ROUTINE PREOPERATIVE CHEST X-RAYS

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= INTRODUCTION =

When chest X-rays are ordered it is normally because they are clinically indicated to confirm the presence, or extent, of an already suspected illness. However they are sometimes carried out as a matter of routine before surgery or upon admission of patients to hospital; such X-rays are not done to make a specific diagnosis, but to find unsuspected pathology which, undetected, might increase the risk of complications at the time of surgery. Another reason they may be ordered is to have on hand a baseline reference that may facilitate interpretation of later films. Such X-rays will be referred to as routine.

During the last 20 years many have expressed doubts concerning the need for routine X-rays on admission of a patient to hospital in the absence of a medical history or a clinical examination suggesting increased risk of post-operative pulmonary complications [Lurie,1987; Fowkes, 1986]. Suggested exceptions are for people who have high risks of pulmonary lesions, such as smokers over 50 years of age, and immigrants who have not had a medical examination for more than a year [Kerr, 1974].

Several official organizations have reached similar conclusions. Thus, in 1983, the US Department of Health and Human Services recommended that "preoperative chest X-rays not be automatically required for the admission of a patient to the operating room" [US Department HHS, 1983, 1986], while a scientific group from the World Health Organization concluded that if the clinical examination is done carefully and does not show any signs of pulmonary disease, a preoperative chest X-ray is not necessary [WHO, 1983]. Following a review of the subject, the Swedish Council on Technology Assessment in Health Care concluded that "chest X-rays should not be routinely carried out" [SBU, 1989]. In the same vein, the Corporation professionnelle des médecins du Québec does not include a chest X-ray as a routine examination in the "Guide de l'exercice de l'anesthésie" but suggests that it should be done "in accordance with medical indications" [Corporation, 1981].

Despite these opinions several hospitals, including university hospitals, continue to perform X-rays on every patient before any surgery. An investigation carried out in 1990 by the Service de technologie biomédicale of the Ministère de la Santé et des Services sociaux revealed that of the 162 institutions in Quebec that have a radiology service, 102 performed routine X-rays before any surgery, including non-thoracic surgery [Desmarais, 1991].

Because of the discrepancy between such opinions and the practices of some hospitals, the *Conseil d'évaluation des technologies de la santé* undertook a review of the published evidence relating to the value of routine preoperative chest radiography.

= REVIEW OF THE EVIDENCE =

We searched for all articles relating to routine radiography using the Medline database and references listed in reviews and periodicals published between 1966 and 1991 in French, English, and Spanish, or in other languages, if the articles included an adequately detailed summary in one of these languages.

To estimate the frequency of X-ray abnormalities in comparable populations, we also examined reports of routine chest X-rays carried out on other categories of patients; for example, patients at the time of admission to hospital, women having prenatal examinations, or patients in geriatric hospitals. In the past, routine X-rays were carried out during prenatal examinations to detect tuberculosis, an illness that can become accelerated during pregnancy. They were also performed for different reasons on patients upon admission to hospital, most commonly to detect chest infections in elderly or psychiatric patients.

Reducing the risk of complications of anesthesia or surgery

No studies have been able to establish that routine preoperative chest X-rays minimize the risk of complications. For example, in a review of the files of 803 patients who were operated on for varicose veins and inguinal hernia, no evidence was found that routine chest X-rays influenced the treatment [Delahunt, 1980]. Similarly Tape and Mushlin, after reviewing 341 files of patients admitted for vascular surgery found that any beneficial effects of chest X-rays were confined to those patients who already had clinical evidence of thoracic disease. Thus, the taking of routine chest X-rays did not influence clinical care [Tape, 1988].

In a retrospective study of 2,765 patients who did not have radiographs before their operations, Charpak et al., estimated that only two might have benefited from X-rays. Even these two patients' files did not reveal any complications resulting from the lack of this information. The authors concluded that stopping routine chest X-rays would not be harmful [Charpak, 1988].

Several other studies failed to demonstrate the usefulness of routine chest X-rays. It is difficult to synthetize quantitative data from these studies because of the different definitions employed and because of the different characteristics of the populations studied. Excellent qualitative reviews have been published [Tape, 1988; Roizen, 1987]. However, in addition to qualitative conclusions, we have attempted to extract quantitative estimates from those reports which were sufficiently detailed. We approached the question as follows :

The frequency with which new, significant information shows up on a routine X-ray would depend on two factors : the prevalence of intrathoracic abnormalities in the background population and the reliability of the patient's history and clinical examination. The more effective the history and physical examination, the smaller will be the number of unsuspected findings detected in a routine examination. What, in fact, is the number of such findings?

Table 1 summarizes the data from all the studies published between 1977 and 1990 relating to patients who had chest X-rays before surgery. The methodology used in the studies varied considerably. Eleven were carried out prospectively and 10 were based on retrospective reviews of patients' records. Nevertheless, all the studies that contained sufficient detailed information to establish estimates of the frequency of abnormalities were included. In these 21 studies, the prevalence of abnormal X-ray findings was on average 10%.

In many of these reports, we could also estimate the frequency with which unsuspected abnormalities were detected by routine preoperative chest X-rays, because the number of cases with previously known chest abnormalities was reported. In addition, there was often the mention of a positive history or clinical examination that would have led to an X-ray being carried out on clinical grounds. With this information we calculated the proportion of cases in which X-ray abnormalities were truly unsuspected, i.e. would not have been found had a routine X-ray not been done.

In all such studies unsuspected intrathoracic abnormalities were found, on average, in 1.3% of cases (95% confidence interval (CI 95%) 0% to 2.8% (Table 1)). One of these series was from an extremely elderly population aged 70 to 94 years [Törnebrandt, 1982]. Excluding the data of this series, the average frequency of new unsuspected abnormalities was 1.0% (95% CI : 0% to 2.5%).

It was also possible to determine from most of these reports the frequency with which the discovery of unsuspected abnormalities on routine preoperative chest X-rays influenced management : this was on average 0.1% (95% CI : 0% to 0.6%) (Table 1). The nature of the changes in management was rarely described or was described only very imprecisely : they generally concerned items such as the ordering of additional tests or consultations, the postponement of surgery, or a change in anesthesia.

The information contained in these studies was insufficient to form a judgment on how much the health of patients was affected by the changes in management. An occasional report indicated how often a routine examination had a subsequent negative effect; for example the unnecessary postponement of surgery, or the unnecessary requirement of further tests. These negative effects were not always insignificant.

Table 2 shows the frequency of X-ray abnormalities in 13 other non preoperative studies. In these, clinical situations were so different that average rates were not estimated. However, it is evident that in most, the prevalence of new unexpected abnormalities was low. The lowest prevalence was observed in three studies involving over 18,000 pregnant women in which the frequency of unsuspected findings ranged from 0 to 0.1% [Bonebrake, 1978; Hadlock, 1979; Mattox, 1973]. By contrast, the highest prevalence rates were reported in elderly populations [Domoto, 1985; Denham, 1984; Sewell, 1981; Fink, 1981; Hubbell, 1985; Törnebrandt, 1982].

Other authors have also reported that the frequency with which unsuspected abnormalities are found increases with age [Michel, 1989; Seymour, 1982; Loder, 1978; Delahunt, 1980; Boghosian, 1987; Denham, 1984; Rees, 1976; Roizen, 1987]. However, age is recorded imprecisely in most reports and it is thus not possible to establish a quantitative relationship between age and frequency of abnormalities discovered in routine examinations.

= DISCUSSION =

Frequency of unsuspected findings.

In theory, the frequency of unsuspected abnormalities revealed by routine examinations must depend upon the prevalence of chest pathology in the population in question on the one hand, and on the reliability with which the clinical examination and the patient's medical history are carried out, on the other. As the reliability of the examination and medical history decreases, the number of unsuspected abnormalities found in routine chest X-rays will increase. It is thus not surprising that the value of routine chest X-rays is greater in elderly populations among whom there is both an increase in prevalence of pathology and a decrease in the reliability of the medical history.

Similarly it is reasonable to suppose that, when the reliability of the patient's medical history decreases for cultural and/or linguistic reasons, especially when this obtains in populations with a high prevalence of thoracic abnormalities, the clinical value of routine examinations will again increase. Thus, in a study done in Ibadan, Nigeria, the frequency of significant unsuspected abnormalities was 22% of 203 patients who were waiting for surgery [Ogunseyinde, 1988]. The same trend was observed in a study of the therapeutic and clinical impact of routine X-ray examinations done upon admission to hospital in Harare, Zimbabwe, where abnormalities were identified on 17% of 427 chest X-rays and led to a change in the treatment plan in 5% of these patients [Taylor, 1988]. Similarly, in Thailand, 19.4% of 1,013 routine examinations done on patients before surgery showed abnormalities that brought about changes in treatment in 3.6% [Bhuripanyo, 1990]. From this, we conclude that for the reasons mentioned above routine chest X-rays may provide

more useful information in some African and Asian populations.

Excluding such populations, Table 1 suggests that, except for very elderly patients, routine chest X-rays before elective surgery in industrialized countries are of little value and can be expected to reveal the presence of unsuspected abnormalities in only about 0.1% of the cases studied.

The value of routine chest X-rays as a clinical baseline reference

Little attention has been paid to the usefulness of routine chest X-rays as a baseline reference to facilitate interpretation of further tests. In a study of 350 children, Farnsworth et al. concluded that routine chest X-rays before elective pediatric surgery were not necessary [Farnsworth, 1980]. On the other hand, in a study of 369 adults, Mendelson et al. noted that preoperative examinations had facilitated the interpretation of post-operative tests in 21% of the cases and the quality of post-operative care had been improved in 9% of the cases [Mendelson, 1987]. This and two similar studies [Seymour, 1982; Michel, 1989] are, however, impossible to interpret because the cases in which the clinical examination detected an abnormality could not be identified and it is thus impossible to know for how many of these patients X-rays would have been performed for clinical reasons.

Harmful effects of routine X-rays

Apart from wasting resources, there are other reasons to take a critical look at routine chest X-rays. The finding of a "positive" result often leads to a "cascade" of diagnostic tests such as additional radiography, axial tomography, bronchoscopy, sputum tests, and even thoracotomies and lung biopsies, in order to establish that the "positive" result is not clinically significant. One study concluded that "the psychological trauma to a patient confronted with a false, positive diagnosis can be devastating" [Robin, 1986].

The risks of cancer from exposure to radiation

The risks of cancer caused by the taking of a chest X-ray are generally considered to be negligible. The organs known to be the most sensitive to radiation-induced cancers are the lungs, breasts, digestive organs, bone marrow, and the thyroid gland [BEIR, 1990]. The risk of cancer from low doses of ionizing radiation, such as those from chest X-rays, is estimated by extrapolation from the risks observed in populations exposed to high doses of radiation. Recent estimates of the risks of radiation-induced cancers are three to four times higher than previous calculations [BEIR, 1990].

Based on typical doses from chest X-rays and the BEIR V risk estimates, we calculate that 457,000 routine preoperative chest X-rays could lead to approximately 5 or 6 deaths during

the lifetime of exposed people (methods available on request). This number must be considered in the perspective of the approximately 82,000 deaths to be expected from cancer during the lifetime of an equal number of individuals who have not undergone this routine examination. Similar risks were estimated for chest X-rays carried out to detect tuberculosis in Japan [Kunamoto, 1985]

Financial considerations

Approximately 457,000 routine chest X-rays are performed each year in Quebec (Appendix). The Régie de l'assurance-maladie du Québec (RAMQ) pays $18.75 for each X-ray done in a private clinic. When carried out in a hospital, the cost of this test is $23.11 [Desmarais, 1991]. The total annual cost for these X-rays is thus between $8.6 and $10.6 million. This figure does not include costs connected with the tests, consultations or periods of hospitalization which may follow the finding of insignificant abnormalities.

Even in the absence of accurate data on the clinical value of routine chest X-rays, it is still of interest to relate their possible benefits to their costs, based on certain assumptions (Table 3). If the direct cost of a chest X-ray is $23 and if we assume (according to the data in Table 1) that one out of 100 routine X-rays reveals an unexpected finding, each such finding would cost $2,300. Still referring to Table 1, if one test in 1,000 leads to a positive change in treatment, each such test would cost about $23,000. Again, not included here, are the costs of unnecessary tests and the postponement of surgery, or the savings which might be generated from treatments avoided because of routine examinations.

Unfortunately the health benefits of chest X-rays cannot be estimated because sufficient information is not available. If, based on pure speculation, it was assumed that 10% of the changes in treatment might produce a positive health benefit, each such change would cost $230,000 and if 10% of these changes resulted in the avoidance of a death or of a serious complication, each such event avoided would represent an expenditure of $2,300,000.

= CONCLUSION =

Having examined and reviewed all the available data, the *Conseil* concludes that :

- Given the considerable cost and the small benefits, the performance of routine chest X-rays is no longer justified before all surgery or anesthesia.
- Nevertheless there may be exceptions. In populations with a high prevalence of

pulmonary disease, or in cases where the medical history is for any reason unreliable (e.g. senility, intoxication, dementia, linguistic or cultural barrier) routine chest X-rays can be of significant value.

TABLE 1

STUDIES ON EFFICACY OF ROUTINE CHEST X-ray EXAMINATIONS

Author (year)	Study Design	Population		Abnormalities		New abnormalities			
						Information new and significant		Influence on treatment	
		Age (years)	N	n	%	n	%	n	%
Sane (1977)	P.	0-19	1,500	111	7.4	41	2.7	0	0
Wood (1981)	R.	0-19	749	35	4.7	9	1.2	3	0.4
Farnsworth (1980)	R	1 à 14	350	31	8.9	1	0.3	0	0
Maigaard (1978)	P.	> 30	1,256	57	4.5	2	0.2	0	0
Lamers (1989)	P.	> 40	810	5	0.6	1	0.1	0	0
Wyatt (1989)	R.	$\geq$ 50	388	4	1.0	1	0.4	1	0.4
Gagner (1990)	R.	0->70	1,000	74	7.4	6	0.6	0	0
Jeavons (1987)	P.	adults	500	33	6.6	11	2.2	4	0.8
Rucker (1983)	P.	<20->60	872	115	13.2	1	0.3	0	0
Thomsen (1978)	R.	> 40	1,823	241	13.0	42	2.3	4	0.2
Haubek (1978)	P.	1-94	400	24	6.0	6	1.9	0	0
Tape (1988)	R.	24-90	341	20	5.9	-	-	0	0
Catchlove (1979)	R.	40->70	79	5	6.3	-	-	0	0
Petterson (1977)	P.	child. adults	1,530	134	8.8	-	-	2	.1
Loder (1978)	R.	9-30	437	5	1.1	1	0.2	-	-
Turnbull (1987)	R.	adults	691	38	5.5	10	1.4	-	-
Törnebrandt (1982)	P.	70-94	91	43	47.3	10	11	-	-
Seymour (1982)	P.	>65	233	93	40.0	-	-	-	-
Mendelson (1987)	P.	0->80	369	62	17.0	-	-	-	-
Wiencek (1986)	P.	adults	237	101	42.6	-	-	-	-
Weibman (1987)	R.	0-90	734	213	29.0	-	-	-	-
Weighted mean[1]					10.0		1.3		0.1
95% C.I.[2]					(8.6-11.3)		(0-2.8)		(0-0.6)
Weighted mean without Törnebrandt							1.0		
95% C.I.[2]							(0-2.5)		

P. : prospective

R. : retrospective

C.I.: confidence interval

[1] Final rate based on calculations of weighted mean. The weight is inversely proportional to the sum of the sampling variation within each study and any additional variation between studies [Gilbert, 1977].

[2] Confidence interval is calculated from the standard deviation which reflects the rate's baseline heterogeneity.

TABLE 2

OTHER USES OF ROUTINE CHEST RADIOGRAPHY

Author (year)	Study Design	Population		Abnormalities found		New abnormalities			
						Information new and significant		Influence on treatment	
		Age (years)	N	N	%	N	%	N	%
Sagel (1974)[1]	R.	0-70	10,597	913	8.6	250	2.4	0	0
Brill (1973)[1]	P.	0.8 à 18	1,000	60	6.0	1	0.1	0	0.0
Hubbell (1985)[1]	P.	19-92	294	106	36.1	20	6.8	1	0.5
Hughes (1980)[1 2]	R.	adults	231	21	9.1	0	0		
Collen (1969)	P.	all	44,663	3,305	7.4	-	-	-	-
Sewell (1981)[3]	P.	_ 81	28	6	21.4	1	3.6	1	3.6
Denham (1984)[1]	P.	_ 81	200	100	50.0	0	0	0	0
Domoto (1985)[4]	R.	74-97	69	50	72.5	23	33	-	-
Wolf-Klein (1985)[5 5]	P.	_ 81	100	2	2.0	-	-	-	-
Fink (1981)[1]	P.	20-89	113	52	46.0	-	-	-	-
Mattox (1973)[6]	R.	adults	1,030	17	1.7	1	0.1	-	-
Bonebrake (1978)[7]	R.	15-45	11,725	74	0.6	0	0	0	0
Hadlock (1979)[7]	R.	adults	5,422	11	0.2	3	0.1	0	0

R.: retrospective
P.: prospective

[1] Pediatric preventive clinic.
[2] Psychiatric institution.
[3] Acute condition on admission.
[4] Chronic care institution.
[5] Annual examination.
[6] Routine prenatal examination.

TABLE 3

ESTIMATE OF COSTS FOR ROUTINE CHEST X-rays IN RELATION TO EFFICACY

If direct costs of a chest X-ray are : $23

Hypotheses from table 1 :

a) If routine chest X-rays reveal
unsuspected abnormalities in :..... 1.0% (95% CI, 0% to 2.5%)
Each unexpected finding will cost
on average :..... $2,300 ($\infty$ to $5,750)

b) If routine chest X-rays lead to
a modification of treatment in :..... 0.1% (95% CI, 0 à 0.6)
Each modification of treatment will cost on average : $23,000 ($\infty$ to $13,800)

= APPENDIX =

Frequency of routine chest X-rays in Quebec

The exact number of routine chest examinations performed in Quebec is unknown. Estimates of the frequency of these examinations are necessary. We are grateful to Mr. Michel Desmarais for the information on the current practices in Quebec's hospitals [Desmarais, 1991].

An investigation carried out by the Service de technologie médicale revealed that of the 162 hospitals that had a radiology service in Quebec in 1990, 102 performed routine chest X-rays of which 13,217 were performed before intrathoracic operations. If we suppose that each nonthoracic operation necessitates a routine chest X-ray, we can estimate that approximately 457,000 routine chest X-rays have been performed in 1988.

Estimates of frequencies of routine chest X-ray examinations

a)[2]	X-rays performed in private clinics, 1988	488,205
b)[1]	X-rays performed in institutions, 1988	1,610,200
c)	Total X-rays, 1988 (a + b)	2,098,405
d)	Listed institutions	162
e)	Institutions that performed routine chest X-rays	102
f)	Operations in institutions that performed routine chest X-rays	470,648
g)[1]	Intrathoracic operations, 1988	13,217
h)	Number of routine non thoracic chest examinations (f - g)	457,431

[1] Régie de l'assurance-maladie du Québec (RAMQ).

= REFERENCES =

BEIR V (Fifth Committee on the Biological Effects of Ionizing Radiation). Washington DC: National Academy Press. Health effects of exposure to low levels of ionizing radiation. 1990. 421 p.

Bhuripanyo K, Prasertchuang C, Chamadol N, Laopaiboon M, Bhuripanyo P. The impact of routine preoperative chest X-ray in Srinagarind Hospital, Khon Kaen. J Med Assoc Thai 1990;73(1):21-8.

Boghosian SG, Mooradian AD. Usefulness of routine preoperative chest roentgenograms in elderly patients. J Am Geriatr Soc 1987;35(2):142-6.

Bonebrake CR, Noller KL, Loehnen CP, Muhm JR, Fish CR. Routine chest roentgenography in pregnancy. JAMA 1978;240(25):2747-8.

Brill PW, Ewing MD, Dunn AA. The value(?) of routine chest radiography in children and adolescents. Pediatrics 1973;52(1):125-7.

Catchlove BR, Wilson RM, Spring S, Hall J. Routine investigations in elective surgical patients. Med J Aust 1979;2:107-10.

Charpak Y, Blery C, Chastang C, Szatan M. Prospective assessment of a protocol for selective ordering of preoperative chest X-rays. Can J Anaesth 1988;35(3):259-64.

Checkoway H, Pearce NE, Crawford-Brown DJ. Research methods in occupational epidemiology. Monographs in Epidemiology and Biostatistics. Oxford University Press. 1989.

Collen MF, Feldman R, Siegelaub AB, Crawford D. Dollar cost per positive test for automated multiphasic screening. N Engl J Med 1970; 283(9):459-63.

Corporation. Guide de l'exercice de l'anesthésie. Montréal: Corporation professionnelle des médecins du Québec. 1981.

Delahunt B, Turnbull PRG. How cost effective are routine preoperative investigations? NZ Med J 1980;92:431-2.

Denham M, Thakker R, Berman L, De Lacey G. Value of routine chest radiography in an acute geriatric unit. Br Med J 1984;288(June 9):1726-7.

Desmarais M. Personal communication 1991.

Domoto K, Ben R, Wei JY, Pass TM, Komaroff AL. Yield of routine annual laboratory screening in the institutionalized elderly. AJPH 1985;75(3):243-245.

Farnsworth PB, Steiner E, Klein RM, San Filippo JA. The value of routine preoperative chest roentgenograms in infants and children. JAMA 1980;244(6):582-3.

Fink DJ, Fang M, Wyle FA. Routine chest X-ray films in a veterans hospital. JAMA 1981; 245:1056-1057.

Fowkes FGR. The value of routine preoperative chest X-rays. Br J Hosp Med 1986;(Feb):120-3.

Gagner M, Chiasson A. Preoperative chest X-ray films in elective surgery: a valid screening tool. Can J Surg 1990;33(4):271-4.

Gilbert JP, McPeek B, Mosteller F. Progress in surgery and anesthesia: benefits and risks of innovative therapy. In: Bunker Barnes Mosteller (eds). Costs, Risks, and Benefits of Surgery. New York: Oxford University Press. 1977; 124-69.

Hadlock FP, Park SK, Wallace RJ. Routine radiographic screening of the chest in pregnant women. Is it indicated? Obstet Gynecol 1979; 54(4):433-6.

Hammar LM. Admission chest film program: fifteen years' experience. Minn Med 1969;(Dec):1899-1901.

Haubek A, Cold G. Praeoperativ rontenundersogelse af thorax: indikation og konsekvens. Ugeskr Laeg 1978;140:772-3.

Hubbell FA, Greenfield S, Tyler JL, Chetty K, Wyle FA. The impact of routine admission chest X-ray films on patient care. N Engl J Med 1985;312(4):209-13.

Huda W, Sandison GA, Palser RF, Savoie D. Radiation doses and detriment from chest X-ray examinations. Phys Med Biol 1989;34:1477-92.

Hughes J, Barraclough BM. Value of routine chest radiography of psychiatric patients. Br Med J 1980;281:1461-1462.

Jeavons SJ, Siddle KJ, Mitchell C, O'Hare PM. Evaluation of pre-operative chest X-ray. Australas Radiol 1987;31:256-9.

Kerr IH. The preoperative chest X-ray. Br J Anaesth 1974;46:558-63.

Kunamoto Y. Population doses excess deaths and loss of life expectancy from mass chest X-ray examinations in Japan-1980. Health Phys 1985;49:37-48.

Lamers RJS, Van Engelshoven JMA, Pfaff A. Nogmaals, de routinematige preoperatieve thoraxfoto. Ned Tijdschr Geneeskd 1989;133(46):2288-91.

Loder RE. Routine pre-operative chest radiography. 1977 compared with 1955 at Peterborough District General Hospital. Anaesthesia 1978;33:972-4.

Lortie F. Examens radiographiques pulmonaires de routine et de dépistage. Montréal:1991; 32 p.

Lurie P. Toward optimal use of radiographs should admission and preoperative chest films be routine? Postgrad Med 1987;82(2):209-16.

Maigaard S, Elkjaer P, Stefansson T. Vaerdien af praeoperativ rutinerontgenundersogelse af thorax og ekg. Ugeskr Laeg 1978;140(14):769-71.

Mattox JH. The value of a routine prenatal chest X-ray. Obstet Gynecol 1973;41(2):243-5.

McKee RF, Scott EM. The value of routine preoperative investigations. Ann R Coll Surg Engl 1987;69:160-2.

Mendelson DS, Khilnani N, Wagner LP, Rabinowitz JG. Preoperative chest radiography. Value as a baseline examination for comparison. Radiology 1987;165:341-3.

Michel C. Valeurs des examens préopératoires: étude prospective des radiographies de thorax et des ECG préopératoires de 201 patients. Rev Med Suisse Romande 1989;109:225-33.

Ogunseyinde AO. Routine pre-operative chest radiographs in non-cardiopulmonary surgery. Afr J Med Med Sci 1988;17(3): 157-61.

Petterson SR, Janower ML. Is the routine preoperative chest film of value? Appl Radiol 1977;6:70.

Rees AM, Roberts CJ, Bligh AS, Evans KT. Routine preoperative chest radiography in non-cardiopulmonary surgery. Br Med J 1976;1:1333-5.

Robin ED, Burke CM. Risk-benefit analysis in chest medicine: routine chest X-ray examinations. Chest 1986;90(2):258-62.

Roizen MF, Kaplan EB, Schreider BD, Lichtor LJ, Orkin FK. The relative roles of the history and physical examination, and laboratory testing in preoperative evaluation for outpatient surgery: the "starling" curve of preoperative laboratory testing. Anesthesiol Clin N Am 1987; 5(1):15-20.

Rucker L, Frye EB, Staten MA. Usefulness of screening chest roentgenograms in preoperative patients. JAMA 1983;250(23):3209-11.

Sagel SS, Evens RG, Forrest JV, Bramson RT. Efficacy of routine screening and lateral chest radiographs in a hospital-based population. N Engl J Med 1974;291(19):1001-4.

Sane SM, Worsing RA, Wiens CW, Sharma RK. Value of preoperative chest X-ray examinations in children. Pediatrics 1977;60(5):669-72.

SBU (Swedish Council on Technology Assessment in Health Care). Stockholm. Preoperative routines. 1989;1-7.

Sewell JME, Spooner LLR, Dixon AK, Rubenstein D. Screening investigations in the elderly. Age Ageing 1981;10:165-8.

Seymour DG, Pringle R, Shaw JW. The role of the routine pre-operative chest X-ray in the elderly general surgical patient. Postgrad Med J 1982;58:741-5.

Tape TG, Mushlin AI. How useful are routine chest X-rays of preoperative patients at risk for postoperative chest disease? J Gen Intern Med 1988;3:15-20.

Taylor HG, Stein CM. Clinical effect of admission chest X-rays in Zimbabwe. Lancet 1988;(Aug 20):440-2.

Thomsen HS, Gottlieb J, Madsen JK, et al. Rutinemaessig rontgenundersogelse af thorax inden kirurgiske indgreb i universel anaestesi. Ugeskr Laeg 1978;140(14):766-68.

Törnebrandt K, Fletcher R. Pre-operative chest X-rays in elderly patients. Anaesthesia 1982;37(9):901-2.

Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. Arch Intern Med 1987;147:1101-05.

U.S. Department of Health and Human Services. The selection of patients for X-ray examinations. Rockville (MA): U.S. Department of Health and Human Services, 1983. 51 p.

U.S. Department of Health and Human Services. The selection of patients for X-ray exami-

nations: presurgical chest X-ray screening examination. Rockville (MA): U.S. Department of Health Services, 1986. 14 p.

Wardrope J, Chennells PM. Should all casualty radiographs be reviewed? Br Med J 1985;290(June 1):1638-40.

Weibman MD, Shah NK, Bedford RF. Influence of preoperative chest X-rays on the perioperative management of cancer patients. Anesthesiology 1987;67(3A):A332.

Wiencek RG, Weaver DW, Bouwman DL, Sachs RJ. Usefulness of selective preoperative chest X-ray films: a prospective study. Am Surg 1987;53:396-8.

Wood RA, Hoekelman RA. Value of the chest X-ray as a screening test for elective surgery in children. Pediatrics 1981;67:447-52.

Wolf-Klein GP, Holt T, Silverstone FA, Foley CJ, Spatz M. Efficacy of routine annual studies in the care of elderly patients. J Am Geriatr Soc 1985;33:325-329.

World Health Organization (WHO). A rational approach to radiodiagnostic investigations: report of a WHO Scientific Group on the indications for and limitations of major X-ray diagnostic investigations. Geneva: World Health Organization (WHO), 1983. 29 p.

Wyatt WJ, Reed DN, Apelgren KN. Pitfalls in the role of standardized preadmission laboratory screening for ambulatory surgery. Am Surg 1989;55:343-6.

1. Admission.
2. Desmarais, 1991. MSSS.