

Clinicians' justification of imaging: do radiation issues play a role?

Lars Borgen

Ansgar Espeland

Erling Stranden



Justification: cost vs benefit

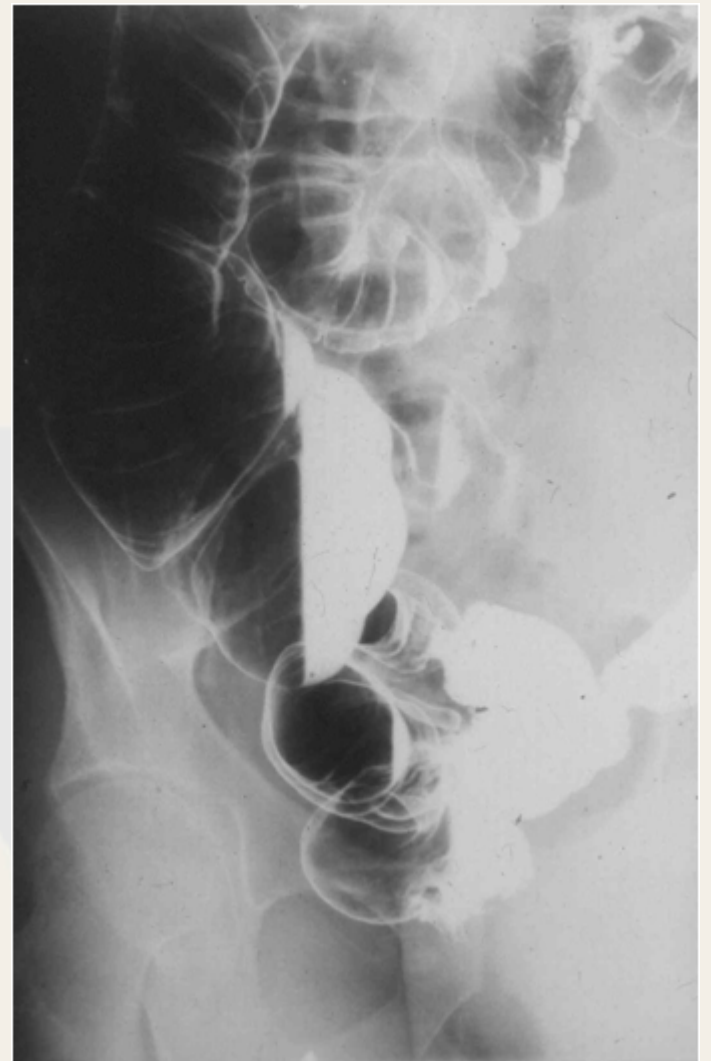
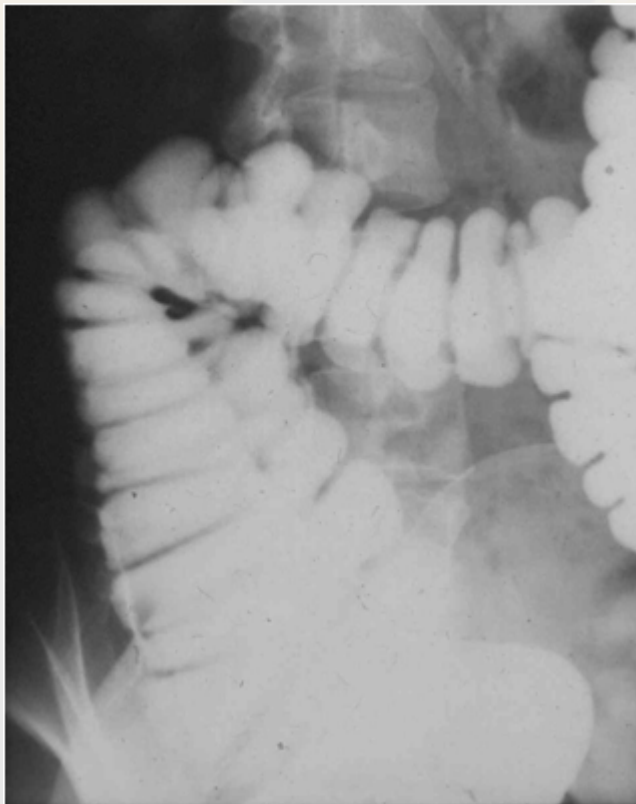
•Cost

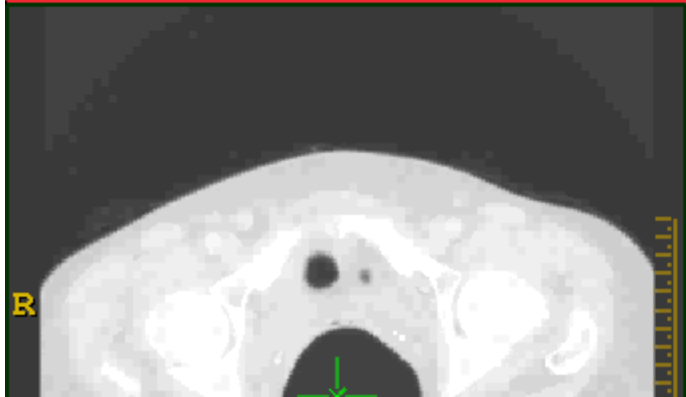
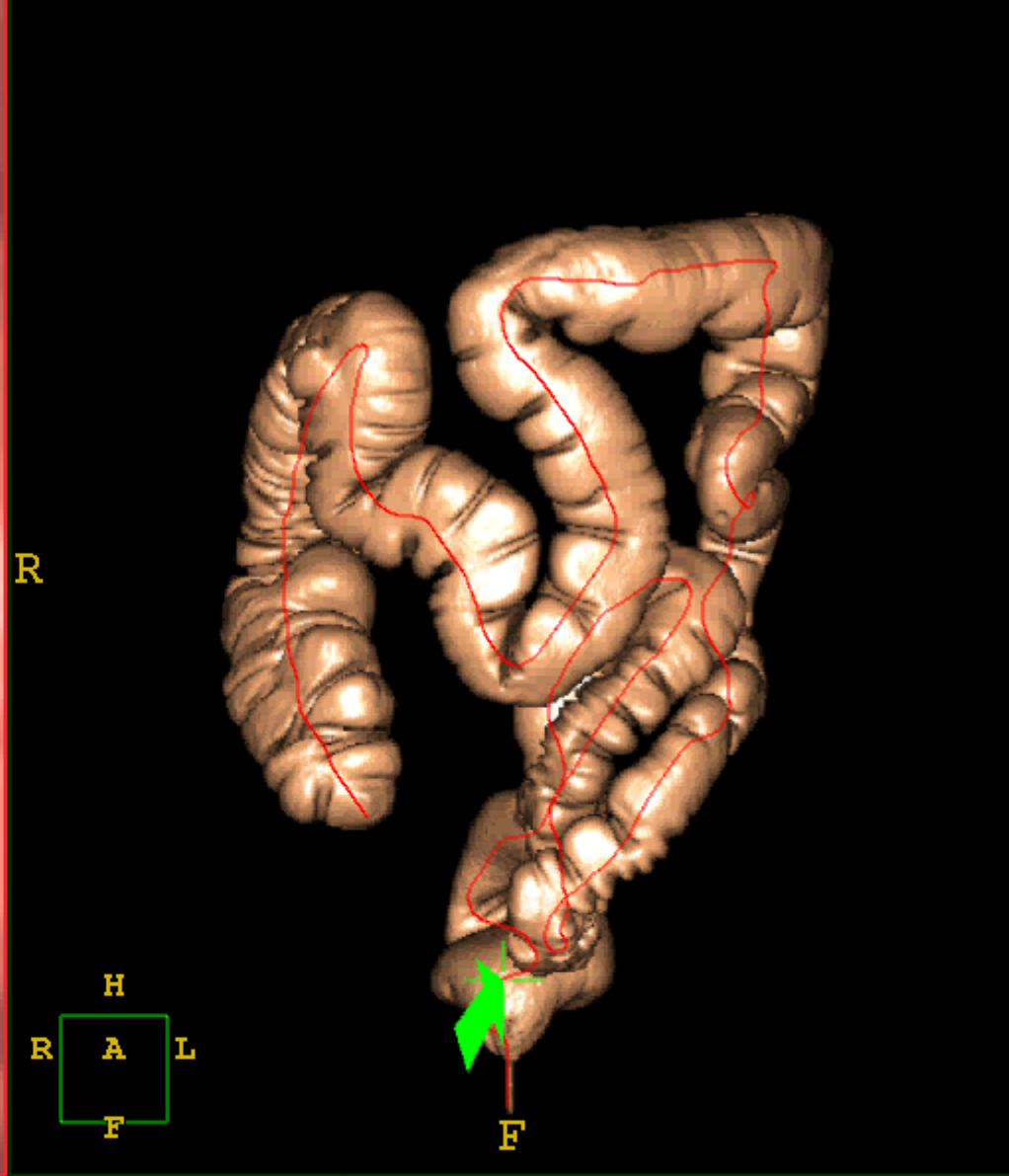
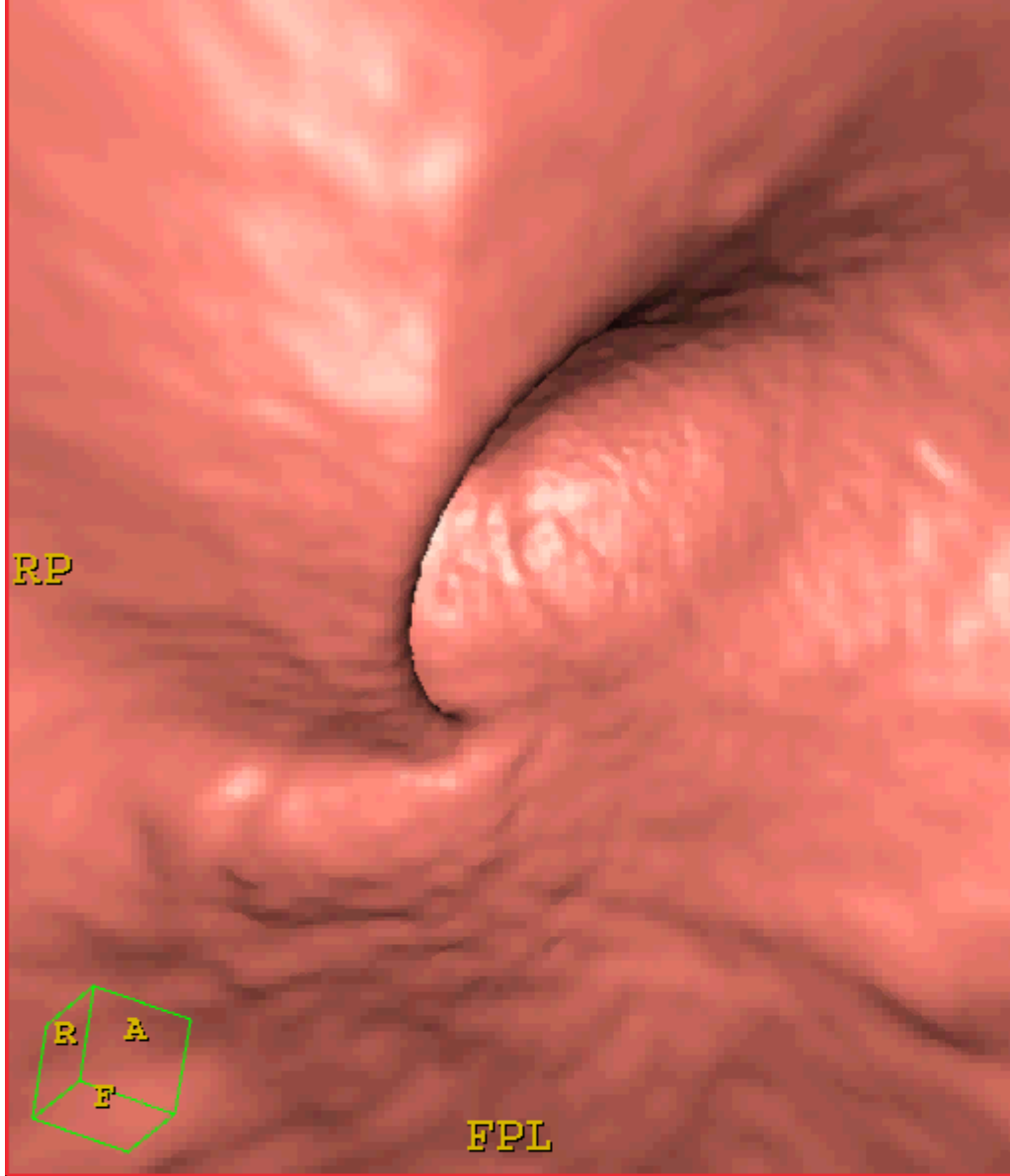
- Money
- Time
- Discomfort
- Contrast exposition
- False positive findings
- Radiation

•Benefit

- Getting a diagnose
- Ruling out diagnoses
- Being taken seriously
- Reassured patient and doctor



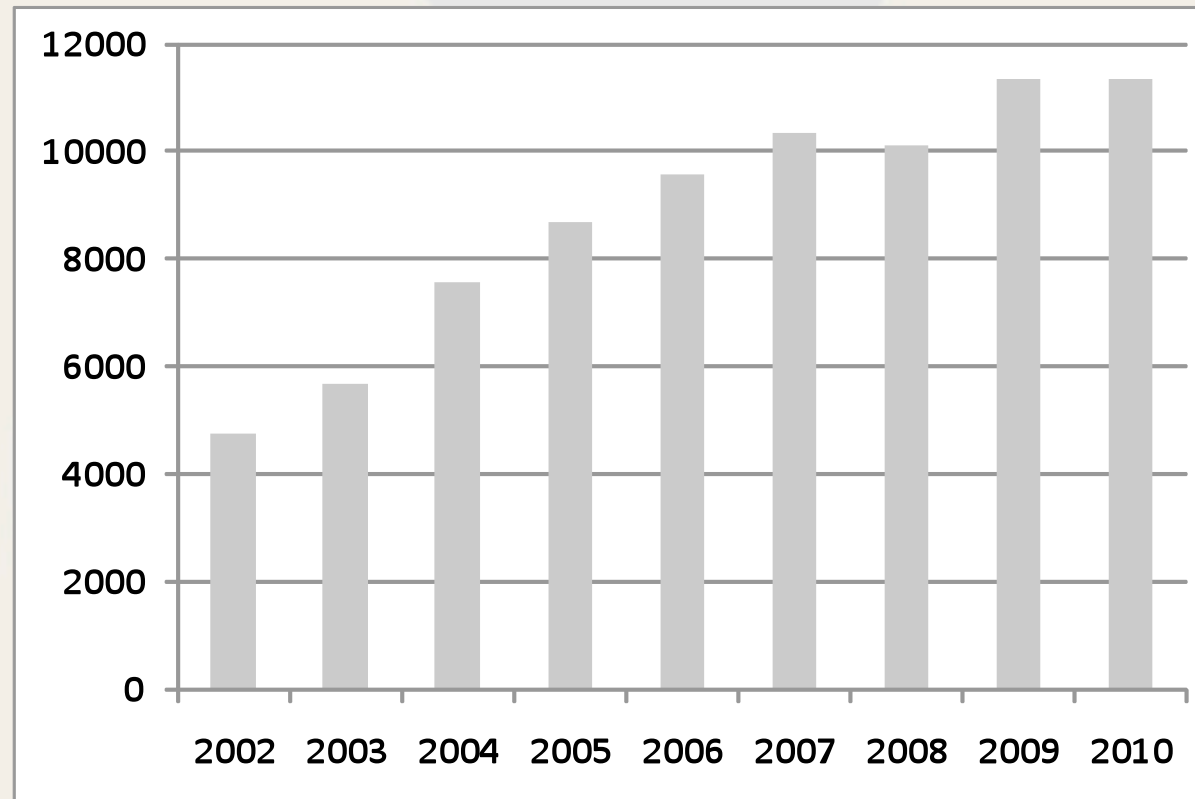




Respondents

Type of clinician	Number
General practitioners	77
Hospital physicians	71
Surgeons	13
Internists	20
Neurologists	10
Orthopedics	12
Pediatricians	13
Rheumathologists	4
Non-phycisians	65
Manual physiotherapists	55
Chiropractors	10
Total	213

Total annual number of MSCT examinations performed at Drammen Hospital from 2002-2010.



Referring clinicians in Norway

- Manual physiotherapists acquired a referral licence for all techniques in 2006 and chiropractors in 1991

Research questions

- What is the level of radiation knowledge among referring physicians and non-physicians in Norway?
- How are radiation issues weighted when referring?
- Are clinicians aware of referral guidelines, and do they use them?
- What are the rate and reasons for referrals most unlikely to affect treatment?
- Is the rate of such referrals and guideline use related to radiation knowledge and weighting?

Method

Data collection

- Unprepared respondents, questionnaire physically handed out
- 71 hospital physicians at all grades during their morning meetings at a 500-bed general hospital
- 77 general practitioners, 55 manual physiotherapists and 10 chiropractors during lectures at nation- or countywide courses of general interest within their fields, not related to radiation issues

Radiation knowledge

Question 5

Please estimate the **effective dose** of the listed imaging procedures, compared to a chest x-ray (front and side projection). Please put a mark, even if you are uncertain.



Imaging procedure	Corresponding numbers of chest x-rays (front and side projection)			
	0-1	1-10	10-50	50-200
Cerebral CT				

Pelvic

Cereb

Intrav

pyelography

Chest

Barium

fluorography

Barium

Abdominal

Kidney

Thoracic

radiography

Sinus

Sinus

Question 6

In this question, we ask you to rank the contributors to the mean effective radiation dose for a Norwegian in 2006. Please rank the contributors from 1 to 5, where 1 is the largest contributor and 5 is the smallest.

Question 7

Detrimental effects of radiation are divided into deterministic and stochastic effects. Are you familiar with these terms?

Put a circle around

If yes, go to question

Question 8

This is a list of potential detrimental effects of radiation. Please mark whether you think these effects are stochastic or deterministic (one mark per detrimental effect).

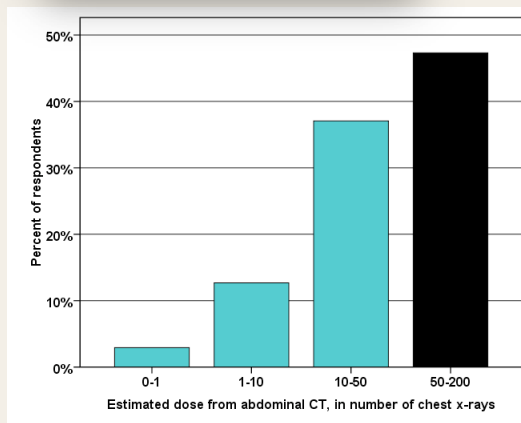
Detrimental effect	Stochastic	Deterministic
Leukemia		
Infertility		
Fetus abnormalities		
Genetic adverse effects		
Cataract		
Lung cancer		

Question 5

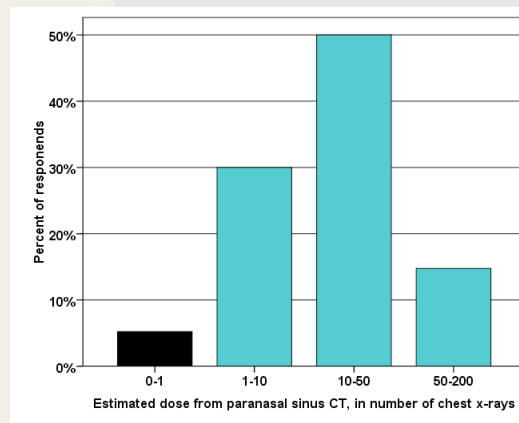
Please estimate the effective dose of the listed imaging procedures, compared to a chest x-ray (front and side projection). Please put a mark, even if you are uncertain.

Imaging procedure	Corresponding numbers of chest x-rays (front and side projection)			
	0-1	1-10	10-50	50-200
Cerebral CT				
Pelvic radiography				
Cerebral MRI				
Intravenous pyelography				
Chest CT				
Barium meal fluoroscopy				
Barium enema				
Abdominal CT				
Kidney ultrasound				
Thoracic spine radiography				
Stomach x-ray				
Stomach CT				

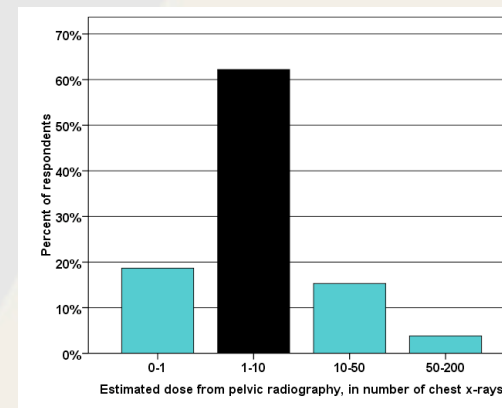
Radiation knowledge – imaging procedures



Abdominal CT



Paranasal sinus CT



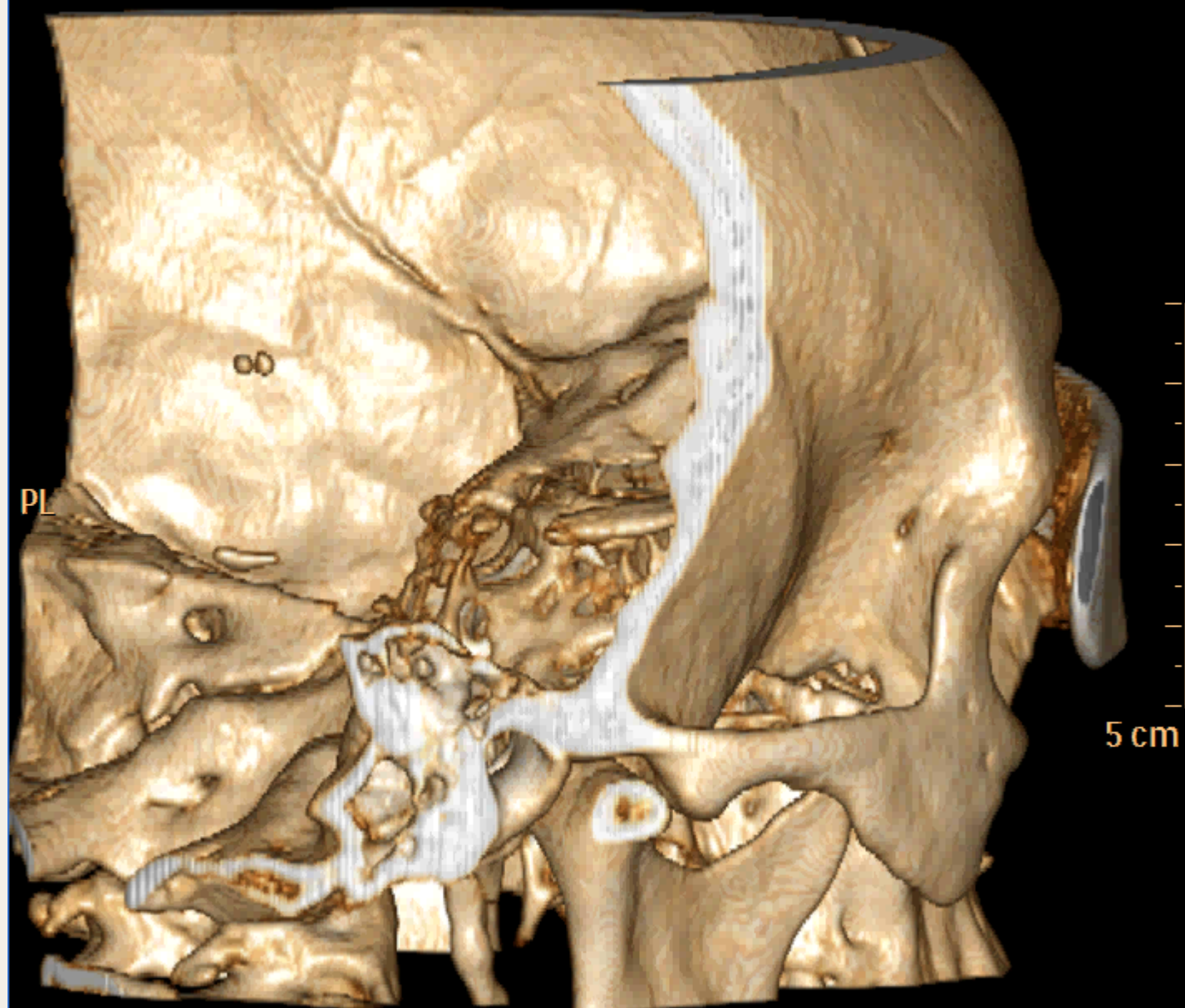
Pelvic radiography

- Tendency of underestimating radiation dose from high dose imaging
- Tendency of overestimating radiation dose from low dose CT imaging
- Ballanced estimation of doses from radiography

	General practitioners	Hospital physicians	Non-physicians
Score question 5	21,1	22,15	18,6

Radiation knowledge – total score

Type of clinician	Mean total score	SD
General practitioners	31.0	8.4
Hospital physicians	32.3	9.4
Surgeons	34.2	10.3
Internists	37.0	11.6
Neurologists	24.9	4.6
Orthopedics	31.4	5.3
Pediatricians	30.9	8.4
Rheumatologists	29.5	5.2
Non-physicians	27.7	6.7
Manual physiotherapists	27.3	6.4
Chiropractors	30.3	8.4
Total	31.6	8.9



Weighting of different factors when referring for imaging

Question 1

To what extent are the listed factors important when you refer a patient for imaging?

Factors	Weighting of importance 1-6:
	1 = very important 6 = not important
Radiation dose to patient	
Patient's wish	
Impact on diagnosis	
Impact on treatment	
Impact on patient's future health	

Table 3 Median score (interquartile range) for weighting the importance of different factors when referring for imaging; 1=very important, 6=not important

	Radiation dose	Patient's wish	Impact of imaging on diagnosis	Impact of imaging on treatment	Impact of imaging on future health
General practitioners (n=77)	3.0 (2.0)	4.0 (3.0)	1.0 (1.0)	1.0 (0.0)	1.0 (1.0)
Hospital physicians (n=70)	3.0 (1.0)	4.0 (2.0)	1.0 (1.0)	1.0 (0.0)	1.0 (1.0)
Non-physicians (n=65)	2.0 (2.0)	5.0 (1.0)	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)
Total (n=212)	2.5 (1.0)	4.0 (2.0)	1.0 (1.0)	1.0 (0.0)	1.0 (1.0)

Referral guidelines

Question 2

Do you know of imaging referral guidelines, where referrers can seek information on which investigations are indicated for which conditions?

Put a circle around your answer YES NO

If yes, do you know where to find these guidelines? _____

Have you ever used such referral guidelines?

Put a circle around your answer YES NO

Type of clinician	Knew of referral guidelines	Had used referral guidelines
General practitioners	44.7%	19.5%
Hospital physicians	40.8%	19.7%
Non-physicians	92.3%	72.3%

Only 7 clinicians could state www.radiologforeningen.no or www.helsebiblioteket.no

Referrals most likely to not affect treatment

Question 3

Do you refer patients for imaging in cases when you consider it most unlikely that the imaging results will affect treatment of the patient?

Put a circle around your answer YES NO

If yes, what is the proportion of such referrals among all your referrals (circa)?

Put a circle around your answer: 1% 5% 10% 20% 50%

Type of clinician	Do you refer patients to imaging that most likely will not affect treatment	If yes, what is the proportion of such referrals
General practitioners	83.3 % answeres yes	Median 10%
Hospital physicians	81.3 % answered yes	Median 5%
Non-physicians	56.9% aswered yes	Median 5%

Reasons for such referrals

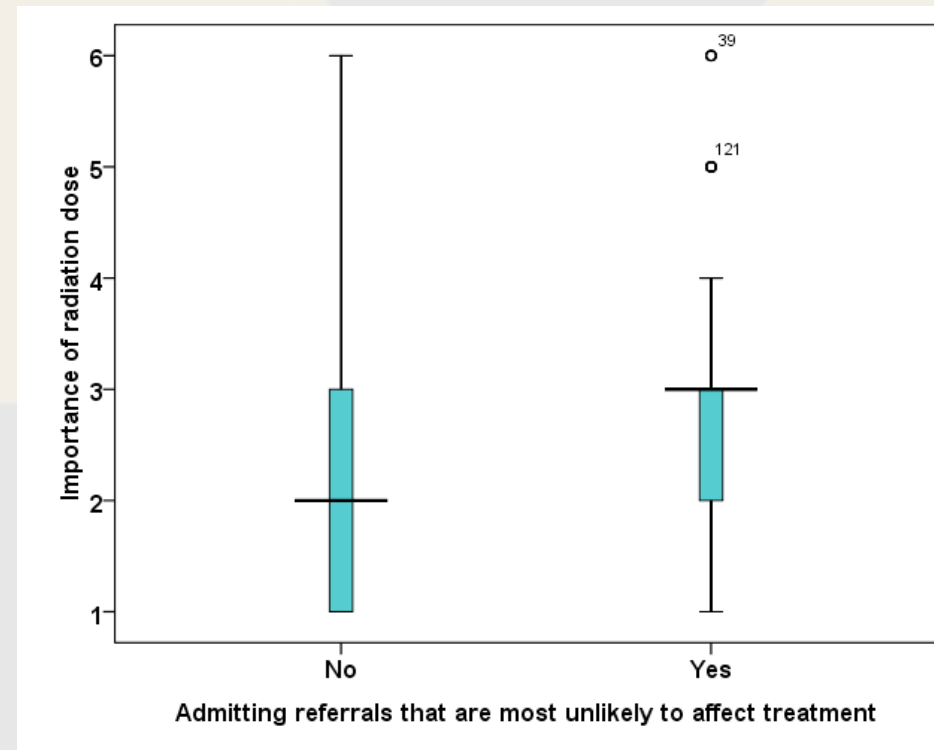
Question 4

What are the reasons why you may refer, when the imaging results most likely will not affect treatment? Please weight the listed reasons.

Reasons	Weighting of importance 1-4: 1 = very important 4 = not important
Patient expectations	
Give the patient the feeling of being taken seriously	
Lack of time, "get the patient out of the office", discharge the patient	
Expectations from relatives	
Compensate for insufficient clinical examination	
Normal findings will reassure the patient	

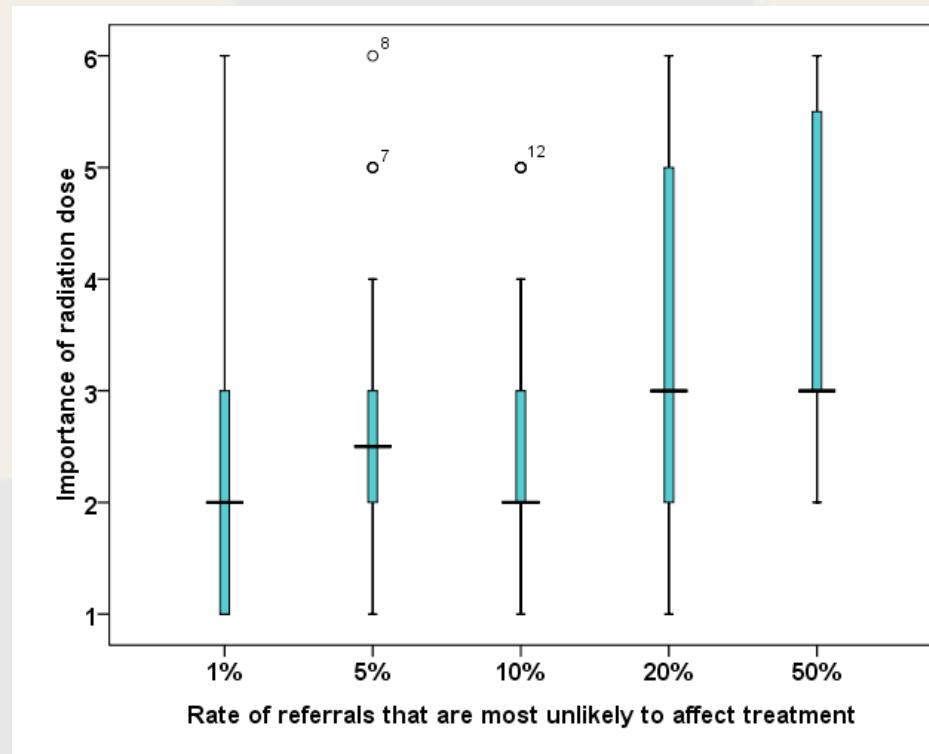
Type of clinician	Patient expectations	Give the patient the feeling of being taken seriously	Lack of time, "get the patient out of the office", discharge the patient	Expectations from relatives	Compensate insufficient clinical examination	Normal findings will reassure the patient
General practitioner	2.0	2.0	4.0	3.0	3.0	2.0
Hospital physician	3.0	3.0	3.50	3.0	3.5	2.0
Non-physician	3.0	2.0	4.0	4.0	4.0	2.0
Total	3.0	2.0	4.0	3.0	4.0	2.0

Weighting the importance of radiation dose in relation to admitting referrals that are most unlikely to affect treatment



$r = 0.14$, $p = 0.037$, Spearman rho. 1=very important, 6=not important. Box-and-whisker plot where the grey box represents the interquartile range, the middle horizontal line the median and the whiskers the range. Numbered points are outliers

Weighting the importance of radiation dose in relation to percentage of referrals being most unlikely to affect treatment



Weighting the importance of radiation dose in relation to percentage of referrals being most unlikely to affect treatment ($r=0.21$, $p=0.005$, Spearman rho). 1=very important, 6=not important. Box-and-whisker plot.

Weighting the importance of radiation dose in relation to using referral guidelines

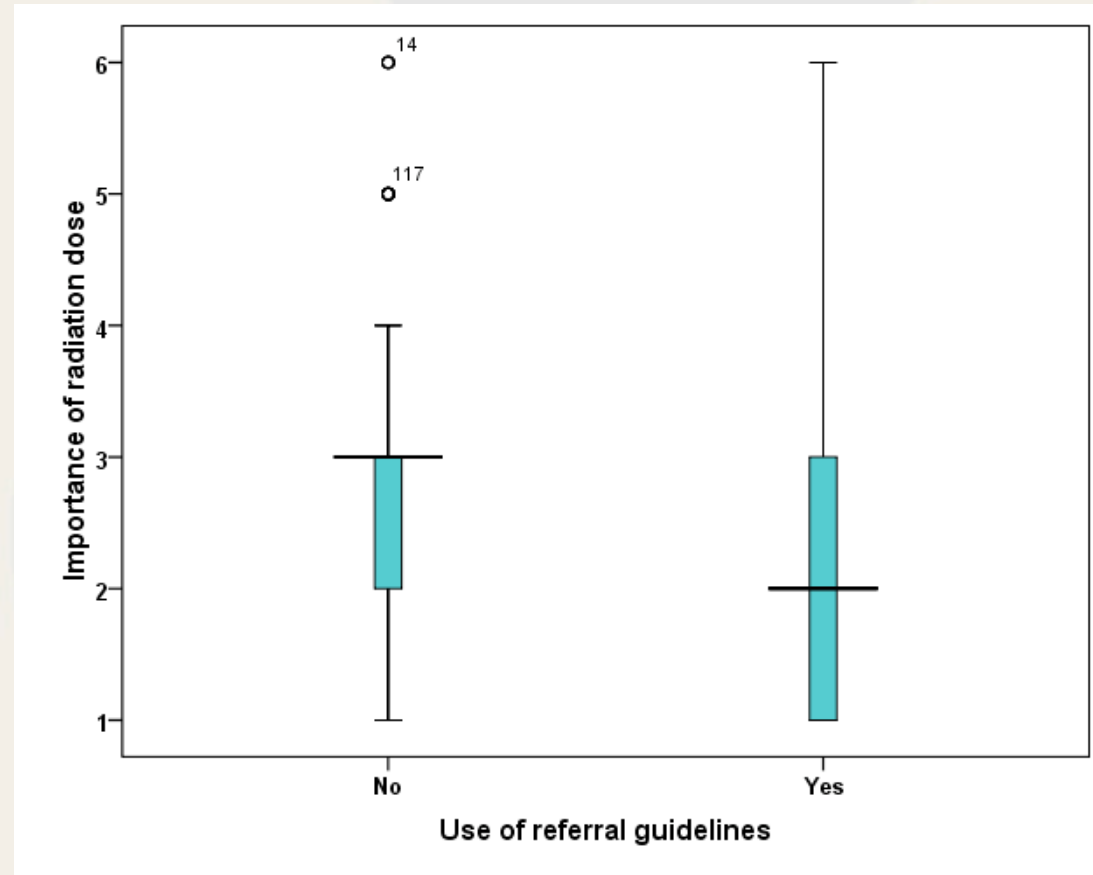
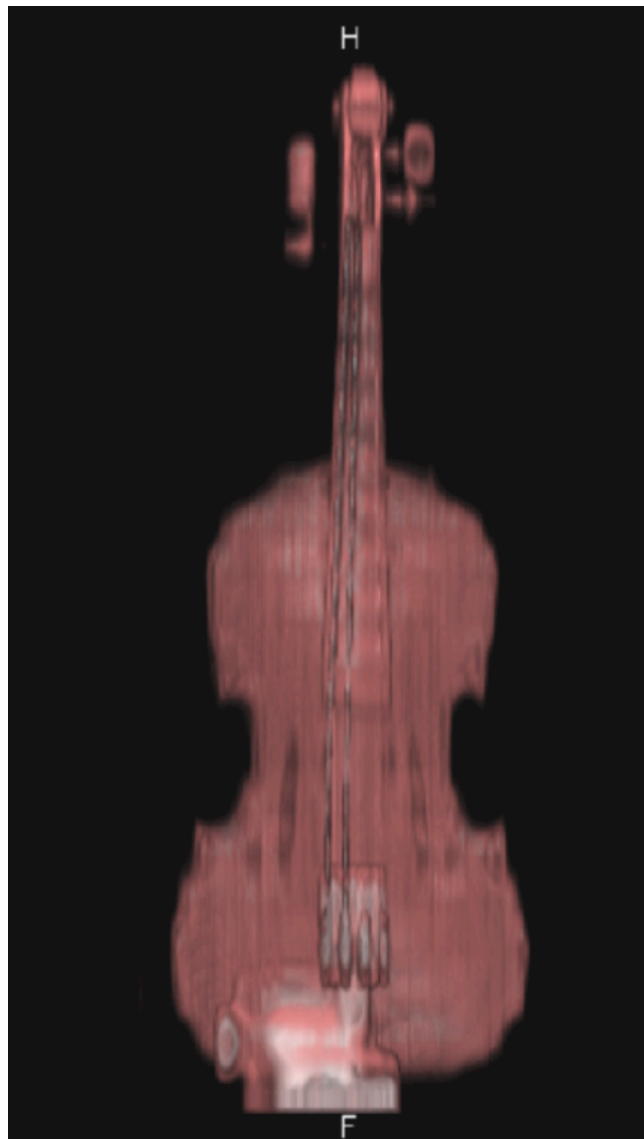


Fig. 4 Weighting the importance of radiation dose in relation to using referral guidelines ($r=0.18$, $p=0.009$, Spearman rho). 1=very important, 6=not important.



- No relation between radiation knowledge and referral practice or use of guidelines



Conclusion

- Referring clinicians have limited radiation knowledge and use referral guidelines to a limited extent
- Clinicians who put more weight on radiation doses in the justification process use referral guidelines to a larger extent and refer less to imaging that most likely will not affect treatment
- Lack of radiation knowledge is not compensated by using referral guidelines
- No relation between radiation knowledge and referral practice

The future

- Technological development – Iterative reconstruction...
- Accumulated radiation doses in patient records available for referring clinicians
- Electronic referral systems with integrated referral guidelines / radiation doses, giving instant decision support for the referring clinician
- A nationwide PACS?
- Closer cooperation between radiologists and clinicians

References

1. Borretzen I, Lysdahl KB, Olerud HM (2007) Diagnostic radiology in Norway trends in examination frequency and collective effective dose. *Radiat Prot Dosimetry* 124:339-347
2. Brenner DJ, Hall EJ (2007) Computed tomography--an increasing source of radiation exposure. *N Engl J Med* 357:2277-2284
3. Fazel R, Krumholz HM, Wang Y, Ross JS, Chen J, Ting HH, Shah ND, Nasir K, Einstein AJ, Nallamothu BK (2009) Exposure to low-dose ionizing radiation from medical imaging procedures. *N Engl J Med* 361:849--857
4. Lauer MS (2009) Elements of danger--the case of medical imaging. *N Engl J Med* 361:841-843
5. The International Commission on Radiological Protection (2007) Recommendations of the International Commission on Radiological Protection. ICRP publication 103. *Ann ICRP* 37:1-332
6. The International Commission on Radiological Protection (2007) Radiation protection in medicine. ICRP Publication 105. *Ann ICRP* 37:1-63
7. The Royal College of Radiologists (2007) Making the best use of clinical radiology services, 6th ed., London
8. European Commission (2007) Referral Guidelines for imaging, Luxembourg. http://ec.europa.eu/energy/nuclear/radioprotection/publication/doc/118_update_en.pdf. Accessed 12 Oct 2009
9. American College of Radiology. ACR Appropriateness Criteria. http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx. Accessed 30 Sept 2009
10. Thomas KE, Parnell-Parmley JE, Haidar S, Moineddin R, Charkot E, BenDavid G, Krajewski C (2006) Assessment of radiation dose awareness among pediatricians. *Pediatr Radiol* 36:823-832
11. Soye JA, Paterson A (2008) A survey of awareness of radiation dose among health professionals in Northern Ireland. *Br J Radiol* 81:725-729
12. Shiralkar S, Rennie A, Snow M, Galland RB, Lewis MH, Gower-Thomas K (2003) Doctors' knowledge of radiation exposure: questionnaire study. *BMJ* 327:371-372
13. Rice HE, Frush DP, Harker MJ, Farmer D, Waldhausen JH (2007) Peer assessment of pediatric surgeons for potential risks of radiation exposure from computed tomography scans. *J Pediatr Surg* 42:1157-1164
14. Renston JP, Connors AF, Jr., DiMarco AF (1996) Survey of physicians' attitudes about risks and benefits of chest computed tomography. *South Med J* 89:1067-1073
15. Quinn AD, Taylor CG, Sabharwal T, Sikdar T (1997) Radiation protection awareness in non-radiologists. *Br J Radiol* 70:102-106
16. Lee CI, Haims AH, Monico EP, Brink JA, Forman HP (2004) Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. *Radiology* 231:393-398
17. Jacob K, Vivian G, Steel JR (2004) X-ray dose training: are we exposed to enough? *Clin Radiol* 59:928-934
18. Heyer CM, Peters S, Lemburg S, Nicolas V (2007) [Awareness of radiation exposure of thoracic CT scans and conventional radiographs: what do non-radiologists know?]. *Rofo* 179:261-267
19. Gumus Cesur (2009) Turkish Pediatric Surgeons Knowledge on Radiation Exposure of Patients During Diagnostic Imaging. *Turk Klinikleri J Med Sci*
20. Finestone A, Schlesinger T, Amir H, Richter E, Milgrom C (2003) Do physicians correctly estimate radiation risks from medical imaging? *Arch Environ Health* 58:59-61
21. Correia MJ, Hellies A, Andreassi MG, Ghelarducci B, Picano E (2005) Lack of radiological awareness among physicians working in a tertiary-care cardiologic centre. *Int J Cardiol* 103:307-311
22. Arslanoglu A, Bilgin S, Kubal Z, Ceyhan MN, Ilhan MN, Maral I (2007) Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. *Diagn Interv Radiol* 13:53-55
23. Mankad K, Bull M (2005) Awareness of 'Making the best use of a Department of Clinical Radiology' amongst physicians. *Clin Radiol* 60:618-619
24. Bautista AB, Burgos A, Nickel BJ, Yoon JJ, Tilara AA, Amorosa JK (2009) Do clinicians use the american college of radiology appropriateness criteria in the management of their patients? *AJR Am J Roentgenol* 192:1581-1585
25. Newton J, Knight D, Woolhead G (1996) General practitioners and clinical guidelines: a survey of knowledge, use and beliefs. *Br J Gen Pract* 46:513-517
26. Tunis SR, Hayward RS, Wilson MC, Rubin HR, Bass EB, Johnston M, Steinberg EP (1994) Internists' attitudes about clinical practice guidelines. *Ann Intern Med* 120:956-963
27. Ammendolia C, Bombardier C, Hogg-Johnson S, Glazier R (2002) Views on radiography use for patients with acute low back pain among chiropractors in an Ontario community. *J Manipulative Physiol Ther* 25:511-520
28. Ammendolia C, Cote P, Hogg-Johnson S, Bombardier C (2007) Do chiropractors adhere to guidelines for back radiographs? A study of chiropractic teaching clinics in Canada. *Spine (Phila Pa 1976)* 32:2509-2514
29. Act of 28. Feb 1997 no. 19 National Insurance Act. Ministry of Health and Social Affairs. Oslo. <http://www.lovdata.no/all/nl-19970228-019.html>. Accessed 12 Oct 2009
30. Friberg EG, Widmark A, Olerud HM, Tynes S, Saxebøl G (2005) Guidance for use of medical X-ray and MR equipment subjected to approval. Guidance to "Regulations for radiation protection and use of radiation". Guidance No.5. In Norwegian (tror vanligst å skrive in Norwegian og ikke bare Norwegian. Norwegian Radiation Protection Authority, Østerås
31. Norwegian Radiation Protection Authority Web site. <http://www.nrpa.no/index.asp>? Accessed 1 Oct 2009
32. Norwegian Medical Association Web site. <http://www.legeforeningen.no/id/146323>. Accessed 12 Oct 2009
33. Ratnapalan S, Bona N, Chandra K, Koren G (2004) Physicians' perceptions of teratogenic risk associated with radiography and CT during early pregnancy. *AJR Am J Roentgenol* 182:1107-1109
34. Kumar S, Mankad K, Bharti B (2007) Awareness of making the best use of a Department of Clinical Radiology amongst physicians in Leeds Teaching Hospitals, UK. *Br J Radiol* 80:140
35. Norwegian Radiology Society Web site. <http://www.radiologforeningen.no/external/guidelines/INDEX.html>. Accessed 12 Oct 2009.
36. Manuellterapeutenes servicekontor (2007) Retningslinjer for bilde diagnostisk utredning (Guidelines for diagnostic imaging workup). http://www.manuellterapi.no/dokumenter/RI_bilddiagnostisk_utredning_20070000.pdf Accessed 12 Oct 2009
37. Royal College of Radiologists Working Party (1992) A multicentre audit of hospital referral for radiological investigation in England and Wales. *World Hosp* 28:7-13
38. Royal College of Radiologists Working Party (1992) Influence of the Royal College of Radiologists' guidelines on hospital practice: a multicentre study. *BMJ* 304:740-743
39. Almén, A, Leitz, W, and Richter, S. National Survey on Justification of CT-examinations in Sweden. 2009:3. 2009. Swedish Radiation Safety Authority.
40. Matowe L, Ramsay CR, Grimshaw JM, Gilbert FJ, Macleod MJ, Needham G (2002) Effects of mailed dissemination of the Royal College of Radiologists' guidelines on general practitioner referrals for radiography: a time series analysis. *Clin Radiol* 57:575-578
41. Remedios D, McCoubrie P, The Royal College Of Radiologists Guidelines Working Party (2007) Making the best use of clinical radiology services: a new approach to referral guidelines. *Clin Radiol* 62:919-920
42. Grimshaw JM, Winkens RA, Shirran L, Cunningham C, Mayhew A, Thomas R, Fraser C (2005) Interventions to improve outpatient referrals from primary care to secondary care. *Cochrane Database Syst Rev* CD005471
43. Mendelson RM, Murray CP (2007) Towards the appropriate use of diagnostic imaging. *Med J Aust* 187:5-6
44. Siström CL (2005) The ACR appropriateness criteria: translation to practice and research. *J Am Coll Radiol* 2:61-67
45. Amis ES, Jr., Butler PF, Applegate KE, Birnbaum SB, Brateman LF, Hevezi JM, Mettler FA, Morin RL, Pentecost MJ, Smith GG, Strauss KJ, Zeman RK (2007) American College of Radiology white paper on radiation dose in medicine. *J Am Coll Radiol* 4:272-284
46. Prevedello LM, Sodickson AD, Andriole KP, Khorasani R (2009) IT tools will be critical in helping reduce radiation exposure from medical imaging. *J Am Coll Radiol* 6:125-126