The role of the routine pre-operative chest X-ray in the elderly general surgical patient

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Summary

In an unselected group of 233 patients aged 65 years and over undergoing non-cardiopulmonary surgery, 57.5% had some abnormality on routine pre-operative chest X-ray and 40.3% had an abnormality which was regarded as clinically significant. Of all patients, 32.2% subsequently required a postoperative chest film for diagnostic purposes, and in these cases the pre-operative X-ray was invaluable as a baseline. During the study period there were ten occasions where the discovery of an abnormality on a routine pre-operative chest film directly affected the treatment plan. Pre-operative chest radiology proved ineffective as a method of predicting postoperative respiratory complications and was of only limited effectiveness in predicting postoperative cardiac morbidity.

It is concluded that a routine pre-operative chest X-ray should be available in all elderly surgical patients (a) as a baseline measurement and (b) to exclude unsuspected disease. The prediction of post-operative cardiac and respiratory morbidity, however, is best achieved by non-radiological means.

Introduction

It is well known that the number of abnormalities found on routine pre-operative chest X-rays tends to rise steeply with age (Sagel *et al.*, 1974; Rees *et al.*, 1976). In a patient under 30 years of age undergoing elective non-cardiopulmonary surgery, the chances of detecting any abnormality on chest radiology are very small, while above the age of 70 years, 40 to 60% of such patients may have abnormal X-rays (Sagel *et al.*, 1974; Rees *et al.*, 1976).

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The present investigation looks at the abnormalities found in the chest X-rays of a group of unselected elderly patients who were submitted to surgery. It then relates these pre-operative abnormalities to the cardiac and respiratory complications which developed postoperatively. In the light of this information, the value of routine pre-operative chest radiology in the elderly surgical patient is reassessed.

Patients and methods

1. Clinical assessment

During the period of the study, a prospective evaluation was made of all patients aged 65 years and over who had elective or emergency surgery in a general surgical unit in Ninewells Teaching Hospital, Dundee.

Pre-operatively, a detailed history and examination was supplemented by a biochemical screen, a full blood count, an electrocardiogram, and a routine postero-anterior chest X-ray. Postoperative complications were monitored by a single observer using the following criteria: (a) Respiratory complications: two or more of the following—productive cough, fever of 38°C or over, physical signs in the chest which were not present pre-operatively. Three patients with clinically diagnosed pulmonary emboli were excluded from this category. (b) Cardiac complications: myocardial infarction (Mauney, Ebert and Sabiston, 1970), cardiac failure (Goldman *et al.*, 1978).

2. Assessment of pre-operative chest X-rays

We followed the existing practice of the surgical unit when obtaining reports on the pre-operative chest X-rays: films were sent for routine reporting to the Department of Radiology, where they were seen by one of a number of different radiologists. The

TABLE 1. Classification of abnormalities on pre-operative chest X-ray
(from Rees *et al.*, 1976 with kind permission of the authors and the Editor, *British Medical Journal*)

	'Significant' abnormalities	'Non-significant' abnormalities
Heart	Cardiomegaly	
Aorta and pulmonary artery	Left ventricle enlarged Enlarged pulmonary artery	Unfolded aorta Right-sided aorta
Lung field	Chronic obstructive airways disease Collapse Metastases Asbestosis Fibrosis Pulmonary infarction Complicated pneumoconiosis	Old tuberculosis Simple pneumoconiosis
Pleura	Effusion Asbestotic plaques	Thickening
Skeletal	Metastases Cervical spondylosis	Kyphosis and scoliosis Old fractures Enchondromata Disc degeneration Old rib operations Pectus excavatum Congenital rib anomalies Arthritides (shoulder) Calcified nodes
Mediastinum	Deviated trachea Goitre	

reports were later gathered together and the abnormalities reported were classified as 'clinically significant' or 'clinically non-significant', following the criteria and practice of Rees *et al.* (1976) as shown in Table 1. To supplement the information obtained from the radiologists' reports, some additional measurements were made directly from the pre-operative films. Cardiothoracic ratio (CTR) was measured using the technique of Cowan (1959) and the height of the right diaphragm was noted (Edge *et al.*, 1964). Statistical testing was by 2×2 χ^2 squared analysis.

Results

Of the 258 patients aged 65 years and over who had operations during the period of the study, 233 had pre-operative chest X-rays available which were of sufficient quality for analysis. Analysis was therefore confined to these 233 patients.

Abnormalities present on the pre-operative chest X-ray

Table 2 lists the main abnormalities on routine reporting of the pre-operative chest X-ray. Only 42.5% of the 233 elderly patients had no abnormality of any kind reported, but this figure rose to 59.7% when clinically non-significant changes were also included. Of the clinically significant changes, cardiomegaly (including single chamber enlargement) was the commonest cardiac abnormality, being reported

in 18.0% of men and 26.0% of women. In contrast, diffuse lung changes and evidence of old respiratory disease were more commonly found in men. The 15 'miscellaneous' cases included six instances where a primary or secondary carcinoma was suspected, and two cases of thyroid enlargement.

For further analysis the 233 patients were divided into four groups depending on the major clinically significant abnormality reported on the pre-operative chest X-ray. This yielded (1) 139 patients who had either a normal chest X-ray or a clinically non-significant abnormality, (2) 45 patients with predominantly cardiac pathology, and (3) 41 patients with predominantly respiratory abnormalities, (4) the remaining eight patients had other miscellaneous abnormalities. All subsequent analyses are based on the first three of these groupings.

Cardiac abnormalities on the pre-operative X-rays of these patients were not significantly associated with sex, emergency surgery, or age over 75. Pre-operative radiological pulmonary abnormalities, however, were present in 29% of emergencies as compared with only 13% of electives, a difference which is statistically significant ($P < 0.01$). The incidence of pre-operative pulmonary abnormalities was also higher on the chest X-rays of the over-75s, but this failed to reach statistical significance ($P < 0.10$). Elective patients and patients under 75 years of age had the highest incidence of normal chest X-rays pre-

TABLE 2. Abnormalities reported on pre-operative chest X-rays in 233 patients

Chest X-ray findings	Number of abnormalities found				Totals (% of patients)
	Male Electives (n = 101)	Male Emergencies (n = 32)	Female Electives (n = 63)	Female Emergencies (n = 37)	
No abnormality reported	49	8	29	13	99 (42.5%)
Cardiomegaly*	12	12	20	6	50 (21.5%)
Heart failure*	2	4	1	2	9 (3.9%)
Unfolded aorta	8	2	10	3	23 (9.9%)
Diffuse lung changes*	8	6	2	2	18 (7.7%)
Infection/Basal collapse*	7	5	5	7	24 (10.3%)
Apical scarring/ Pleural changes	16	7	4	7	34 (14.6%)
Miscellaneous	8	2	5	0	15 (6.4%)

*Clinically significant abnormality (after Rees *et al.*, 1976, by kind permission of the authors and the Editor, *British Medical Journal*)

operatively, but this also was not statistically significant.

The cardiothoracic ratio (CTR) is known to increase with age even in fit people (Cowan, 1964) and, for this reason, the common practice of defining CTR values over 0.500 as abnormal is unacceptable in the elderly. The patients in the present study also had a rise in the CTR with age ($r=0.224$, $P=0.01$ in men; $r=0.325$, $P=0.001$ in women) with the result that 33% of the men and 79% of the women aged 75 years and over had CTRs which exceeded 0.500. However, when these CTR values were adjusted for the effects of age and sex (Cowan, 1964), only 20 of the men and seven of the women had high CTR values. It was these age- and sex-adjusted values that were used in the statistical analyses.

A right diaphragm at or below the level of the anterior end of the seventh rib has been suggested as one indicator of chronic lung disease (Edge *et al.*, 1964; Simon, 1973). The diaphragm was lowered to this extent in the pre-operative X-rays of 19.5% of the men and 10.0% of the women. There was no statistical association between the level of the diaphragm and age.

Pre-operative radiological abnormalities and postoperative complications

The hypothesis that heart or lung abnormalities on the pre-operative chest X-ray might be associated with post-operative respiratory and/or cardiac complications was examined.

In Table 3 the pre-operative chest X-rays are classified according to the radiologists' reports. It can be seen that there is no evidence that postoperative respiratory or cardiac complications were more common in patients with lung abnormalities on the pre-operative X-ray. A pre-operative heart abnor-

mality on X-ray, however, was associated with twice the incidence of postoperative cardiac complications and a decreased incidence of respiratory complications, although only the former attained statistical significance. When the data for males and females were examined separately, no additional statistical association appeared.

TABLE 3. Pre-operative chest X-ray and postoperative complications

	Postoperative complications	
	Cardiac	Respiratory
Significant pre-operative heart abnormality (n = 45)	22.2% v*	33.3% v
No significant pre-operative heart abnormality (n = 188)	10.6%	41.5%
Significant pre-operative lung abnormality (n = 41)	9.8% v	36.6% v
No significant pre-operative lung abnormality (n = 192)	13.5%	40.6%

* $\chi^2=4.3$; $P<0.05$.

No relationship was seen between the presence of a high CTR (Cowan's criteria) or a low-lying diaphragm on the pre-operative chest X-ray, and the development of postoperative respiratory or cardiac complications.

Patients needing postoperative chest X-rays

Chest X-rays were not repeated routinely after operation but were carried out only for diagnostic reasons at the discretion of the surgical team. The percentages of patients in various sub-groups who

received one or more postoperative chest X-rays are summarized in Table 4. It can be seen that over a third of all the patients in the study were judged by the surgeons to require a postoperative chest X-ray to confirm or exclude a postoperative complication and the implications of this are discussed below.

TABLE 4. Number of postoperative chest X-rays performed

Group	n	Percentage of patients having one or more postoperative chest X-ray
Male electives	101	35.6%
Male emergencies	32	37.5%
Female electives	63	27.0%
Female emergencies	37	45.9%
Total	233	35.2%

Discussion

A routine chest X-ray before non-cardiopulmonary surgery might be expected to provide clinical benefit in three ways. (a) As a baseline against which to compare any subsequent postoperative radiological changes (Kerr, 1974; Milne, 1980; Harris, 1980). (b) As a means of detecting significant disease, such as secondary malignancy, which will affect surgical management (Kerr, 1974; Milne, 1980). (c) As a method of predicting which patients will develop intra- or postoperative complications.

When cardiac and/or respiratory complications develop postoperatively, their early detection on chest X-ray is made much easier if a good pre-operative film is available to act as a baseline for comparative purposes (Milne, 1980). In the present study, over one-third of all our elderly patients were judged by the surgical team to require a postoperative chest X-ray for diagnostic reasons. The radiologists reading these postoperative films had the benefit of a routine pre-operative X-ray as a baseline in all cases, and were therefore aware that just under 60% of the patients had some type of pre-operative radiological abnormality. If these baseline pre-operative X-rays had not been available the problem of discerning old lesions from new on the postoperative chest film would have been much more difficult. Our criteria for defining postoperative respiratory and cardiac complications did not require a chest X-ray to be carried out (see Patients and Methods). However, a postoperative chest X-ray aided patient evaluation in 63% of those with chest infections and 75% of those with cardiac problems. We consider that the above information strongly supports the view of Milne (1980) that a pre-operative chest X-ray should be available in all elderly general surgical patients as

a baseline against which to compare postoperative changes.

In a small percentage of patients, an unsuspected lesion on a routine pre-operative chest X-ray may affect the choice of surgical treatment. Among the 258 elderly patients who underwent surgery in the present study, six such cases had radiological lesions suggestive of neoplasia. Five of these lesions proved to be malignant and the surgical procedure and follow-up were modified accordingly. In addition, over the period of the study there were five elderly patients in whom the decision *not* to operate was substantially influenced by an abnormal pre-operative chest X-ray. Three of these patients had secondary carcinoma, one had tuberculosis, and the fifth had dysphagia secondary to left atrial enlargement. Thus, over the period of the study, the pre-operative chest film directly affected surgical management in at least ten people.

The role of the routine pre-operative chest X-ray as a predictor of postoperative complications is much less certain. In the present study pre-operative radiology was unable to predict which patients would develop postoperative respiratory complications. In this respect, it was inferior to much simpler indicators such as a history of smoking, exercise intolerance, site of surgical incision, age over 75, and peak flow rate (unpublished observations). Even though there was some success in predicting postoperative cardiac complications from the pre-operative chest X-ray, 20 out of the 30 patients in whom postoperative cardiac complications developed had no significant cardiac abnormality in their pre-operative chest films. Direct measurement of the CTR or the level of the right diaphragm failed to enhance the predictive value of the radiologists' reports.

The failure of the pre-operative chest X-ray to predict postoperative respiratory morbidity might appear surprising. However, the causes of a postoperative chest complication are multifactorial (Schmidt, 1977; Pierce and Robertson, 1977; Vickers, 1982), and it is unlikely that any single test will have a high predictive value. It remains possible that chest radiology, combined with other selected tests in defined groups of patients will have a predictive role, but this would need to be tested by a multivariate analysis of multiple risk factors.

We consider that our findings, together with those of other workers (Sagel *et al.*, 1974; Rees *et al.*, 1976) make a convincing case for carrying out routine pre-operative chest X-rays, as a baseline measurement, in all general surgical patients over 65 years of age. In a small proportion of patients a pre-operative film will also be helpful in revealing unsuspected pathology which will alter the method of surgical management. As a method of predicting postoperative respiratory complications in elderly patients, however, the pre-

operative chest X-ray appears to be ineffective, and thus inferior to several simple non-radiological tests.

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