

Debunking Myths- Appropriate Radiological Investigation

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Alternative title...

Issues in Radiology – how
do I decide which test is
best?

...and what about the
radiation?

Aims

- Which imaging test should I request?
 - Overutilisation
 - Appropriateness criteria
 - Guidelines
 - Some specific conditions
- Interesting cases (GP referrals)
- Improve awareness of radiation exposure and effects
 - General information
 - CT
 - Pregnancy

Which imaging test? - Background

- Diagnostic Radiology increasingly central to patient care
 - ACR: fastest growing service in Medicine
 - \$100,000,000,000 per year (US)
 - Services and costs growing nearly twice rate of other technologies – lab tests and pharmaceuticals
 - Older population
 - May obviate need for more invasive and costly procedures
- *Hendy et al Radiology 2010; 257 (1) 240 - 245*

Which imaging test? - Background

- Rapid advances in technology
 - Clinical information acquired
 - Speed of gathering this information
 - Accessibility
- Patient expectations
 - *'I need an xray/ultrasound/CT/MRI/PET-CT...'*
- Some older tests outmoded
 - IVP vs CT urogram
- Practicalities
 - Get an imaging test before referral



Overutilisation

- *Applications of imaging procedures where circumstances indicate that they are unlikely to improve patient outcome*
- 20 – 50% HTI fails to improve patient outcomes
 - But fails to acknowledge importance of negative tests

Overutilisation

➤ Overutilisation

- Unnecessary radiation dose
- Increases average dose to population
 - US: 700% increase in annual population radiation dose between 1980 and 2006
 - Population increased by 32% in same time
 - Concern about effects in younger patients

Factors affecting overutilisation

➤ Defensive medicine

- *Diagnostic measures applied to safeguard against accusations of malpractice rather than to benefit the patient*
- 25% of HTI
- Anecdotal rather than good data
- Bigger than Radiology

Appropriateness criteria

- Appropriateness criteria
 - Do they exist?
- Not widespread
 - Voluntary use
 - → ignored
 - Consensus opinions of experts rather than comparative effectiveness research

Guidelines

- Practice/referral guidelines
 - Incorporate appropriateness criteria
 - Well publicised
 - Easily accessible
 - Used as intended
 - Some deviation allowed
- Difficult to keep up to date
 - Imaging only one part of patient's care

Guidelines

➤ Referrers

- Knowledge of imaging tests
 - Limitations
 - Alternatives
- Education of referrers on merits and limitations of various imaging tests should begin at medical school
 - Continued by radiologists acting *not as experts but as colleagues*

Guidelines

- Radiologists
 - Review of requests
 - Time-effective? Consultant vs gatekeeper



Perception



Reality

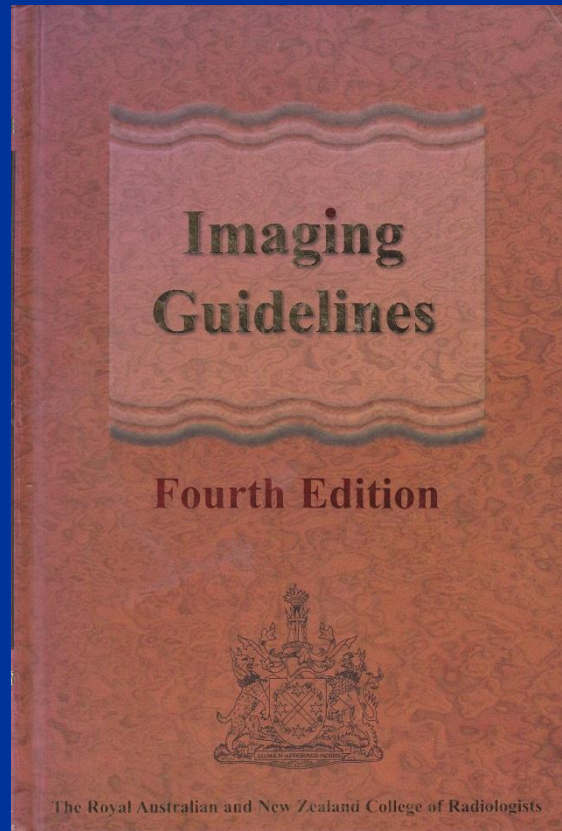
Guidelines

- Recommendation of further tests
 - Obligation to perform?
- Patients
 - Demand imaging test
 - +/- Internet-educated - cyberchondria

What imaging guidelines are there?

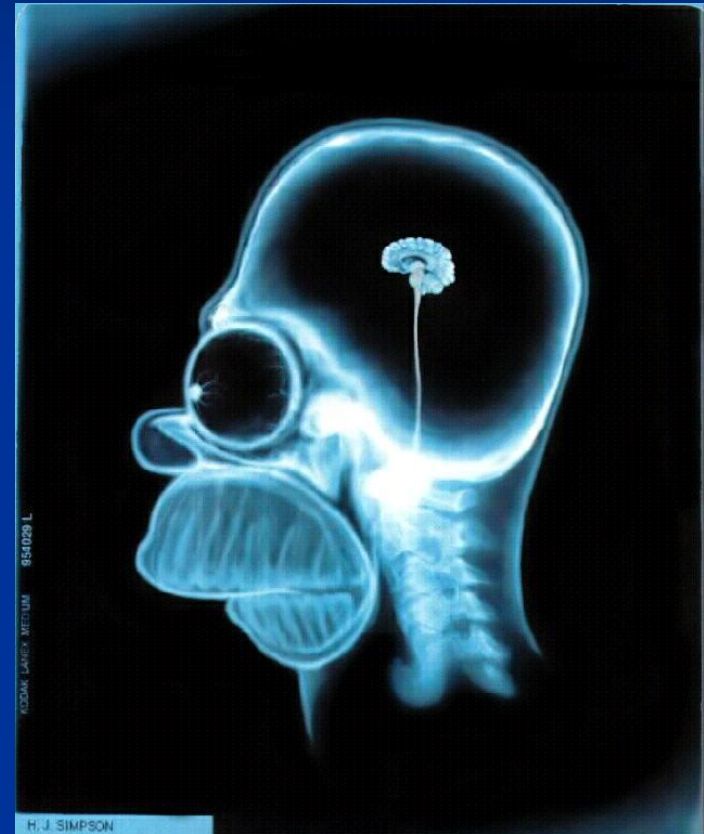
- RANZCR

- 1990 – 2001 'Imaging Guidelines'



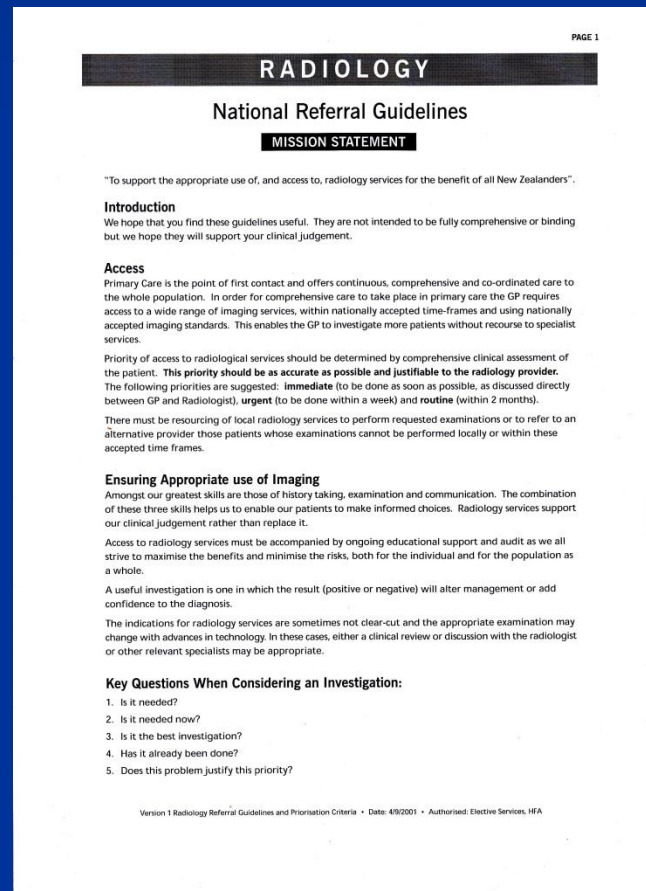
What imaging guidelines are there?

- Currently none! RANZCR
- In development
- MRI first



What imaging guidelines are there?

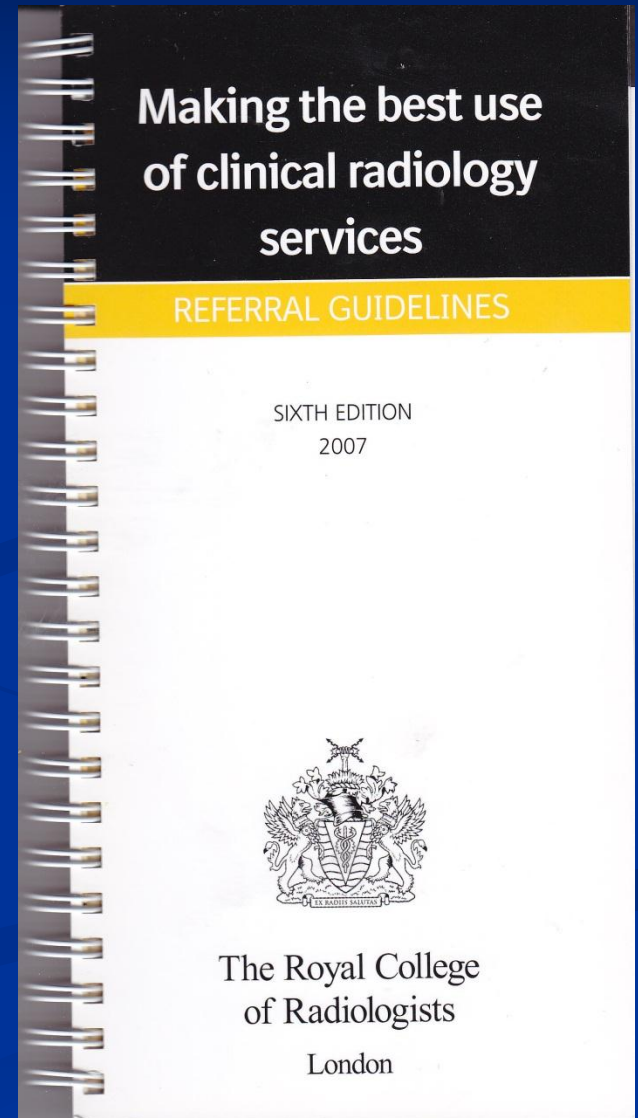
➤ 2001 Elective Services HFA National Referral Guidelines



Still used?

What imaging guidelines are there?

➤ Royal College of Radiologists



RCR Guidelines

- To help referrers and radiologists to determine most appropriate imaging test and avoid waste
- Waste:
 - Has test already been done?
 - Does it need to be done?
 - Does it need to be done now?
 - Is it best investigation?
 - Has the problem been explained?
 - Are they all needed?

RCR Guidelines

- Evidence via medical databases (Medline etc) and journals
- Expert panels
- Consultation with medical colleges, specialist societies

RCR Guidelines

- Levels of evidence

- A → C

- A: high quality diagnostic studies, independently and blindly compared
Systematic reviews and metaanalyses

- C: Opposite of A
Expert opinion

RCR Guidelines

- Recommendations:
 - Indicated
 - Specialised investigation
 - Not indicated initially
 - Indicated only in specific circumstances
 - Not indicated

RCR Guidelines

- Indicated:
 - Most likely to contribute to Dx and management
- Specialised:
 - Complex, time consuming, costly
 - After discussion with radiologist
- Not indicated initially:
 - Clinical situation resolves usually. Image if persists
- Indicated only in specific circumstances
 - Non routine studies
- Not indicated:
 - Untenable

RCR Guidelines

MUSCULOSKELETAL SYSTEM

MUSCULOSKELETAL SYSTEM

Lumbar spine

Chronic back pain with no clinical or serological indicators of infection or neoplasia (ie, no red flags)
(For children see P11)

M04

MRI

None

Indicated [C]

MRI is the preferred investigation for the diagnosis of most spinal diseases.

XR

✱

Indicated only in specific circumstances [C]

XR is only indicated if presentation suggests osteoporotic collapse in the elderly or suspected spondyloarthropathies in young patients.

CT

✱✱

Specialised investigation [C]

CT is used when MR is contraindicated and when further assessment of spondylolyses is required.

NM

✱✱

Specialised investigation [C]

NM is non-specific, and has been largely supplanted by MR and CT in the assessment of chronic back pain. It may show occult osteoid osteomas and spondylolyses.

108

109

M03

urgent referral in elderly patients with sudden pain, to show osteoporotic collapse or other forms of bone destruction. Consider NM for possible metastatic lesions.

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(For children see P11)

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108

109

What imaging guidelines are there?

- American College of Radiology (ACR)
- Appropriateness Criteria 1993
 - Evidence based guidelines
 - To assist referrers in most appropriate imaging
 - Expert panels in diagnostic and interventional radiology, and radiation oncology
 - >160 topics

ACR Appropriateness Criteria

Variant 1:

Initial evaluation for chronic hip pain. First test.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
X-ray pelvis	9		☼ ☼
X-ray hip	9	AP and lateral views of the affected hip.	☼ ☼ ☼
MRI hip without contrast	1		O
MRI hip without and with contrast	1		O
US hip	1		O
CT hip without contrast	1		☼ ☼ ☼
CT arthrography hip	1		☼ ☼ ☼
MR arthrography hip	1		O
Tc-99m bone scan hip	1		☼ ☼ ☼
X-ray arthrography hip with anesthetic ± corticosteroid	1		NS

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative
Radiation Level

Are ACR AC used?

- Bautista (2009)
 - Referrers at 500 bed hospital
 - What resources do you use when referring for imaging tests?
- What percentage used the ACR guidelines?

Are ACR AC used?

2.4%

...last

➤ Radiologist consult (64%) > speciality journal > UpToDate > Google > PubMed

➤ *Bautista et al AJR 2009; 192: 1581-1585*

➤ **ACR AC for MSK imaging used by <30%**

➤ *Tigges et al AJR 2000;175:545-547*

Specific conditions (plain films)

➤ What kind of exams?

- L-spine ~20%
- Hips/pelvis ~20%
- Knees ~15%
- CXR ~15%
- C/T spine ~10%
- Extremities ~7%

Common conditions

- Neck pain
- Lumbar back pain
- Constipation
- Haematuria
- Some MSK conditions

Neck pain

- Non-traumatic
- Pain, stiffness, generalised tenderness
 - Not indicators for imaging
- Neurological signs, point tenderness, decreased ROM
 - Indicators for imaging
- Hx of malignancy, signs of infection
 - Indicators for imaging

Neck pain

- If no radiculopathy → plain films
 - AP, lateral, peg views, obliques
 - Note poor correlation of symptoms with disc space narrowing, osteophytic foraminal narrowing
 - Osteophytes are common > 50 y
 - End plates, foraminae



Neck pain

- If radiculopathy or myelopathy, then MRI
- Contraindication to MRI? CT +/- myelogram
- History of malignancy – bone scan
- Kids – unusual
 - Imaging
 - PF +/- MRI

Lumbar back pain

- A hairy beast...
- Most is self-limiting
- Many receive no imaging
 - Many don't seek medical attention
- Numerous guidelines
 - European Working Group 2006
 - American College of Physicians 2007

Lumbar back pain – why do we image?

- Reassurance
 - Referrer and patient
- Patient expectations
- Identify specific anatomical diagnosis for LBP

Lumbar back pain

- Focussed history and examination can separate nonspecific back pain from radiculopathy or other specific causes
- Xray findings may not be helpful
 - Awareness of physiological age-related changes
 - Rare to find serious underlying conditions in primary care patients with LBP
 - *Balague et al Lancet 2007;369:726-727*
 - Radiation doses

Lumbar back pain

- Agency for Healthcare Policy and Research 1994
- Recommended against routine imaging in first month of acute low back pain
- Based on
 - Observational studies - low incidence of serious conditions in patients with red flags
 - Weak correlation between imaging findings and symptoms
 - Lack of evidence that imaging helps

Lumbar back pain

- Chou et al 2009
- Metaanalysis of RCTs comparing routine lumbar spine imaging against clinical care and no imaging
 - in patients with no indication of serious underlying conditions
- 6 trials, ~ 1800 patients
- *Chou et al Lancet 2009;373:463-72*

Lumbar back pain

- Assessed pain
- Function
- Mental health
- Quality of life
- Patient satisfaction
- Overall patient-reported satisfaction

Lumbar back pain

- *We did not note any significant difference between routine, immediate lumbar imaging and usual clinical care without immediate imaging for improvement in pain or function at short term or long term follow up*
- Short term $\leq 3/12$
- Long term 6 -12 months

LBP - what are the red flags?

- Significant trauma
- Neurological deficits
 - Sphincter/gait disturbance; saddle anaesthesia; motor loss
- Hx of malignancy
- Hx of osteoporosis
- Hx of long term steroid use
- Clinical concern for infection, neoplasia
- Immunosuppression
- (Spondyloarthropathies)

LBP – what imaging test should I get?

➤ Plain films

- Osteoporotic collapse
- Spondyloarthropathies

➤ NM

- Malignancy

➤ MRI

- LBP with radiculopathy
- Infection

Imaging for constipation

- Adults:

- AXR may reveal a colon full of faeces

- Acute constipation in the setting of an empty rectum and a proximal colon that is dilated with air or faeces suggests large bowel obstruction

- Malignancy

- Volvulus

- Kids:

- Plain radiograph of the abdomen

Haematuria

- Microscopic:

- < 45y
- US renal tract + AXR
- May not detect some calculi

- Macroscopic:

- US renal tract + AXR
- CTKUB: if US negative/equivocal



Haematuria

- What about IVU?
 - Less sensitive than CTKUB +/- contrast for stones and urothelial tumours
 - IVU up to 20% stones non-opaque (uric acid)
 - CT - all stones are visible
- CTKUB: issues
 - Access
 - Radiation dose
 - Low dose CTU ~same as IVU
 - 6 mSV

Haematuria



MSK conditions – shoulders, hips, knees

➤ Shoulders:

➤ PF for

- persistent shoulder pain not responding to conservative treatment
- Calcific tendinitis

➤ US for rotator cuff tear

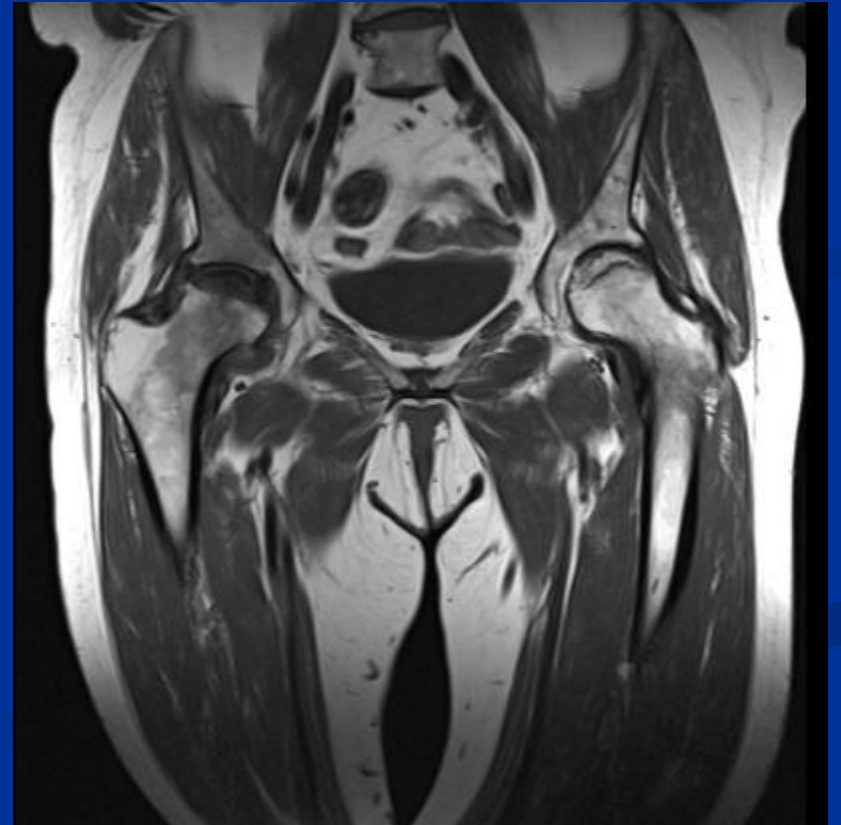
- Complete loss of subacromial joint space on PF indicates full thickness rotator cuff tear ? Need US
- MR for ligamentous injuries, labral tears

MSK conditions – shoulders, hips, knees

➤ Hips:

- PF for persistent pain
 - Assess DJD, focal bony pathology and dysplasia
- MRI – for Xray-ve persistent pain
- ?AVN – PF useful in established disease but NB often normal first 6 – 9/12
 - MRI test of choice otherwise

AVN



MSK conditions – shoulders, hips, knees

- Painful prostheses:
- Infection and loosening
 - PF first – assess local complications – subluxation, heterotopic new bone formation, increased gap at bone-cement interface
 - Comparison to previous xrays
 - Triple phase bone scan
 - Normal: excludes most late complications
 - Increased uptake around loose prostheses
 - Less useful for sterile v infected loosening

MSK conditions – shoulders, hips, knees

➤ Knees:

- Atraumatic
- PF: acute onset, exacerbation, duration > 6/52
- OA changes are common
- Children: remember the hip joint if PF negative
- Locking: PF for radioopaque loose bodies
 - MR for meniscal tears
- US: soft tissue masses, anterior knee pain
 - Baker's cysts, pes anserinus bursitis, patellar tendinitis



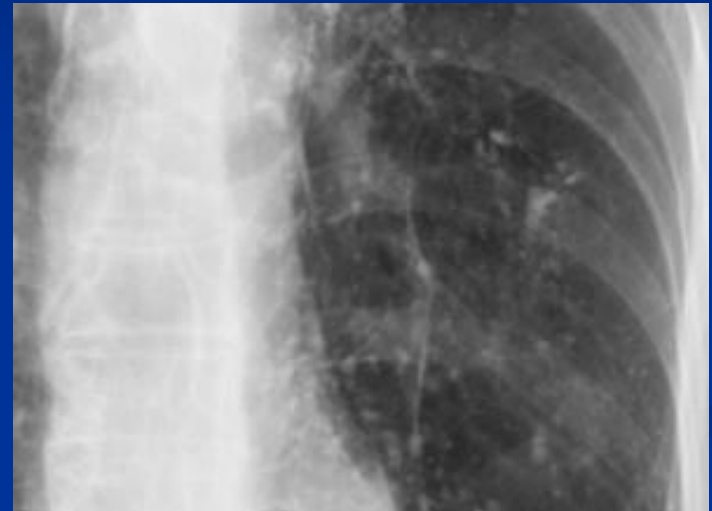
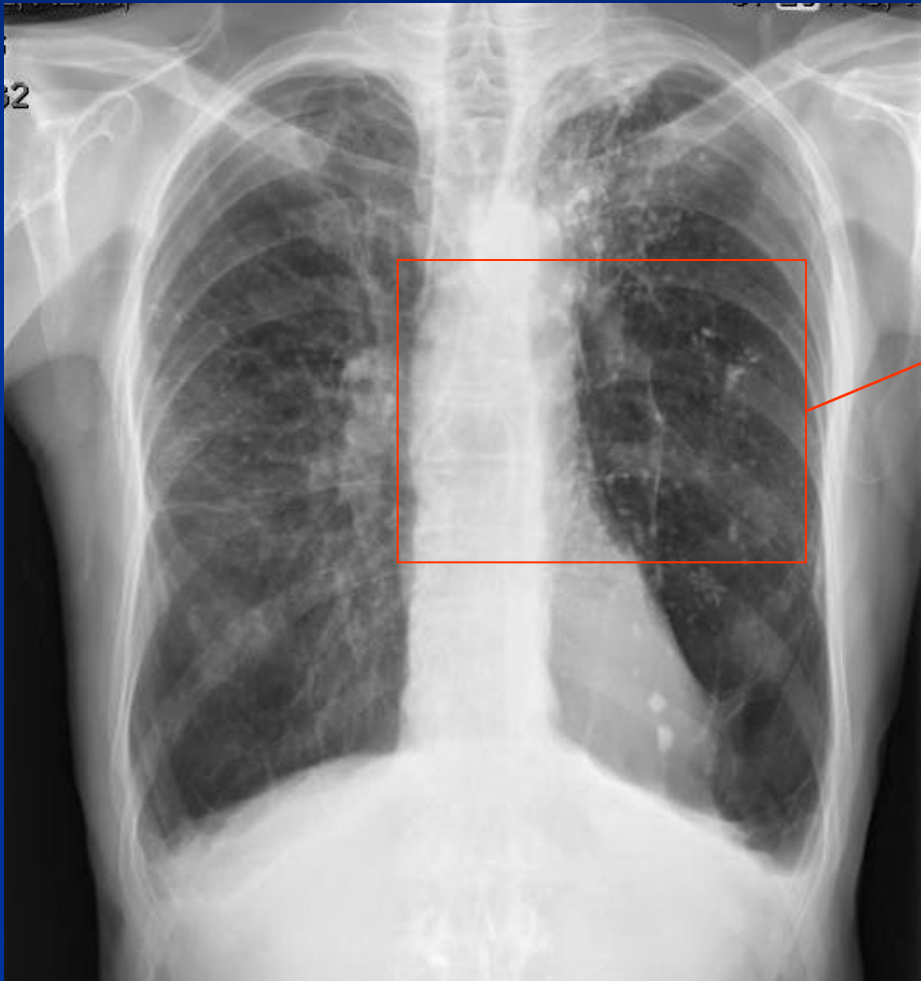
INTERESTING CASES

28 F, fell down stairs, tender sacrum



Partial lumbarisation S1, Gd 1 spondylolisthesis, pars defect

79 M, COPD, weight loss



Busy CXR; old TB, COPD
? Mass lesion

79 M, COPD, weight loss



Current



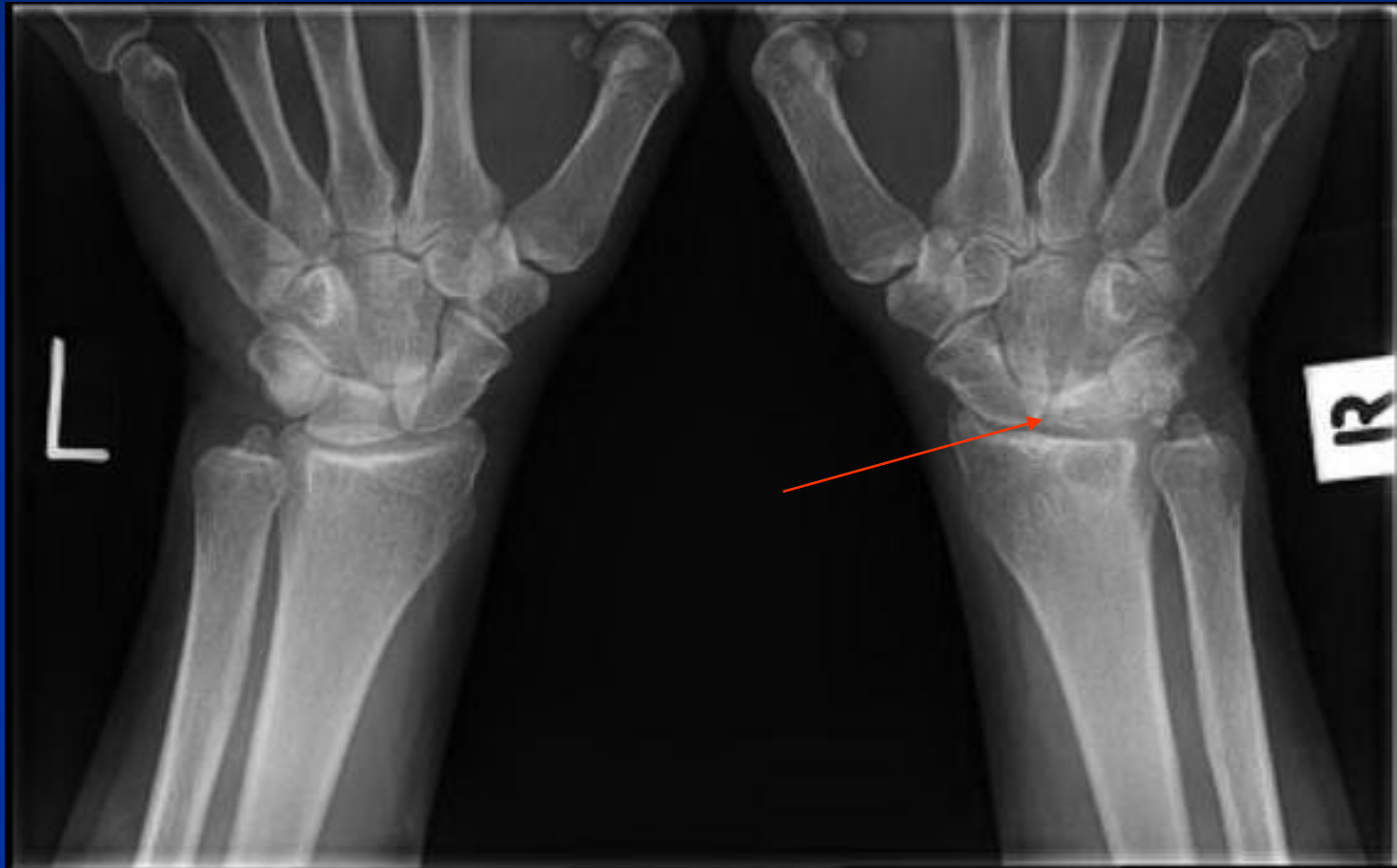
January 2010

15 F, backpain, ? Scheurman's



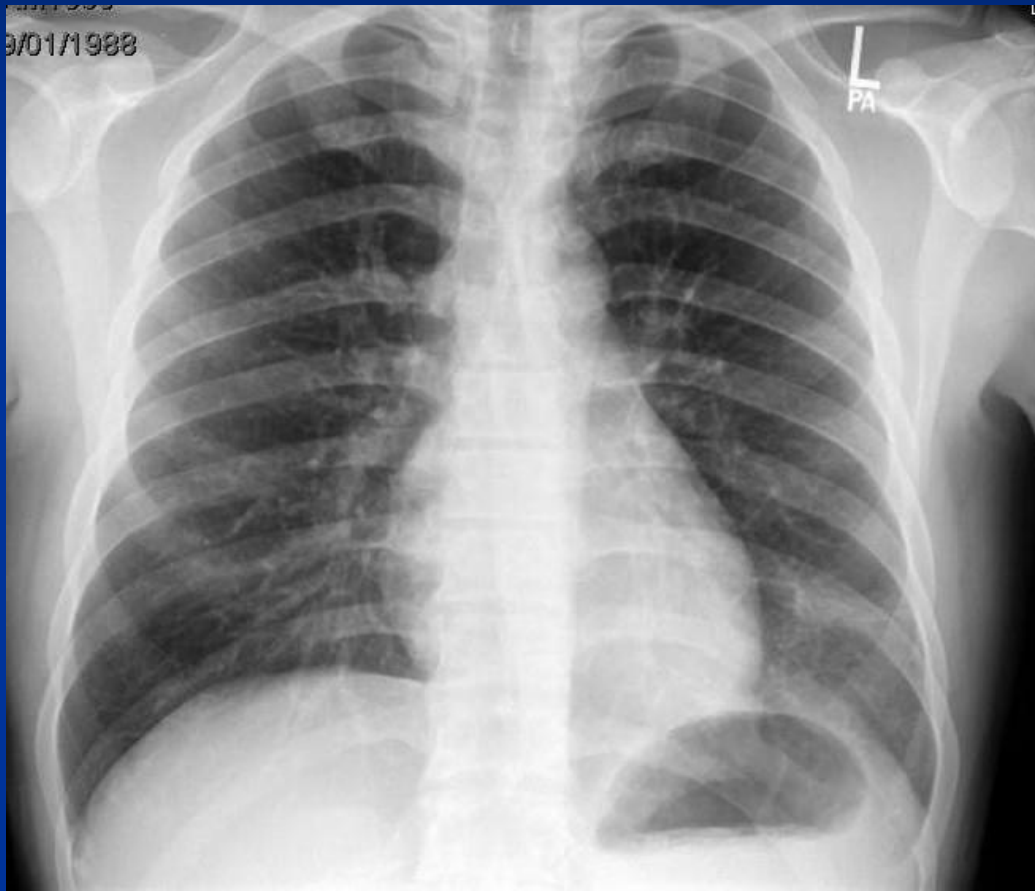
Lumbarised S1,
Articulation of left
transverse process
with sacral ala

48 F, wrist pain ? OA



Sclerosis of lunate, subchondral cyst, irregularity ? Kienbock's

23 M, productive cough ?LRTI



Segmental LLL consolidation

48 F, FOOSH, on steroids

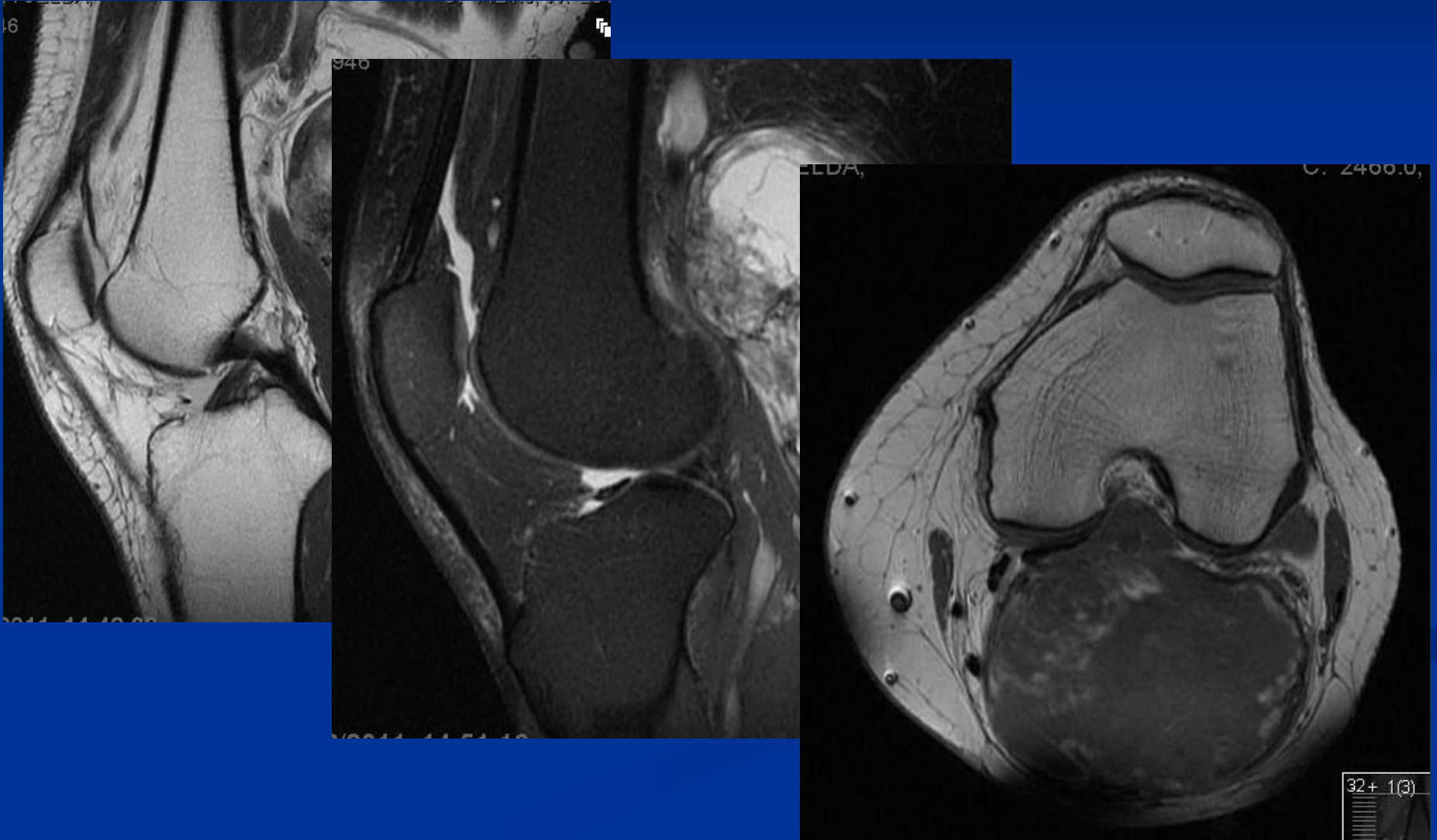


Erosions, JSN, vascular calcification = RA + DM

49 M, popliteal cyst, increasing size after steroid injection



49 M, popliteal cyst, increasing size after steroid injection



14 M, L hip pain 1/52, ? SUFE

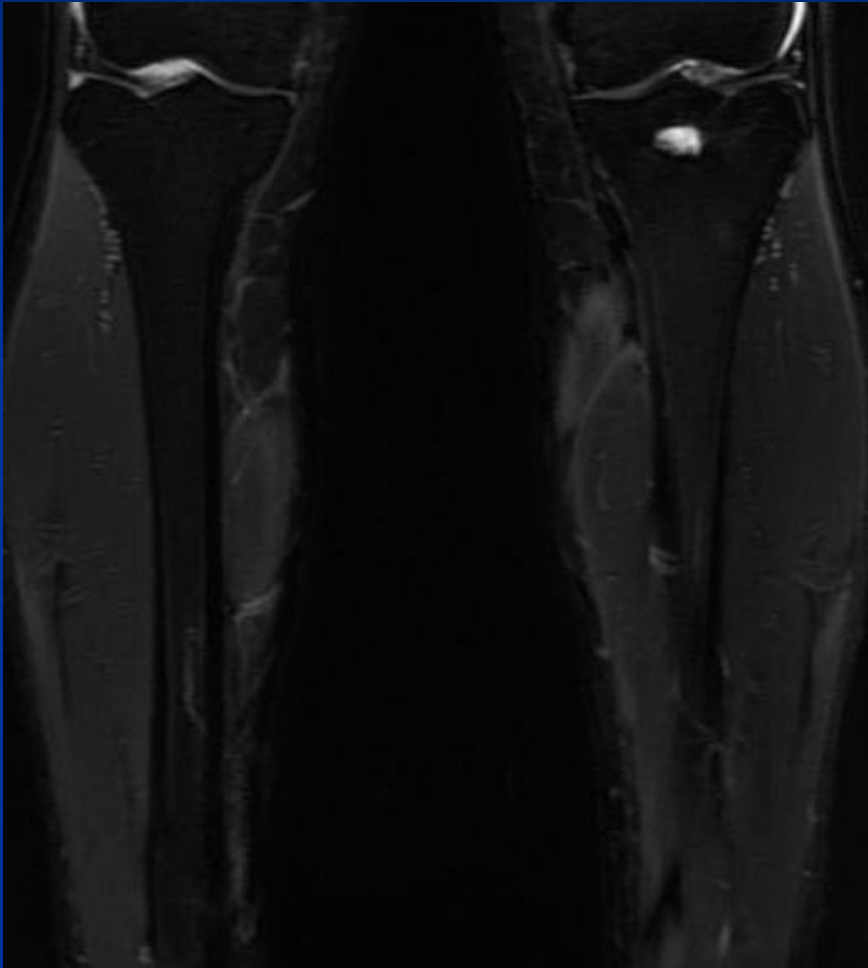


Avulsion of left ASIS – sartorius and TFL

25 M, L knee inflammation

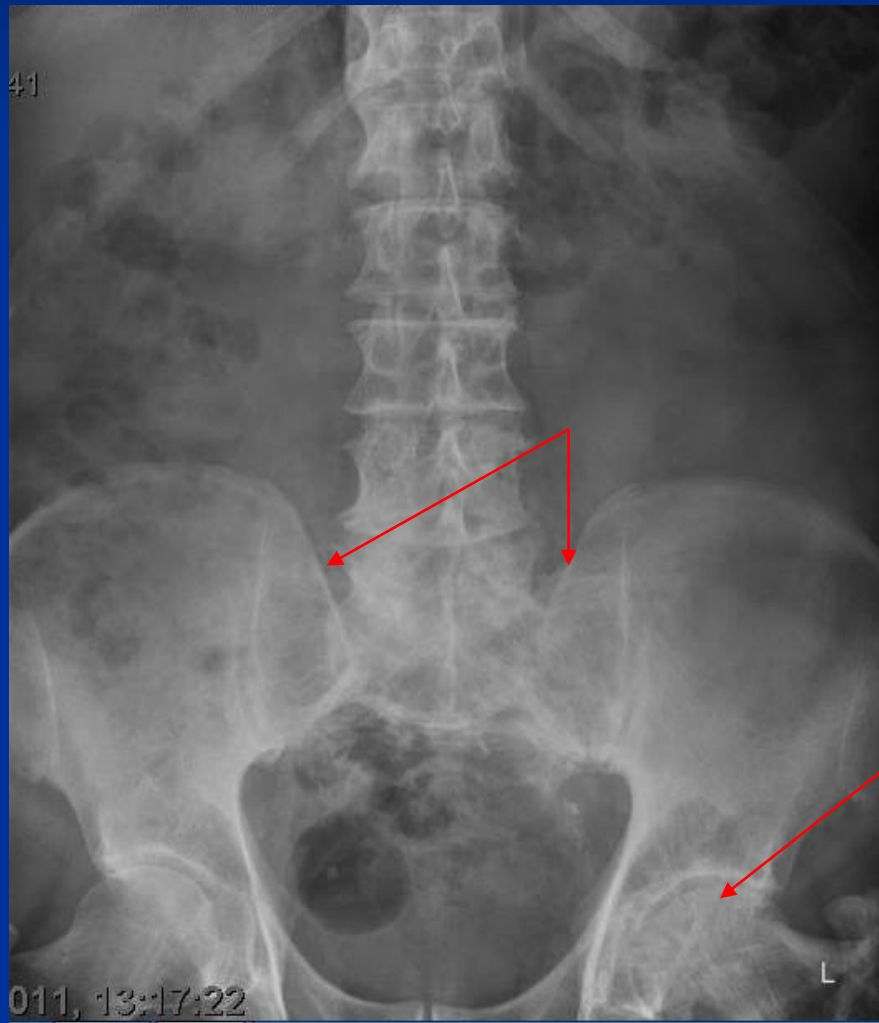


25 M, L knee inflammation



Brodie's abscess

64 M, RUQ pain



Paget's disease

34 M, immigration CXR



Hemivertebra

Radiation doses in Radiology

- Which of the following has the highest radiation dose?
- CT abdomen
- Bone scan
- Flying from Melbourne to London
- MRI lumbar spine
- Lumbar spine xray series
- Mammogram

Radiation doses in Radiology

➤ Which of the following has the highest radiation dose?			<u>N° of CXR</u>
➤ CT abdomen	11 mSv		35
➤ Bone scan	4.5 mSv		12
➤ Flight Melbourne to London	0.16 mSv		0.5
➤ MRI lumbar spine	0 mSv		0
➤ Lumbar spine xray series	1.6 mSv		4.5
➤ Mammogram	0.5 mSv		1.4

Radiation doses in Radiology

- All exposed to background radiation
 - 2 mSv per year (~50 CXR)
 - Natural sources
 - Cosmic radiation, radon and thoron, food and drink, building materials
 - Artificial sources
 - Medical imaging
 - Nuclear testing
 - Chernobyl
 - Nuclear power

Radiation doses in Radiology - units of measure

- Sievert Sv
- USA – rem (Roentgen equivalent man)
- $1 \text{ Sv} = 100 \text{ rem}$
- $1 \text{ mSv} = 100 \text{ mrem}$

Radiation doses in Radiology

- Xrays and gamma rays – ionising radiation
 - Can deposit enough energy to change DNA
 - Different tissues absorb different amounts
 - Bone >> soft tissues

What are risks of ionising radiation?

- Stochastic and deterministic
- Stochastic:
 - Long term risk
 - Concerned with slight increase in possibility of cancer being caused by radiation exposure
 - Expressed as chances per million or %
 - Populations
 - Data from survivors of atomic bombs in Japan

What are risks of ionising radiation?

Procedure	Additional % stochastic risk*
Chest X-ray - posterior-anterior (from the back to the front)	0.00013%
Lumbar spine X-ray (single view image of the lower spine for a bad back)	0.0035%
Pelvis X-ray anterior-posterior (from the front to the back)	0.0035%
CT of the chest	0.04%
CT of the abdomen	0.05%
CT of the pelvis	0.05%
Mammogram	0.0065%
Ultrasound	0
Magnetic resonance imaging (MRI)	0

Over and above normal lifetime incidence of death from cancer

What are risks of ionising radiation?

➤ Deterministic:

- Short term risk
- More immediate effects associated with high radiation doses
- Threshold above which severity increases with dose
- Eg radiation sickness, radiation burns, cataracts

What are risks of ionising radiation?

- Different tissues have different sensitivities
- Breast > thyroid > bone
- F > M 2x
- Children > adults – rapid growth and cell division
- Children – longer expected life so more time for effects to develop

What are risks of ionising radiation?

- Estimating risk is difficult
- Knowledge from Hiroshima and Nagasaki survivors, Chernobyl
- Individual risk is low
- Think of equivalents....

What are risks of ionising radiation?

Procedure	Risk of Fatal Cancer	Equivalent to number of cigarettes smoked	Equivalent to number of highway km driven*
Chest radiograph	1.3 per million	9	37 - 62
Skull X-ray series	6 per million	44	166 - 277
Barium enema	20 per million	148	571 - 952
CT scan of the chest	400 per million	2960	11,420 - 19,040
Radiation exposure from 18 hour plane flight at 1300m	1.3 per million	9	37 - 62

What are risks of ionising radiation?

- Comparison to background radiation:
 - CXR: 3 days
 - Pelvic xray: 10 weeks
 - Lumbar spine: 23 weeks
 - Mammogram: 9 weeks
 - Barium enema: 3.6 years
 - CT head: 1.4 years
 - CT chest: 4.5 years
 - CT abdomen: 7.3 years

What should you tell your patients?

- Emphasise risk from xray procedures is not zero, but in most cases is small and should be outweighed by benefits of procedure

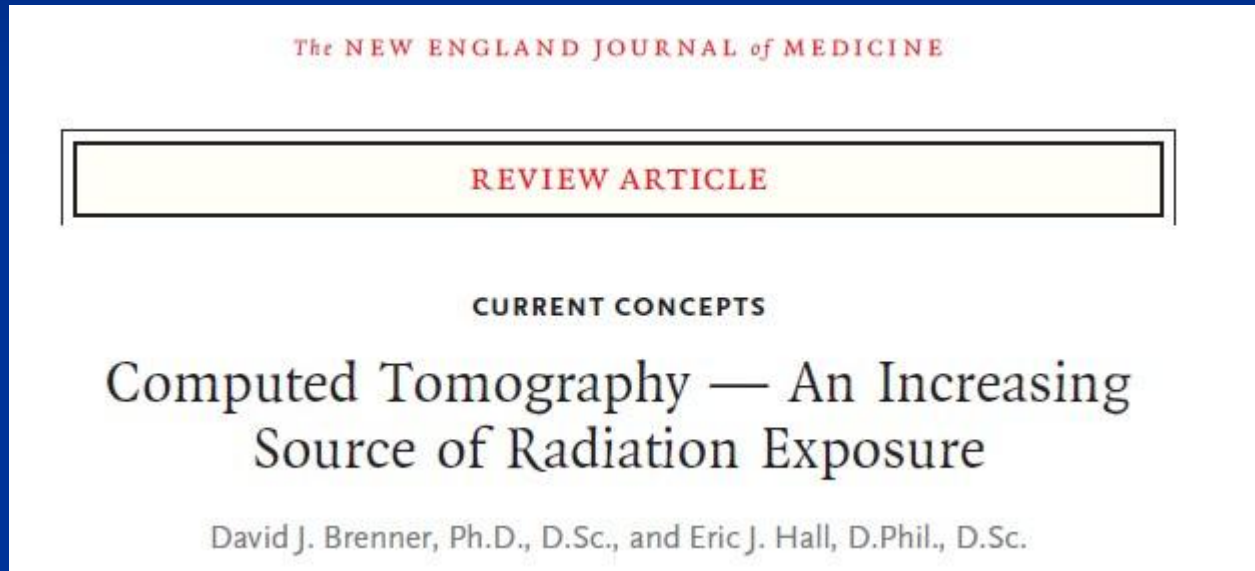
What are risks of ionising radiation?

CT

- Increasing use
- US: 1980 3 million
 - 2011 62 million, 4 million in children
 - Children – appendicitis; fast scan times
- Now about 40% of all studies
 - CTC, CTCA, CT enteroclysis etc
- ~29000 future cancers could be related to CT scans performed in 2007

Berrington de Gonzalez et al 2009 Arch Intern Med 169 22 2071 – 2077`

What are risks of ionising radiation? CT



➤ *NEJM 2007; 357: 2277 - 84*

What are risks of ionising radiation?

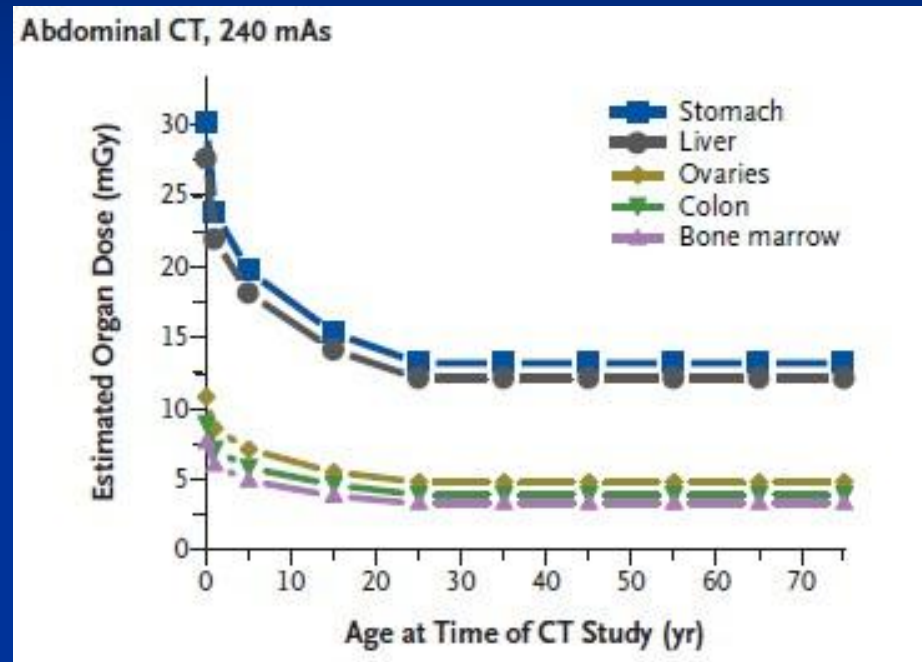
CT

- Atomic bomb survivors
 - Most received doses < 40 mSv
 - Similar to CT doses
 - Increased incidence of cancers in this group
 - Children at greater risk
 - More radiosensitive
 - Longer lifespan to develop cancer

What are risks of ionising radiation?

CT

➤ Organ doses



➤ Overall 0.4% of all cancers in US are attributable to radiation from CT

What are risks of ionising radiation?

Pregnancy

- Short term (deterministic)
 - Death
 - Slowing of normal growth
 - Abnormal growth - deformities
 - Intellectual underdevelopment
- Long term (stochastic)
 - Theoretical risks of cancer some time after birth (child or adult)

What are risks of ionising radiation?

Pregnancy

- International Committee for Radiation Protection ICRP
 - deterministic risks would not be expected to occur in an embryo or foetus that had been exposed to less than 100 mGy of radiation

What are risks of ionising radiation?

Pregnancy

Examination type	Typical foetal dose (mGy)
Group 0: Ultrasound Magnetic resonance imaging (MRI)	0
Group 1: X-ray skull X-ray chest X-ray thoracic spine Mammogram Head or neck CT scan	0.001–0.01
CT pulmonary angiogram Lung ventilation scan	0.01–0.1
Group 2: X-ray of abdomen, pelvis or hip or barium meal CT scan of the chest and upper abdomen Nuclear medicine scans using technetium-99m including: thyroid scan, lung perfusion scan, renal scan (MAG3, DMSA) or white cell scan	0.1–1.0

Examination type	Typical foetal dose (mGy)
Group 3: Lumbar spine X-ray Barium enema Intravenous pyelogram or urogram CT abdomen or CT lumbar spine Nuclear medicine scans using technetium-99m Bone scan Cardiac blood pool scan Myocardial scan Renal scan Thallium-201 myocardial scan	1.0–10
CT of pelvis, or pelvis plus abdomen PET-CT Technetium-99m myocardial SPECT (rest – exercise protocol)	10–50

What are risks of ionising radiation?

Pregnancy

- Long term risk?
 - in the first 3–4 weeks after conception when the pregnancy is unrecognised the risks of childhood cancer will be very small
- Low dose exams
 - estimated potential *additional* risk is approximately 1 in 1,000,000
- High dose exams
 - is approximately 1 in 1000 to 1 in 200

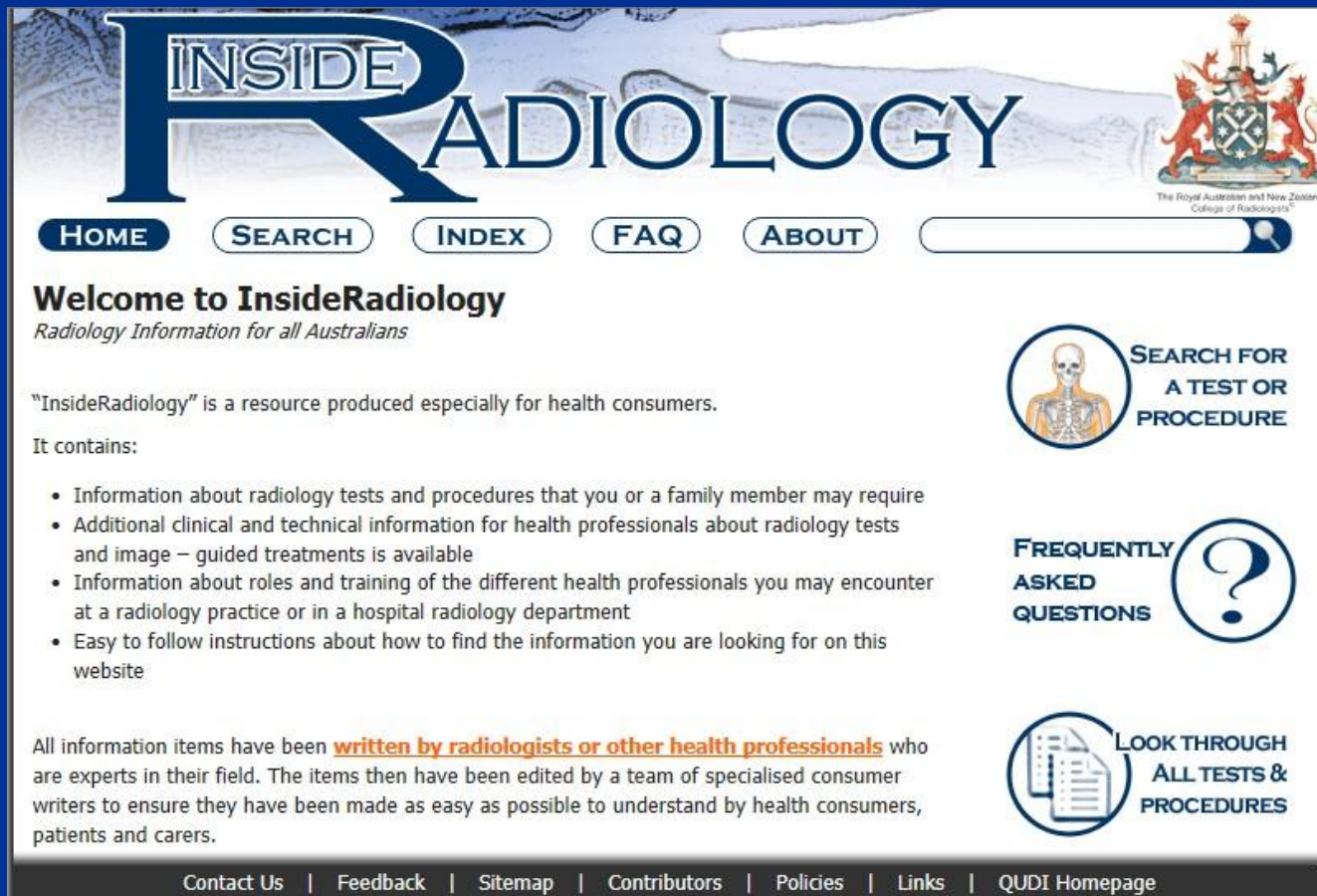
What are risks of ionising radiation?

Pregnancy

Group 1: X-ray skull X-ray chest X-ray thoracic spine Mammogram Head or neck CT scan	< 1 in 1,000,000
CT pulmonary angiogram Lung ventilation scan	1 in 1,000,000 to 1 in 100,000
Group 2: X-ray of abdomen, pelvis or hip or barium meal CT scan of the chest and upper abdomen Nuclear medicine scans using technetium-99m including: thyroid scan, lung perfusion scan, renal scan (MAG3, DMSA) or white cell scan	1 in 100,000 to 1 in 10,000
Group 3: Lumbar spine X-ray Barium enema Intravenous pyelogram or urogram CT abdomen or CT lumbar spine Nuclear medicine scans using technetium-99m Bone scan Cardiac blood pool scan Myocardial scan Renal scan Thallium-201 myocardial scan	1 in 10,000 to 1 in 1,000
CT of pelvis, or pelvis plus abdomen PET-CT Technetium-99m myocardial SPECT (rest – exercise protocol)	1 in 1,000 to 1 in 200 <i>Natural childhood cancer risk:</i> 1 in 500

A plug...

➤ www.insideradiology.com.au



The screenshot shows the homepage of the InsideRadiology website. The header features the large 'INSIDE RADIOLOGY' logo on the left and the Royal Australian and New Zealand College of Radiologists (RANZCR) crest on the right. Below the logo is a navigation bar with buttons for 'HOME', 'SEARCH', 'INDEX', 'FAQ', and 'ABOUT', followed by a search input field. The main content area begins with a 'Welcome to InsideRadiology' heading and the tagline 'Radiology Information for all Australians'. A paragraph states that the resource is produced for health consumers. A section titled 'It contains:' lists five bullet points about the types of information available. To the right of this list are three circular icons: a human skeleton for 'SEARCH FOR A TEST OR PROCEDURE', a question mark for 'FREQUENTLY ASKED QUESTIONS', and a document for 'LOOK THROUGH ALL TESTS & PROCEDURES'. The footer contains a row of links: 'Contact Us', 'Feedback', 'Sitemap', 'Contributors', 'Policies', 'Links', and 'QUDI Homepage'.

INSIDE RADIOLOGY

HOME SEARCH INDEX FAQ ABOUT

Welcome to InsideRadiology
Radiology Information for all Australians

"InsideRadiology" is a resource produced especially for health consumers.

It contains:

- Information about radiology tests and procedures that you or a family member may require
- Additional clinical and technical information for health professionals about radiology tests and image – guided treatments is available
- Information about roles and training of the different health professionals you may encounter at a radiology practice or in a hospital radiology department
- Easy to follow instructions about how to find the information you are looking for on this website

All information items have been **written by radiologists or other health professionals** who are experts in their field. The items then have been edited by a team of specialised consumer writers to ensure they have been made as easy as possible to understand by health consumers, patients and carers.

SEARCH FOR A TEST OR PROCEDURE

FREQUENTLY ASKED QUESTIONS

LOOK THROUGH ALL TESTS & PROCEDURES

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www.insideradiology.com.au



The header of the InsideRadiology website features a large, stylized 'R' with the word 'INSIDE' inside it, followed by 'RADIOLOGY' in a serif font. To the right is the crest of The Royal Australian and New Zealand College of Radiologists. Below the title is a navigation bar with buttons for HOME, SEARCH, INDEX, FAQ, and ABOUT, followed by a search input field with a magnifying glass icon.

What to expect from InsideRadiology

Here are some frequently asked questions about using this website and about Radiology in general:

- [What is Radiology?](#)
- [What is the 'InsideRadiology - Consumer Information' website?](#)
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Summary

- Imaging guidelines aren't all they're cracked up to be
 - Nice in theory
 - Difficult in practice
- If in doubt – ask your friendly radiologist
- Radiation for diagnosis is your friend but be careful with it

Universal symbol of the Radiologist



The hedge...

Thanks for your attention

