Value of routine preoperative chest *x*-rays: a meta-analysis

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The purpose of this study was to estimate the frequency with which routine postoperative chest x-rays lead to clinically relevant new information. All articles in English, French and Spanish relating to routine chest radiography in North American or European populations were reviewed, using the Medline database and references listed in reviews and periodicals published from 1966 to 1992, inclusive. Twenty-one reports which supplied sufficient information were included for meta-analysis. On average, abnormalities were found in 10% of routine preoperative chest films. In only 1.3% of films were the abnormalities unexpected, i.e., were not already known or would not otherwise have been detected (95% CI: 0 to 2.8%). These findings were of sufficient importance to cause modification of management in only 0.1% (95% CI: 0 to 0.6%). The frequency with which the new information influenced health could not be estimated. Assuming only the direct cost to the health care system of each radiograph ($23), each finding which influenced management in any way would cost $23,000. It is concluded that in North American or European populations when a reliable history and a clinical examination are carried out, the cost of this test is so high in relation to the clinical information provided that it is no longer justifiable.

Cette étude vise à évaluer la fréquence des anomalies cliniques significatives découvertes par la radiologie préopératoire systématique. Tous les articles en anglais, en français et en espagnol traitant du sujet en Amérique du Nord et en Europe ont été révisés à l'aide de la banque de données de Medline et des bibliographies de périodiques et de revues publiés de 1966 à 1992. Les 21 rapports fournissant, suffisamment d'informations sont inclus dans la méta-analyse. En moyenne, des anomalies se retrouvent sur 10% des radiographies préopératoires. Sur seulement 1,3% des films, les anomalies sont inattendues, c'est-à-dire qu'elles n'étaient déjà pas connues ou n'auraient pu être décelées autrement (IC 95%: 0 à 2,8%). Ces nouvelles données auraient pu en elles-mêmes modifier la ligne de conduite adoptée dans 0,1% des cas (IC 95%: 0 à 0,6%). La fréquence avec laquelle ces trouvailles ont influencé la santé ne peut être évaluée. En attribuant au système sanitaire le seul coût direct de chaque radiographie (23$), toute trouvaille susceptible de modifier la ligne de conduite coûte 23,000$. On en conclut que pour les populations nord-américaines et européennes, en présence d'une anamnèse et d'un examen clinique fiables, les renseignements obtenus ne justifient pas le coût de l'examen.

Key words
ANAESTHESIA: pre-anaesthetic assessment, chest *x*-ray.

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For many years, it has been routine practice to carry out chest radiography before all surgical operations which require anaesthesia. During the last 20 years, however, doubts have been expressed concerning the need for this examination except when the medical history or clinical examination suggests some intrathoracic pathology.[1,2] Numerous studies have addressed this issue. Most have considered the frequency with which routine radiographs are "abnormal" and some have considered the frequency with which the discovery of some abnormality in the routine film influences anaesthetic decisions. Several reports have also considered whether the information obtained from routine preoperative radiographs have had or might have had, any influence on health outcomes.[15,17-19,29]

Since this test, when carried out on large numbers of patients, is associated with considerable costs and some health effects, it is important to establish the frequency with which new information of clinical value is obtained. The present report describes a meta-analysis of published studies and was carried out with the object of estimating this frequency with greater confidence than could be derived from any individual report on its own. Unfortunately, there is insufficient evidence on which to base estimates of how frequently information resulting from routine radiography influences health outcomes. However, an estimate can be made of how frequently routine radiograph provides information which would otherwise have gone undetected.

TABLE The frequency of abnormalities on routine chest *x*-ray examinations taken in the preoperative context

Author	Study design	Study group		All abnormalities		Unsuspected abnormalities			
						Total		Influencing management	
		Age (y)	N	N	%	N	%	N	%
Sane[23]	P	0–19	1500	111	7.4	41	2.7	0	0
Wood[24]	R	0–19	749	35	4.7	9	1.21	3	0.4
Farnsworth[25]	R	1–14	350	31	8.9	1	0.3	0	0
Maigaard[26]	P	>30	1256	57	4.5	2	0.2	0	0
Lamers[27]	P	>40	810	5	0.6	1	0.1	0	0
Wyatt[28]	R	>49	388	4	1.0	1	0.4	1	0.4
Gagner[29]	R	All	1000	74	7.4	6	0.6	0	0
Jeavons[30]	P	Adults	500	33	6.6	11	2.2	4	0.8
Rucker[31]	P	All	872	115	13.2	1	0.3	0	0
Thomsen[32]	R	>40	1823	241	13.0	42	2.3	4	0.2
Haubek[33]	P	1–94	400	24	6.0	6	1.9	0	0
Tape[17]	R	24–90	341	20	5.9	–	–	0	0
Catchlove[34]	R	40–>70	79	5	6.3	–	–	0	0
Petterson[35]	P	All	1530	134	8.8	–	–	2	0.1
Loder[36]	R	9–30	437	5	1.1	1	0.2	–	–
Turnbull[37]	R	Adults	691	38	5.5	10	1.4	–	–
Törnebrandt[3]	P	70–94	91	43	47.3	10	11	–	–
Seymore[11]	P	>65	233	93	40.0	–	–	–	–
Mendelson[38]	P	All	369	62	17.0	–	–	–	–
Wiencek[38]	P	Adults	237	101	42.6	–	–	–	–
Weibman[40]	R	0–90	734	213	29.0	–	–	–	–
All studies			14,390	1,444		140		14	
Weighted mean*					10.0		1.3		0.1
95% CI					8.6–11.3		0.0–2.8		0.0–0.6
Weighted mean (excluding[3])							1.0		
95% CI							0.0–2.5		

Abbreviations: R = retrospective; P = prospective; CI = confidence interval.
*Weighted according to the number of study subjects.

Methods

All articles in French, English and Spanish, relating to routine preoperative chest radiography published between 1966 and 1993 inclusive were identified, using the Medline database and key words "preoperative," "routine," "chest radiograph" and "chest *x*-ray." References listed in reviews and periodicals were also used. All studies were considered for analysis which were based on North American or European populations and in which the frequency of "abnormalities" detected by routine preoperative chest radiography could be determined. For this purpose, it was essential to know in what proportion the abnormalities detected were already known or would have been revealed because of a clinical history or physical examination indicating that a chest radiograph was indicated. Twenty-one such studies, involving 14,390 patients were identified (Table).

The methodology used in these studies varied considerably. Eleven were carried out prospectively and ten were based on retrospective reviews of patients' medical charts. In 14 studied involving 10,867 patients, sufficient information was supplied with which to judge whether the "abnormality" detected was unexpected, i.e., would not have been found if a routine radiograph had not been performed. In 14 reports (not the same 14) involving 11,598 patients, the abnormality detected was considered of sufficient clinical importance to lead to modification of management. These modifications included such items as the ordering of further tests or of additional consultations or the delaying of surgery.

The interpretation and selection of these reports was carried out by two of the authors independently, the rare differences of opinion being resolved by discussion. Using the data from these reports, the frequency of all abnormalities, of all unexpected abnormalities and of all unexpected abnormalities of sufficient importance to influence management were estimated and the average frequency was derived, weighted according to the number of patients in each study (Table).

Results

The table summarizes the data from the 21 selected studies published between 1966 and 1992. The frequency of "abnormalities" in the 14,390 patients subjected to routine

preoperative chest radiography average 10%, with a 95% confidence interval (CI) of 8.6% to 11.3%. In these reports, it was not always apparent how often these abnormalities were already known. Thus, these chest abnormalities were not necessarily "discovered" by the taking of a chest *x*-ray.

In 14 of these reports, however, the number of cases with previously known chest abnormalities or with a history or clinical examination that would have led to a radiographic examination being carried out on clinical grounds could be ascertained. Using this information, the number of cases could be estimated in which *x*-ray abnormalities were unsuspected, i.e., cases in which abnormalities would not have been found, had a routine chest *x*-ray not been carried out. In these 14 studies, unsuspected intrathoracic abnormalities averaged 1.3% (95% CI: 0% to 1.8%). The frequency of unsuspected abnormalities is likely to be higher in the elderly (see below), and if one study[3] based on a very elderly population, aged 70 to 94 years was excluded, the frequency of unsuspected abnormalities averaged 1.0% (95% CI: 0 to 2.5%).

In 14 of these 21 studies, it was also possible to determine the frequency with which the discovery of unsuspected abnormalities on routine preoperative chest *x*-rays was considered of sufficient importance to cause any action by the medical team, such as the ordering of further tests or postponement of surgery. The frequency of all such discoveries averaged 0.1% (95% CI: 0 to 0.6%). Unfortunately, the more pertinent information as to whether the health of patients was favourably or unfavourably affected by these changes in management was recorded in insufficient studies to be averaged.

Discussion

The decision as to whether to order a routine preoperative chest radiograph or not depends on the probability of finding clinically useful information *versus* the costs and possible adverse health effects of the procedure. The probability of such findings must vary with the population in question and for this reason only those reports which derived from countries with a fairly comparable health status were included in this analysis. The data suggest that in populations comparable to those reflected in the Table, some abnormality will be reported on average in 10% of routine preoperative chest radiographs.

However, in 14 of these studies it can be estimated that 9% of the abnormalities were already known or anticipated because of a history of chest disease or an abnormal clinical examination, and in these the abnormality would have been revealed by clinically indicated radiography. Thus, in only approximately 1% would the abnormality not have been discovered in the absence of routine radiography. However, even in these, the discovered "abnormality" was usually clinically insignificant, since only one of every ten such abnormalities caused any change in patient management. Thus, in these reports, only one of every 1,000 routine preoperative chest radiograms caused any change in management.

There is insufficient information on which to base any estimate of the proportion in which the change in management caused benefit or harm. However, several authors who do not report sufficient information to be included in the quantitative analysis reflected in the Table have considered this issue. In the National Study of the Royal College of Radiologists of 10,619 preoperative patients, no evidence was found that the results of preoperative chest *x*-ray ever influenced the decision to use inhalational anaesthesia. In a report of 1,175 radiographic examinations carried out before gynaecological operations in Germany, the examination only changed patient management in 1 patient (0.009%) in whom tuberculosis had been detected.[4,5] In a retrospective review of 2,765 patients in France in whom preoperative chest *x*-rays were not ordered, in only two (0.1%) would such an examination have been of any value, as judged by the anaesthetist.[6]

The frequency of unsuspected abnormalities revealed by routine chest radiographs must vary, however, with the prevalence of chest pathology in the population in question, and with the reliability of the clinical examination and the medical history. It thus can be anticipated that the frequency with which routine chest films are positive will be greater in populations with increased prevalence of tuberculosis, or in the presence of increased forgetfulness, as in the elderly, or in the presence of intoxication or dementia. It is thus not surprising that in numerous studies of elderly populations, higher frequencies of abnormal findings than those reported here have been discovered by routine chest radiography.[7-13] It is regrettable that in most studies, including many included in the Table, ages are too poorly reported to allow precise definition of the relationship of frequency of abnormal findings to age.

When the patient's medical history is less reliable because of cultural and/or linguistic differences between patients and their health professionals, the frequency of unexpected findings must also increase. Such reasons, together perhaps with a higher prevalence of chest disease in the general population, may explain the finding of 22% unsuspected abnormalities in 203 preoperative patients in Ibadan, Nigeria,[14] of 17% unsuspected abnormalities in 427 chest *x*-rays done upon admission to a hospital in Harare, Zimbabwe[15] or of 19.4% unsuspected abnormalities in 1,013 routine preoperative examinations in Thailand.[16] Routine chest *x*-rays may therefore provide more useful information in such populations.

These data suggest that, except for the reasons listed above, routine preoperative chest *x*-rays in Western industrialized countries can be expected to reveal unsuspected abnormalities of any clinical significance in only a very small proportion of the cases studied. Other reports, although not presenting data in a form suitable for inclusion in this meta-analysis, have also concluded that there is very little or no value to this procedure.[4,5,7,8,17–19]

As long as any clinical value remains possible, the costs and health effects of this routine test must be considered. Since the clinical value of routine chest *x*-rays is seldom reported, no precise estimates of cost-benefit are possible. However, a sensitivity analysis of the possible direct costs to the health care system of each positive finding can be made. The average direct cost of a chest *x*-ray has been estimated in Quebec to be $23.[20] If, as indicated by the data in the Table, one out of 100 routine preoperative chest radiographs reveals an unexpected finding, each such finding would therefore cost $2,300. Furthermore, if only one test in 1,000 is of sufficient importance to cause any management change whatsoever, each such test would cost approximately $23,000. The costs of unnecessary tests or of the unnecessary postponement of surgery caused by the disclosure of information of no clinical importance, and of the savings which might result from possible operations avoided, have not been taken account of.

As stated above, the health benefits of chest *x*-rays cannot be estimated in this analysis because the pertinent information is not available. However, if 5%, 10% or 20% of the changes in management resulting from routine chest *x*-rays were to produce a positive health benefit, each such benefit would cost $460,000, $230,000 or $115,000 respectively.

Apart from their direct costs to the health care system, there are other reasons to take a critical look at routine chest *x*-rays. It is reported that the psychological trauma to the patient confronted with a false positive diagnosis may be "devastating" and that the finding of a "positive" result may often lead to a "cascade" of other diagnostic tests such as additional radiography, axial tomography, bronchoscopy, sputum tests and even thoracotomies and lung biopsies, all carried out in order to establish that the radiographical finding is not clinically important.[21]

There is also a small but real risk of cancer from the exposure to *x*-rays. The organs known to be the most sensitive to radiation-induced cancers are the lungs, breasts, digestive system, bone marrow, and the thyroid gland.[22] The lifetime risk of cancer death which could result from routine preoperative chest *x*-rays can be estimated to be approximately 1.2 per 100,000.[20] Similar risks have been estimated in Japan for chest *x*-rays carried out to detect tuberculosis.[41] Though no cancer risk can be considered trivial, the radiation risk of this procedure must be compared with the background expected cancer mortality, which, in Quebec for example, can be estimated to be approximately 18,000 per 100,000 individuals. Thus, routine radiography might cause an increase in cancer mortality of the order of 7×10^{-5} ($1.2 \div 18{,}000$).

Finally, the value of subjecting such reports, carried out in different ways, often with different objectives, to meta-analysis, can be questioned. Many studies did not have the explicit objective of establishing the frequency with which the test gives information which would not otherwise have been obtained. Many did not report even the average age and age range of the subjects. Few reported the most important outcome, the health of the patient. Nevertheless, we believe the estimates of probability which could be extracted from these reports may be helpful in making the decision as to whether to continue the practice of routine preoperative radiography or not.

In conclusion, it can be estimated that in pre-surgical populations similar to those examined in these reports where clinical history and examination are carried out, each thousand such examinations may reveal information of sufficient importance to cause some change of management. We believe that this dividend is probably insufficient to justify the cost and negative health effects of the procedure in the average Canadian preoperative population. However, any increased prevalence of pulmonary disease in the background population, or any reason to doubt the reliability of the clinical examination or medical history such as the presence of senility, intoxication, dementia, or linguistic or cultural barriers to history taking, may increase the value of the procedure. In the absence of these conditions, however, a decision to abandon this procedure seems justifiable.

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