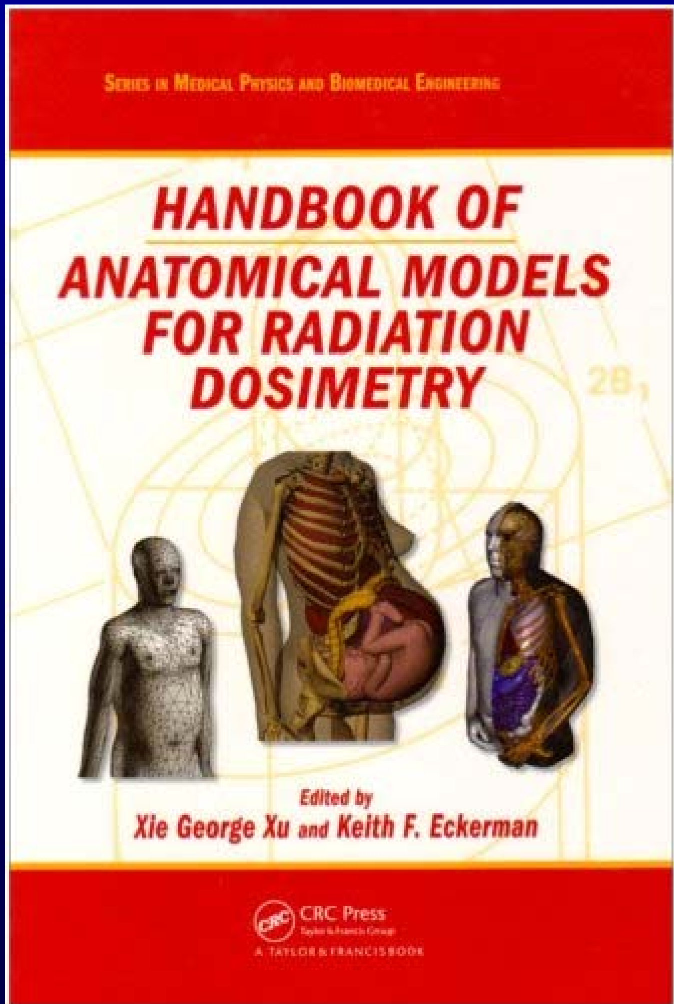
Image-based rigid, 3D model in 1990-2000s

Currently Deformable and moving 4D models 2008-2010

Future?

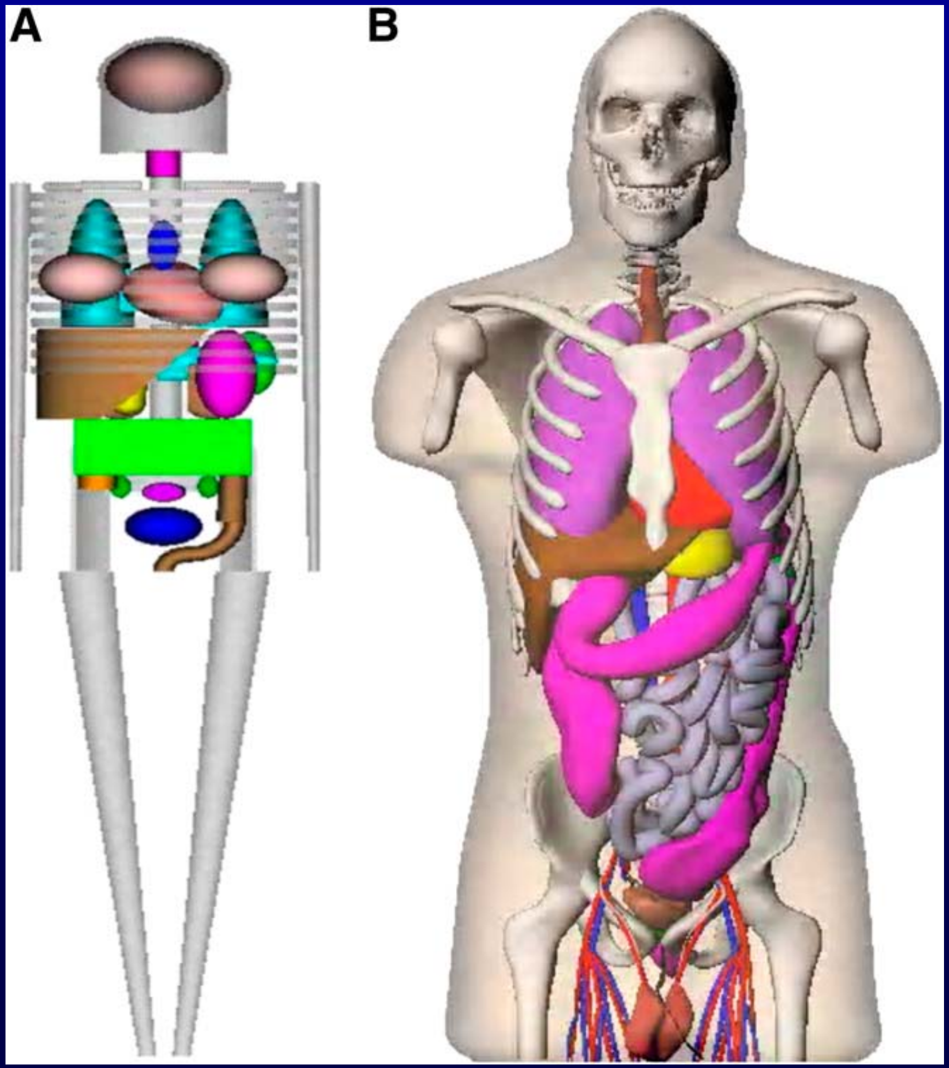
Courtesy of George Xu, RPI

Anatomical Models for Radiation Dosimetry



- Xu G, Eckerman KF, eds. Handbook of Anatomical Models for Radiation Dosimetry. CRC Press, 2009.
- Whalen S, Lee C, Williams J, Bolch WE. Phys Med Biol. 2008;53:453.
- Nosske D, Blanchardon E, Bolch WE, et al. Radiat Prot Dosimetry. 2011;144:314.
- RADAR Realistic Phantom Series. http://www.doseinfo-radar.com

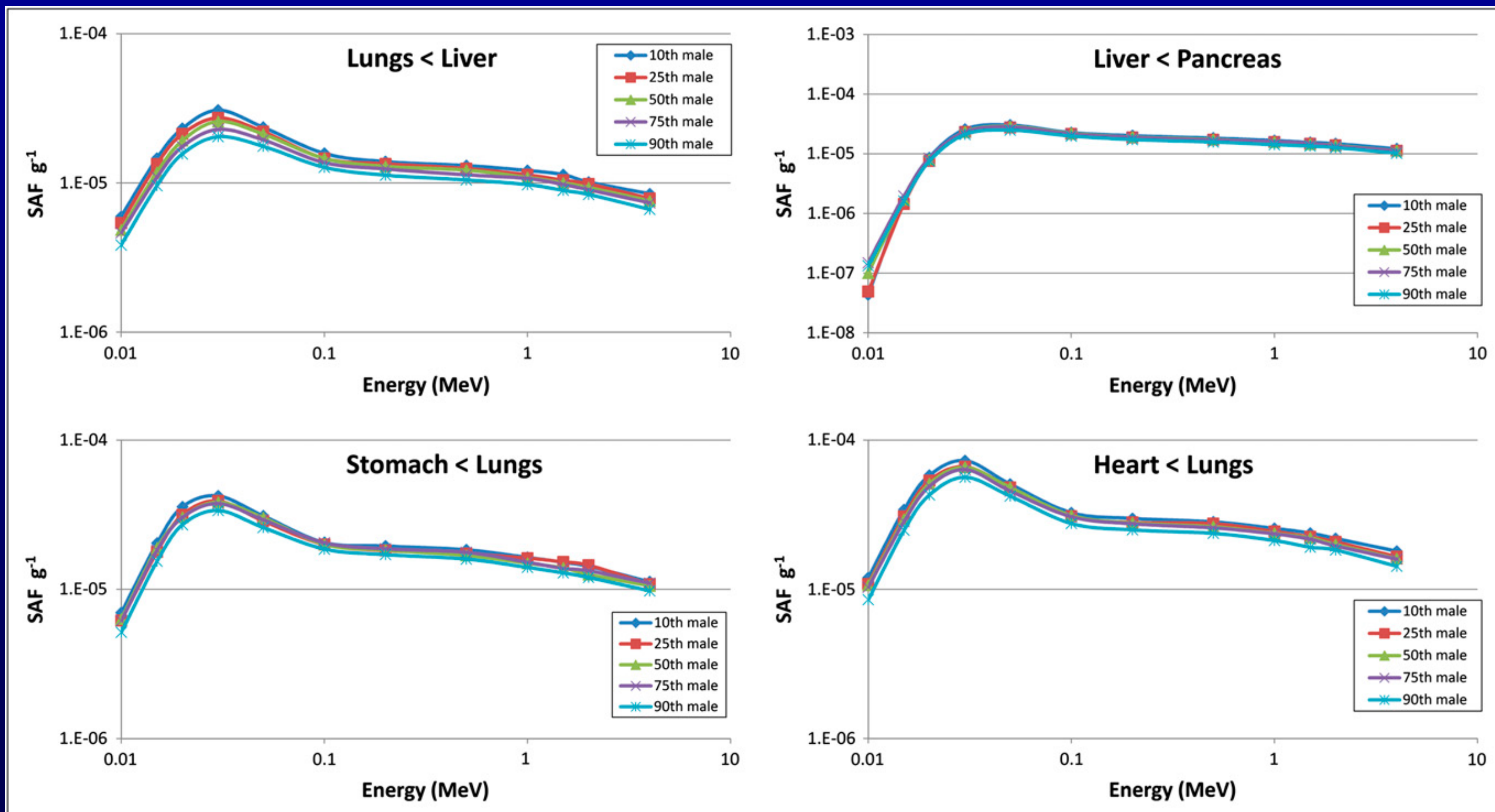
Traditional vs Realistic Phantom



- Use of non-uniform rational B-splines or "NURBS"
- Easier to compute and more scalable than voxel based approaches

Marine et al. J Nucl Med 2010;51:806-811

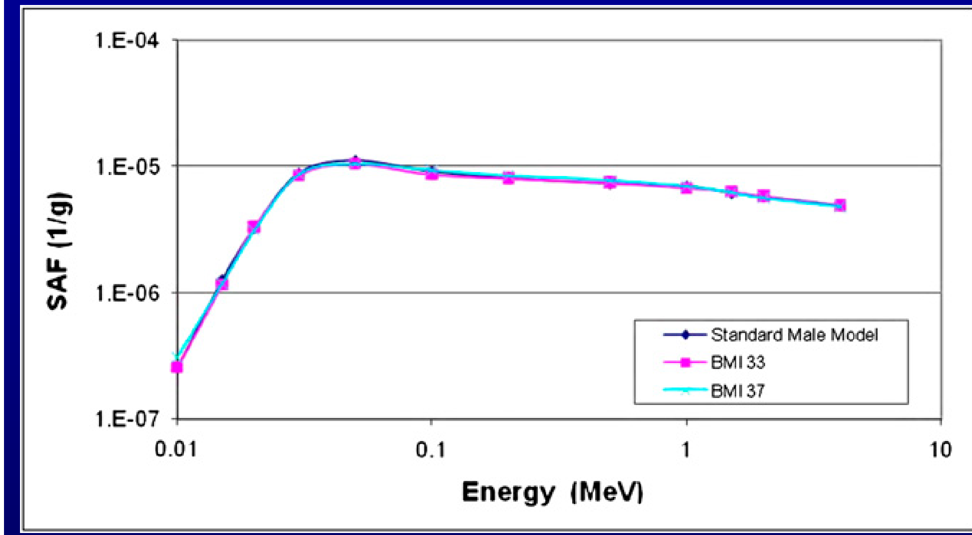
Effect of Differences in Adult Patient Size

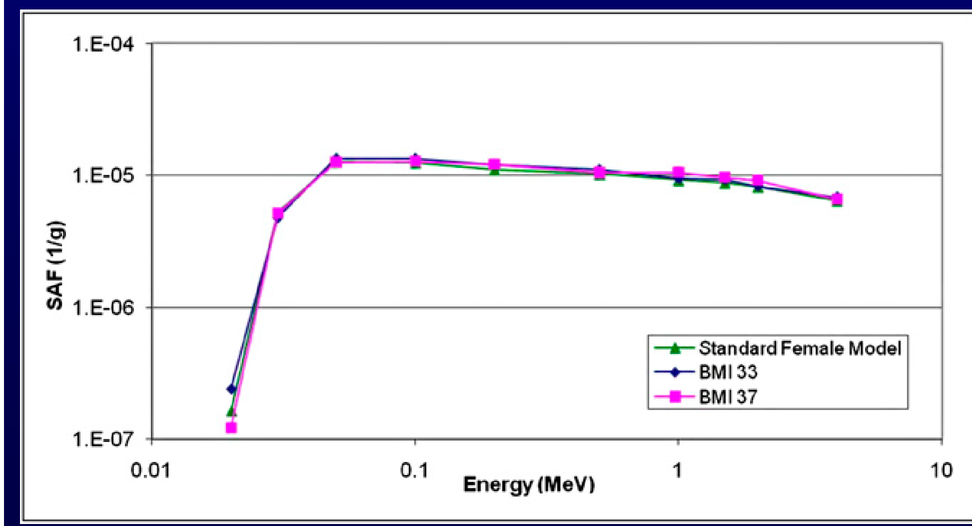


Variations in SAFs in Adult Males (15-30%)

Marine et al. J Nucl Med 2010;51:806-811

Effect of Differences in Adult Patient Size





Obese vs Standard
Varying BMIs

Top- Spleen → Lungs
Bottom – Heart → Pancreas

Not appreciably different than standard man since organs basically in the same place.

Clark et al. J Nucl Med 51:929-32.

Uncertainties

Uncertainties in Internal Dose Calculations for Radiopharmaceuticals

Michael G. Stabin

The combined uncertainties in most radiopharmaceutical dose estimates will be typically at least a factor of 2 and may be considerably greater.

J Nucl Med. 2008;49:853-860

Most of uncertainty in physiologic factors.

Effective Dose

Effective Dose is equivalent to the absorbed dose given to the whole body of the patient that would result in the same biological effect as the actual clinical dose given to a fraction of the patient's whole body.

It is calculated by taking a weighted sum of the absorbed doses delivered to individual organs where each organ is weighted by its radiation sensitivity.

The unit is sievert (Sv) or millisievert (mSv)

(1 rem = 10 mSv and 1 Sv = 100 rem)

Effective Dose (ED)

$$ED = \sum H_T \times W_T$$

Where H_T is radiation dose to organ, T, and W_T is the radiosensitivity weight assigned to that organ.

Note: that the W_T values are averaged over age and sex and may not reflect the risks for a particular patient including children.

Effective Dose

TABLE 1: Tissue-Weighting Factors for International Commission on Radiological Protection (ICRP) Publications 26, 60, and 103

Tissue or Organ	Publication		
	ICRP 26	ICRP 60	ICRP 103
Gonads	0.25	0.20	0.08
Red bone marrow	0.12	0.12	0.12
Lung	0.12	0.12	0.12
Colon		0.12	0.12
Stomach		0.12	0.12
Breast	0.15	0.05	0.12
Bladder		0.05	0.04
Liver		0.05	0.04
Esophagus		0.05	0.04
Thyroid	0.03	0.05	0.04
Skin		0.01	0.01
Bone surface	0.03	0.01	0.01
Brain			0.01
Salivary glands			0.01
Remainder	0.30	0.05	0.12
Total	1.00	1.00	1.00

From Christner et al. AJR 2010;194:881-889

Factors Affecting Dose in NM and SPECT

- Injected activity
  - Total counts and imaging time
- Choice of camera
  - Detector thickness and material
  - Number of detectors
- Choice of collimator
  - Hi Sens, Gen Purpose, Hi Res, Pinhole
- Image processing and reconstruction

Patient Effective Dose (mSv)

Summary	1 Year	5 Year	10 Year	15 Year	Adult
Mass (kg)	9.7	19.8	33.2	56.8	70
Tc-MDP (20 mCi*)	2.8	2.9	3.9	4.2	4.2
Tc-ECD (20 mCi*)	4.1	4.6	5.3	5.9	5.7
Tc-MAG3 (10 mCi*)	1.2	1.3	2.2	2.8	2.7

*max admin activ

ICRP 80 and 106

Patient Effective Dose (mSv)

Summary	1 Year	5 Year	10 Year	15 Year	Adult
Mass (kg)	9.7	19.8	33.2	56.8	70
Tc-MIBI Rest (10 mCi*)#	2.7	2.9	3.2	3.6	3.3
Tc-MIBI (30 mCi*)#	6.9	7.2	8.4	9.0	8.8
Tc-Tetrafosmin Rest (10 mCi*)#	2.2	2.3	2.3	2.9	2.8
Tc-Tetrafosmin Rest (30 mCi*)#	5.3	5.6	6.3	7.3	7.7
Tl-201 (3 mCi*)@	20.0	24.8	29.5	18	15.5

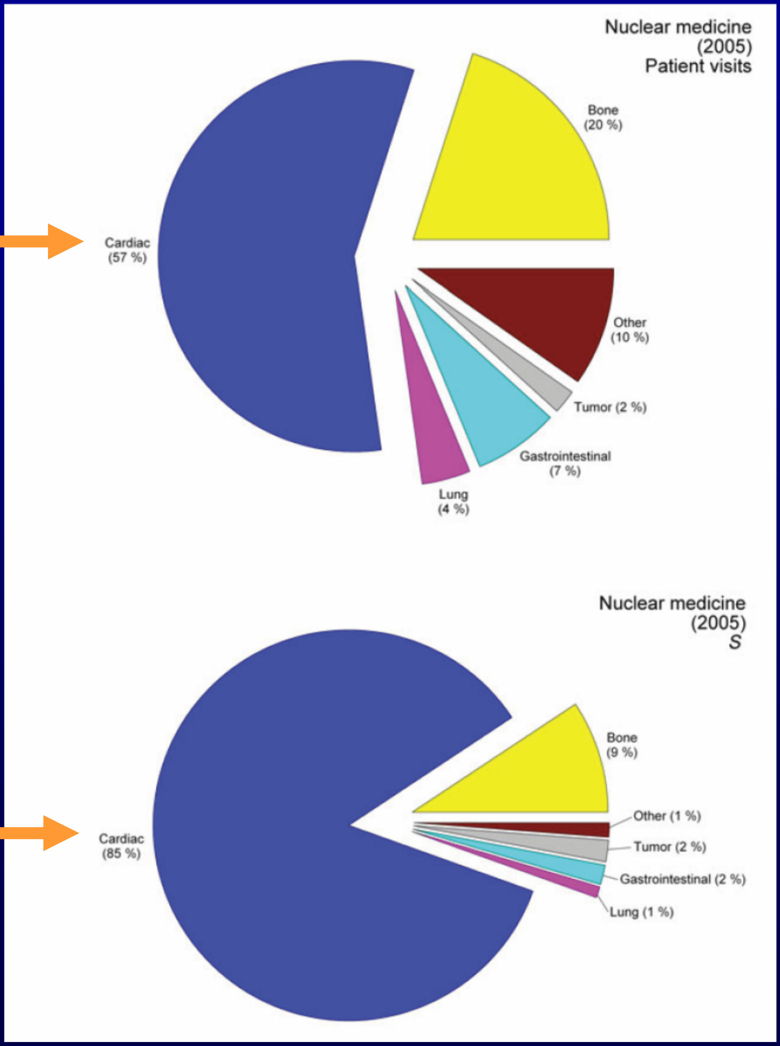
*max admin activity

#ICRP 80, @ICRP 106

Nuclear Cardiology

57% of Patient Visits

85% of Collective Dose



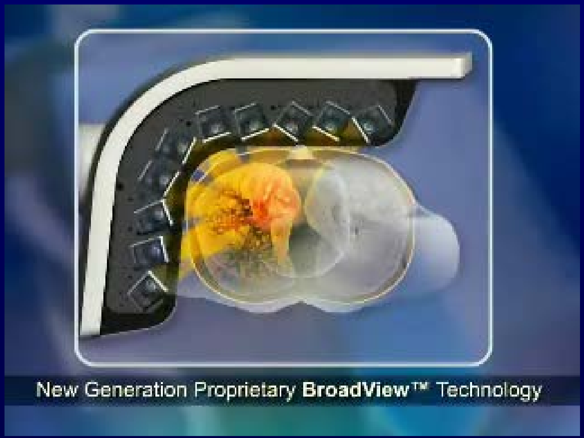
NCRP 160

Cardiovascular Nuclear Imaging: Balancing Proven Clinical Value and Potential Radiation Risk

SNM Cardiovascular Council Board of Directors

"In summary, radionuclide MPI can provide scientifically validated, accurate, and in certain cases unique information for management of patients with known or suspected coronary artery disease at risk for major cardiovascular events. The radiation exposure risk associated with radionuclide MPI, albeit small and long term as opposed to the higher and more immediate risk for major cardiovascular events, mandates careful adherence to appropriateness criteria and guidelines developed or endorsed by [SNM, ASNC, ACC and AHA]. With recent developments in technology, there are many opportunities to further reduce radiation exposure and further enhance the benefit-to-risk ratio of this well-established, safe imaging modality."

Cardiac SPECT



DSPECT (10 CZT detectors)

GE Discovery 530c

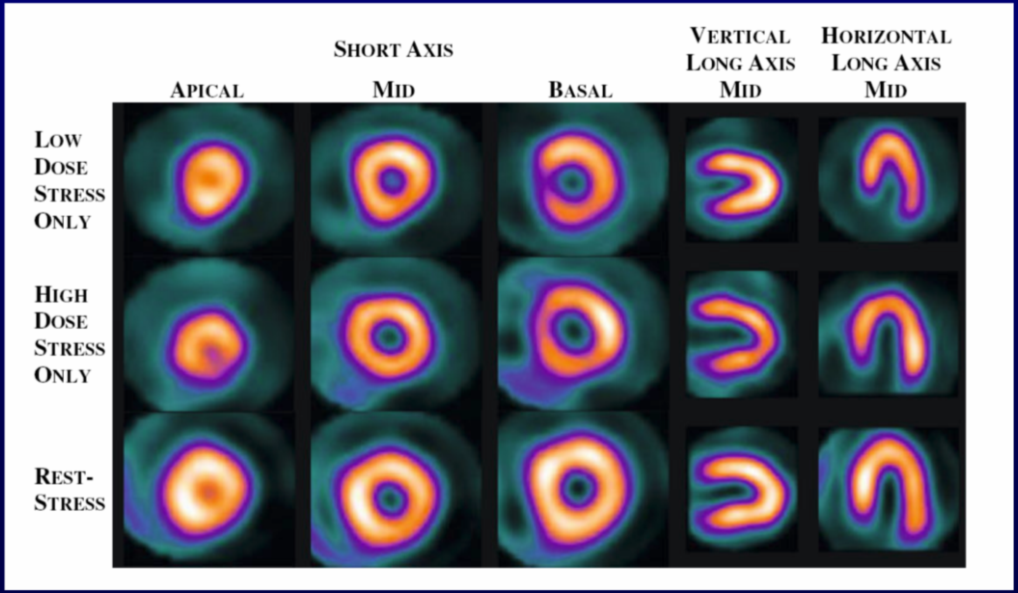
(Shown with CT)

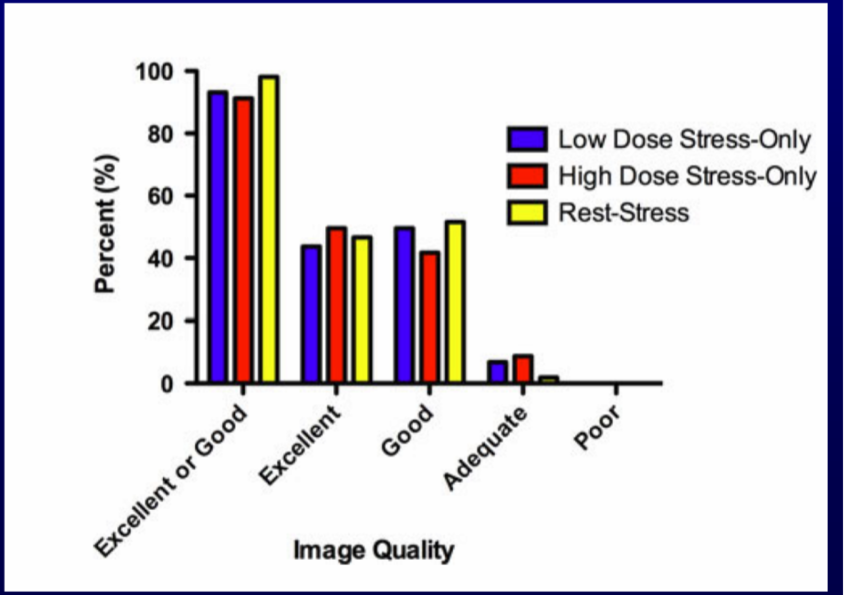
- 19 stationary CZT detectors, 32x32 (5mm) array
- Multiple pinhole (5mm) apertures

Potential for dose reduction as well as greater throughput.

Duvall et al. J Nucl Cardiol 2010;17:1009-1014.

- GE Discovery NM 530c Camera
- Low-dose (12.5 mCi) stress only, high-dose (25-36 mCi) stress only, standard rest-stress (8-13 mCi for rest) => 4.2, 8.0 & 11.8 mSv ED, respectively
- Subjective grading of image quality on a 4-point scale by 2 readers





DePuey et al. J Nucl Cardiol 2011;18:273-280.

- Acquired with conventional dual-head gamma camera
- Wide beam reconstruction (WBR): utilizes system information in reconstruction, suppresses noise, enhances signal-to-noise
  - Group A: Full-time with OSEM: 9-12 mCi rest, 32-40 mCi stress
  - Group B: Half-dose with WBR: 5.7 and 17.6 mCi for rest, stress

Table 2. Image quality of "full-time" OSEM and "half-dose" myocardial perfusion SPECT processed with Wide Beam Reconstruction

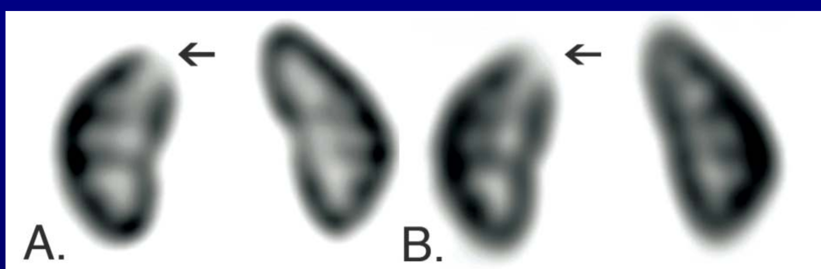
	Full-time Group A	Half-dose WBR Group B
Rest	3.6 ± 0.7	4.3 ± 0.8*
Stress	3.8 ± 0.7	4.6 ± 0.6*
Post-stress gated	3.9 ± 1.0	4.7 ± 0.6*

For grading image quality 1 = poor, 2 = fair, 3 = average, 4 = good, 5 = excellent.
* $P < .001$ vs full-time OSEM.

•Subjective image quality of 5-pt scale by 2 observers

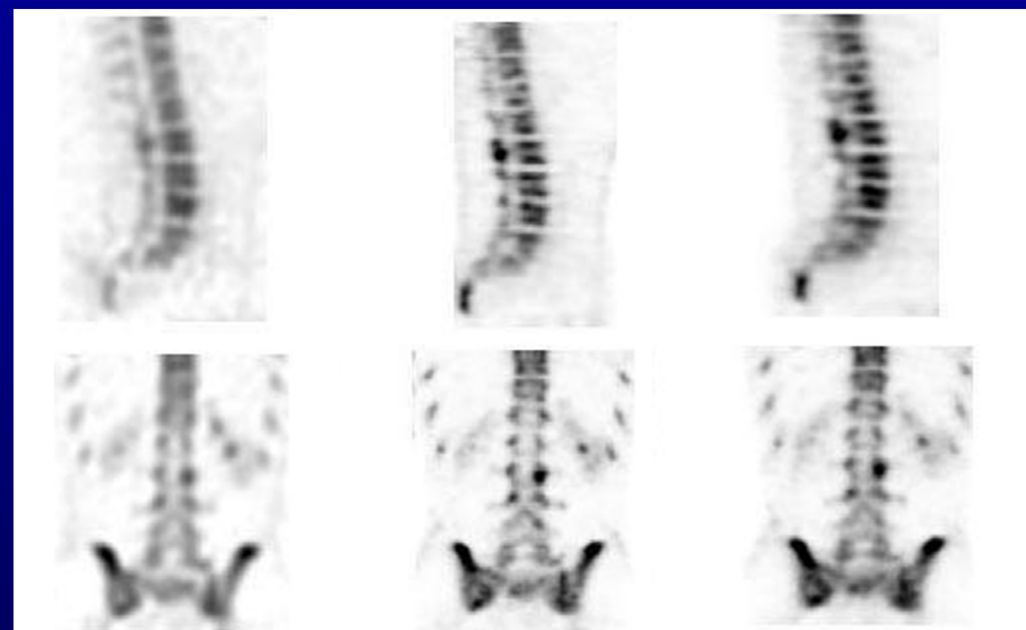
Half dose WBR: 5-6 mCi compared to Full-time OSEM ~11 mCi

Use of OSEM-3D Reconstruction in SPECT



FBP Full Cts OSEM Half Cts

Sheehy et al. Radiol 2009; 251:511-516



FBP Full Cts OSEM Full Cts OSEM Half Cts

Stansfield et al. Radiol 2010; 257:793-801

Factors Affecting Dose in PET

- Injected activity
  - Total counts and imaging time
- Choice of scanner
  - Crystal material and thickness
  - 2D vs 3D
  - Axial field of view
- Image processing

Patient Dose from FDG (mSv)

Summary	**1 Year**	**5 Year**	**10 Year**	**15 Year**	**Adult**
Mass (kg)	9.7	19.8	33.2	56.8	70
Act (mCi)	*1.46*	*2.97*	*4.98*	*8.52*	*10.5*
Bladder*	25.6	35.9	44.4	48.8	50.5
Eff Dose*	5.2	5.9	6.6	7.3	7.4

ICRP 106

Factors Affecting Radiation Dose in Multi-Detector CT

- Tube current or time (α mAs)
- Reduce tube voltage (α kVp^2)
- Beam collimation
- Pitch (table speed) (α 1/pitch)
- Patient size
- Region of patient imaged

CIRS Tissue Equivalent Phantoms

- Dosimetric CT phantoms
- Simulated spine
- Five 1.3 cm holes
- Five different sizes

Phantom	AP x Lat (cm)	Circum (cm)
Newborn	9 x 10.5	32
1 Year Old	11.5 x 14	42
5 Year Old	14 x 18	53
10 Year Old	16 x 20.5	61
Med Adult	25 x 32.5	96

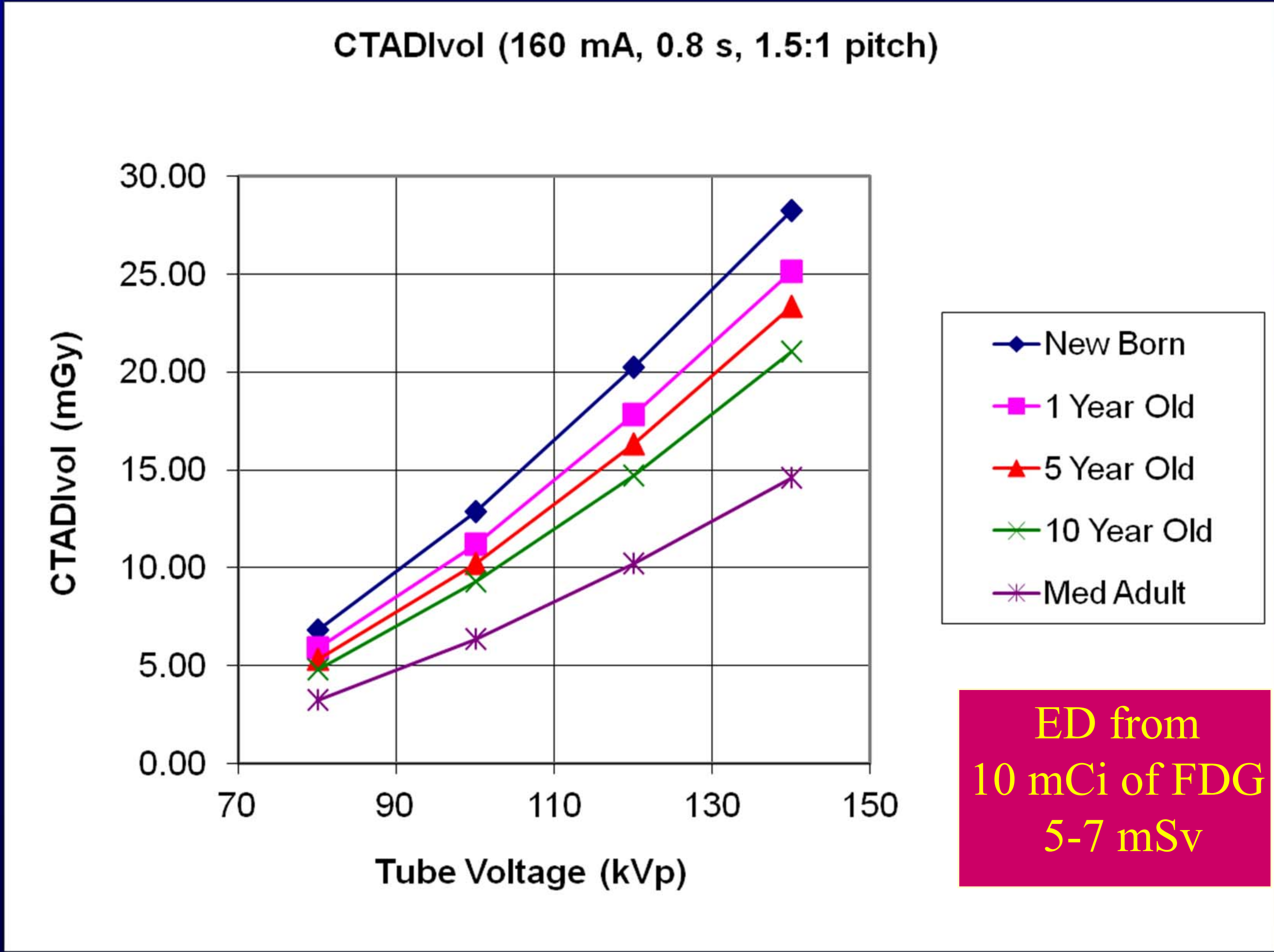
Fahey et al. *Radiology* 2007;243:96-104

Dosimetry of PET-CT and SPECT-CT

- PET/CT
  - GE Discovery LS

- SPECT/CT
  - Philips Precedent

Dose from CT of PET-CT GE Discovery LS (4-slice)



ED from
10 mCi of FDG
5-7 mSv

ImPACT CT Dose Calculator

120 kVp, 100 mAs, Pitch 1:1

"eyes to thighs" (95 cm)

CTDIvol = 11.1 mGy

DLP = 1053 mGy-cm

Effective Dose = 16 mSv

ImPACT CT Patient Dosimetry Calculator

Version 1.0 28/08/2009

Scanner Model:		
Manufacturer:	GE	
Scanner:	GE LightSpeed VCT	
kV:	120	
Scan Region:	Body	
Data Set	MCSET20	Update Data Set
Current Data	MCSET20	
Scan range		
Start Position	-10	cm
End Position	85	cm

Get From Phantom Diagram

Organ weighting scheme	ICRP 103

Acquisition Parameters:			
Tube current		100	mA
Rotation time		1	s
Spiral pitch		1	
mAs / Rotation		100	mAs
Effective mAs		100	mAs
Collimation			mm
Rel. CTDI	Look up	1.00	(assumed)
CTDI (air)	Look up	35.0	mGy/100mAs
CTDI (soft tissue)		37.4	mGy/100mAs
$_nCTDI_w$	Look up	11.1	mGy/100mAs

$CTDI_w$	11.1	mGy
$CTDI_{vol}$	11.1	mGy
DLP	1053	mGy.cm

Organ	w_T	H_T (mGy)	$w_T.H_T$
Gonads	0.08	17	1.4
Bone Marrow	0.12	12	1.4
Colon	0.12	15	1.8
Lung	0.12	18	2.2
Stomach	0.12	17	2
Bladder	0.04	18	0.72
Breast	0.12	14	1.6
Liver	0.04	16	0.64
Oesophagus (Thymus)	0.04	21	0.82
Thyroid	0.04	27	1.1
Skin	0.01	11	0.11
Bone Surface	0.01	25	0.25
Brain	0.01	5.7	0.057
Salivary Glands (Brain)	0.01	5.7	0.057
Remainder	0.12	16	1.9
Not Applicable	0	0	0
Total Effective Dose (mSv)			16

Remainder Organs
Adrenals
Small Intestine
Kidney
Pancreas
Spleen
Thymus
Uterus / Prostate (Bladder)
Muscle
Gall Bladder
Heart
ET region (Thyroid)
Lymph nodes (Muscle)
Oral mucosa (Brain)
Other organs of interest
Eye lenses
Testes
Ovaries
Uterus
Prostate

Scan Description / Comments

Imaging Performance Assessment of CT Scanners, an MHRA Evaluation centre

http://www.impactscan.org

Organ	w_T	H_T (mGy)	$w_T.H_T$
Gonads	0.08	17	1.4
Bone Marrow	0.12	12	1.4
Colon	0.12	15	1.8
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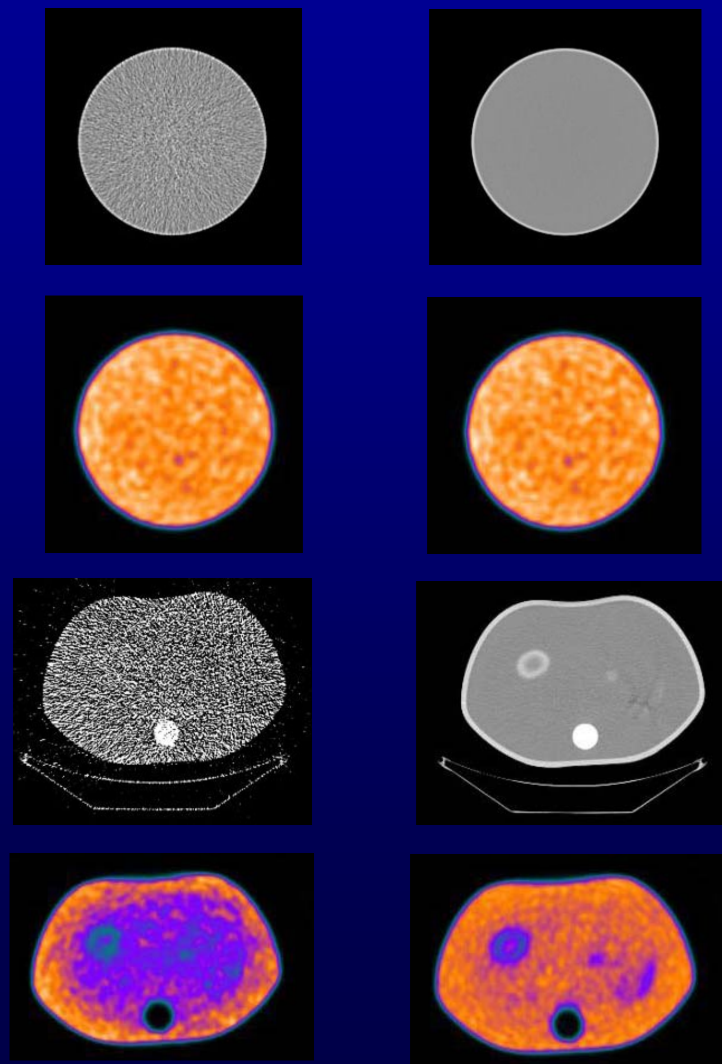
Remainder	0.12	16	1.9
Not Applicable	0	0	0
Total Effective Dose (mSv)			16

Quality of CT-based Attenuation Correction

80 kVp
10 mA
0.5 s/rot
1.5:1



140 kVp
160 mA
0.8 s/rot
1.5:1

Initial Experience with weight-based, low-dose pediatric PET/CT protocols

Alessio et al. J Nucl Med 2009;50:1570-1578

- 0.144 mCi/kg FDG (1 & 10 mCi min & max)
- 120 kVp
- Weight-based (Broselow-Luten color scale) 10-40 mAs
- 45 patients (9.2-109 kg, 1.4-23 YO)
- Dosimetry extrapolated from standard phantoms
- WB PET/CT effective dose from 5.4 to 10.0 mSv for 9 and 70 kg patient, respectively

Axial Extent of CT

- "Whole Body" PET typically acquired "Eyes to Thighs"
- Potential for SPECT acquisitions to all be extended, particularly with more efficient reconstruction
- Thus CT component can be combination of head & neck, thoracic, abdominal and pelvic CT
- Is "One size fits all" appropriate?
- Alternative paradigm suggested by George Segall of Stanford and Palo Alto VA Medical Center
- Standardization of technique

Adult Effective Doses (mSv)

Procedure	Ave ED (mSv)
Radiograph of Extremity	0.001
Posterior/Anterior and Lateral Chest Radiograph	0.1
Mammography	0.4
Abdominal Radiograph	0.7
Head CT	2.0
^{99m}Tc MAG3 Renal Scan	***2.7***
Intravenous Urography	3.0
^{99m}Tc MDP Bone Scan	***4.2***
^{99m}Tc ECD Brain Scan	***5.7***
Pelvic CT	6.0
Chest CT	7.0
^{18}F FDG PET Scan	***7.4***
Abdominal CT	8.0
^{99m}Tc MIBI for Stress/Rest Cardiac Scan	***11.8***
Coronary Angiographic CT	16.0

Mettler et al. Radiol 2008;248:254-263, ICRP 80 and 106

Pediatric Administered Dose Survey

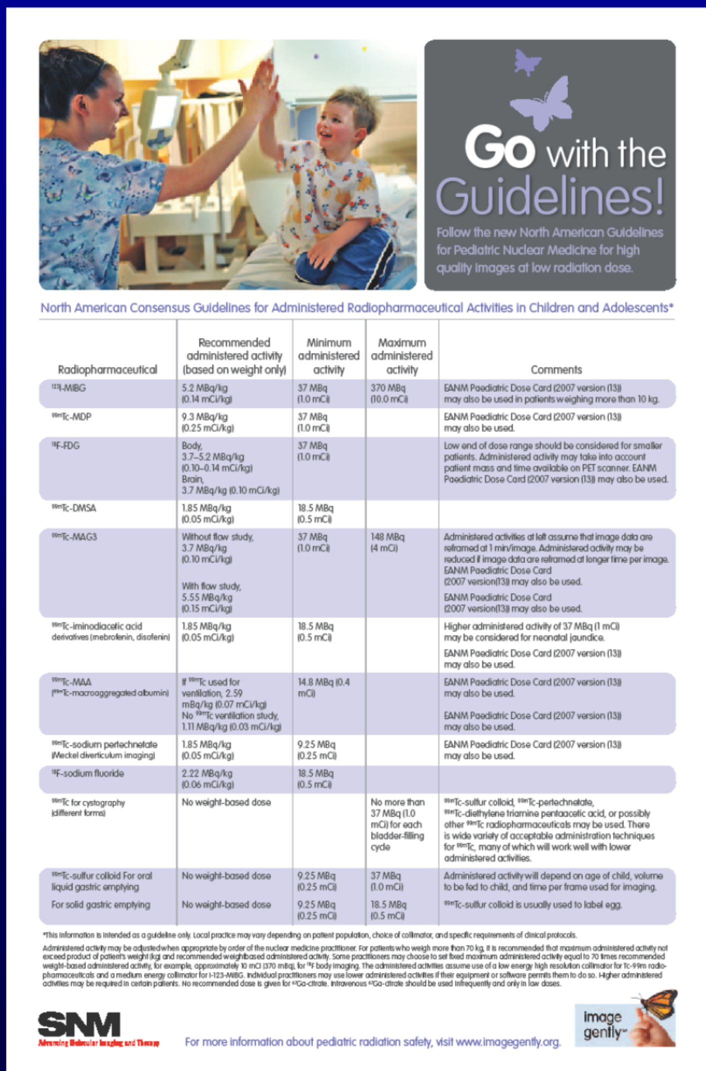
- Surveyed 15 dedicated pediatric hospitals in North America (13 responded)
- Requested information on 16 studies commonly performed in pediatric NM
  - Administered dose/kg, Max admin dose, Min admin dose
- Consider the maximum/minimum as the range factor
- For Admin dose/kg and Max dose the range factor varied, on average, by factor of 3 (max 10)
- Min dose range factor varied, on average, by factor of 10 (max 20)

Treves ST, Davis RT, Fahey FH. *J Nucl Med*, 2008;49:1024-1027.

Image Gently

Gelfand MJ, Parisi MT, Treves ST *Pediatric radiopharmaceutical administered doses: 2010 North American consensus guidelines*. J Nucl Med. 2011;52:318-22.

Image Gently



North American Consensus Guidelines for Administered Radiopharmaceutical Activities in Children and Adolescents*

Radiopharmaceutical	Recommended administered activity (based on weight only)	Minimum administered activity	Maximum administered activity	Comments
^{123}I-MIBG	5.2 MBq/kg (0.14 mCi/kg)	37 MBq (1.0 mCi)	370 MBq (10.0 mCi)	EANM Paediatric Dose Card (2007 version (13)) may also be used in patients weighing more than 10 kg.
^{99m}Tc-MDP	9.3 MBq/kg (0.25 mCi/kg)	37 MBq (1.0 mCi)		EANM Paediatric Dose Card (2007 version (13)) may also be used.
^{18}F-FDG	Body, 3.7–5.2 MBq/kg (0.10–0.14 mCi/kg) Brain, 3.7 MBq/kg (0.10 mCi/kg)	37 MBq (1.0 mCi)		Low end of dose range should be considered for smaller patients. Administered activity may take into account patient mass and time available on PET scanner. EANM Paediatric Dose Card (2007 version (13)) may also be used.
^{99m}Tc-DMSA	1.85 MBq/kg (0.05 mCi/kg)	18.5 MBq (0.5 mCi)		
^{99m}Tc-MAG3	Without flow study, 3.7 MBq/kg (0.10 mCi/kg) With flow study, 5.55 MBq/kg (0.15 mCi/kg)	37 MBq (1.0 mCi)	148 MBq (4 mCi)	Administered activities at left assume that image data are reframed at 1 min/image. Administered activity may be reduced if image data are reframed at longer time per image. EANM Paediatric Dose Card (2007 version(13)) may also be used. EANM Paediatric Dose Card (2007 version(13)) may also be used.
^{99m}Tc-iminodiacetic acid derivatives (mebrofenin, disofenin)	1.85 MBq/kg (0.05 mCi/kg)	18.5 MBq (0.5 mCi)		Higher administered activity of 37 MBq (1 mCi) may be considered for neonatal jaundice. EANM Paediatric Dose Card (2007 version (13)) may also be used.
^{99m}Tc-MAA (^{99m}Tc-macroaggregated albumin)	If ^{99m}Tc used for ventilation, 2.59 mBq/kg (0.07 mCi/kg) No ^{99m}Tc ventilation study, 1.11 MBq/kg (0.03 mCi/kg)	14.8 MBq (0.4 mCi)		EANM Paediatric Dose Card (2007 version (13)) may also be used. EANM Paediatric Dose Card (2007 version (13)) may also be used.
^{99m}Tc-sodium pertechnetate (Meckel diverticulum imaging)	1.85 MBq/kg (0.05 mCi/kg)	9.25 MBq (0.25 mCi)		EANM Paediatric Dose Card (2007 version (13)) may also be used.
^{18}F-sodium fluoride	2.22 MBq/kg (0.06 mCi/kg)	18.5 MBq (0.5 mCi)		
^{99m}Tc for cystography (different forms)	No weight-based dose		No more than 37 MBq (1.0 mCi) for each bladder-filling cycle	^{99m}Tc-sulfur colloid, ^{99m}Tc-pertechnetate, ^{99m}Tc-diethylene triamine pentaacetic acid, or possibly other ^{99m}Tc radiopharmaceuticals may be used. There is wide variety of acceptable administration techniques for ^{99m}Tc, many of which will work well with lower administered activities.
^{99m}Tc-sulfur colloid For oral liquid gastric emptying	No weight-based dose	9.25 MBq (0.25 mCi)	37 MBq (1.0 mCi)	Administered activity will depend on age of child, volume to be fed to child, and time per frame used for imaging.
For solid gastric emptying	No weight-based dose	9.25 MBq (0.25 mCi)	18.5 MBq (0.5 mCi)	^{99m}Tc-sulfur colloid is usually used to label egg.

*This information is intended as a guideline only. Local practice may vary depending on patient population, choice of collimator, and specific requirements of clinical protocols.

Administered activity may be adjusted when appropriate by order of the nuclear medicine practitioner. For patients who weigh more than 70 kg, it is recommended that maximum administered activity not exceed product of patient's weight (kg) and recommended weight-based administered activity. Some practitioners may choose to set fixed maximum administered activity equal to 70 times recommended weight-based administered activity, for example, approximately 10 mCi (370 mBq), for ^{18}F body imaging. The administered activities assume use of a low energy high resolution collimator for Tc-99m radiopharmaceuticals and a medium energy collimator for I-123-MIBG. Individual practitioners may use lower administered activities if their equipment or software permits them to do so. Higher administered activities may be required in certain patients. No recommended dose is given for ^{67}Ga-citrate. Intravenous ^{67}Ga-citrate should be used infrequently and only in low doses.

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Guidelines poster published Nov/Dec 2011 in J Nucl Med, J Nucl Med Technol, Radiology, Pediatric Radiology

Available from Image Gently, SPR and SNM

Image Wisely Nuclear Medicine Project

- Image Wisely initially concentrated on CT
- Now expanding to nuclear medicine
- Kick-off Meeting October 27, 2011
- SNM and ASNC asked to participate in addition to ACR, RSNA, ASRT and AAPM

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- IW Leadership
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  - Donald Peck (AAPM)
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- SNM/SNMTS
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- RSNA
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Image Wisely Nuclear Medicine Project

- Develop material for imaging professionals first followed by that for referring physicians and patients
  - General Nuclear Medicine
  - Cardiac Nuclear Medicine
  - PET and PET/CT
- Target Date – Summer 2012

Questions?

Safe Travels!