

# Routine Chest X-Ray on Hospital Admission: Does it Contribute to Diagnosis or Treatment?

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**ABSTRACT:** **Background:** In many hospitals a routine chest X-ray is performed on admission. There are, however, scant data regarding its usefulness in contemporary patient populations.

**Methods:** We studied consecutive patients admitted during a 2 month period to a single department of medicine, where hospital policy mandates performing an admission CXR. Two senior clinicians not involved in the care of these patients assessed the discharge summaries for a clinical indication to perform CXR on admission, as well as its contribution to patient management (major positive, major negative, minor positive, or no contribution).

**Results:** There were 675 patients whose mean age was  $64.5 \pm 17.2$  years. In 19.6% (130 cases) CXR was not performed. Of the 545 CXRs done, 260 (48%) were normal. In only 128 (23.5%) did the admission CXR make a major positive contribution to diagnosis or treatment. In 61 (11.2%) it provided a minor positive contribution and in 153 (28.1%) a major negative contribution. In 184 patients (33.8%) the CXR did not affect either diagnosis or management. It made a major positive contribution to management in patients for whom there was an indication for performing the X-ray (odds ratio 10.3,  $P < 0.0005$ ) and in those with a relevant finding on physical examination (OR 1.63,  $P = 0.110$ ). For the 329 patients who had neither a clinical indication for performing a CXR nor an abnormal chest examination the admission CXR contributed to patient management in only 12 cases (3.6%).

**Conclusions:** A routine admission CXR has a significant impact on patient management only in those patients in whom there are relevant findings on physical examination or a clear clinical indication for performing the test. There is no need to routinely order CXR on admission to hospital.

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**KEY WORDS:** routine admission chest X-ray, diagnostic testing, patient evaluation

CXR = chest X-ray  
OR = odds ratio

**M**any medical centers worldwide still routinely perform chest X-ray for all hospital admissions. Studies done several decades ago found a low diagnostic yield associated with routine chest X-rays [1–8]. In a study from a U.S. Veterans Administration Medical Center of 294 routine CXRs, abnormalities were found in 106 (36%). However, there were new findings in only 20 patients, treatment was changed as a result of the CXR findings in only 12 (4%), and in the majority there was no effect on the patients' outcome [9]. Nevertheless, another study in New York suggested that a blanket recommendation to eliminate routine admission CXR may be premature [10]. Several factors that increased the likelihood of a meaningful routine CXR on admission were identified. These include age  $> 65$  years, cigarette smoking, altered mental status, and human immunodeficiency virus seropositivity. It has been estimated that 100 million chest X-rays are performed yearly in the United States. The current proportion of routine admission chest X-rays is unknown but they are still being ordered in many hospitals in the U.S. and worldwide. Importantly, in the largest health management organization in Israel (Clalit Health Services), which operates 11 hospitals, the percentage of routine CXRs in patients admitted to internal medicine departments is considered a marker of the quality of care.

Is this practice evidence based? Nowadays, older and sicker patients are being admitted for shorter hospital stays [11]. In addition, many more patients are on immunosuppressive medications or are otherwise immunosuppressed, and there is a resurgence of tuberculosis. These factors were not present when most of the earlier studies were conducted. We therefore decided to examine the current role of the routine admission chest X-ray in patient management in a university-affiliated department of medicine.

## PATIENTS AND METHODS

Kaplan Medical Center is a university-affiliated teaching hospital in central Israel that serves a population of 350,000. The Center has 595 beds. In 2008 there were 16,512 medical admissions to 140 beds in four internal medicine wards. There is a standing order for physicians working in the

emergency room to perform a chest X-ray on admission in all cases, unless a CXR had been performed within the previous 21 days and the result is available. The Department of Medicine C has 35 beds and a staff of 4 senior physicians, 7 residents and an intern, caring for about 300 patients admitted each month. Consecutive patients who were admitted to the Department during a 2 month period in 2007 were included in the study. Planned admissions were excluded from the study and almost all patients were admitted after presenting to the emergency room. Standard clinical data from the discharge summaries were obtained, including age, gender, presenting complaint, chronic illnesses, smoking history, and findings on physical examination of the chest and heart. The discharge summaries were then reviewed by two tenured highly experienced clinicians from another department of medicine (A.S. and J.C.) who were not involved in the treatment of these patients. An assessment of the clinical indication for the performance of a CXR was made according to a predetermined list that included shortness of breath, cardiac chest pain, non-cardiac chest pain, fever of no obvious source, findings on physical examination, after a procedure, and no indication. The contribution of routine CXRs to patient management was also assessed and graded as major positive (i.e., identifying pulmonary consolidation or congestion in a patient with dyspnea); minor positive (finding increased cardiothoracic ratio, or an old inactive TB not previously known but not linked to the patient's current presenting symptoms); major negative (ruling out congestive heart failure or cancer in patients with a compatible presentation); or no contribution at all (no new information and no effect on patient's diagnosis or management). The routine CXR findings were scored [Table 1]. Statistical analysis including logistic regression analysis was performed with the SPSS 12 software program.

## RESULTS

Altogether, 675 patients were studied, of whom 385 (57.2%) were male. They included all unplanned admissions to the Department of Medicine C over 2 months. The mean age of all patients was  $64.5 \pm 17.2$  years (range 17–104). Major past illnesses included ischemic heart disease in 188 patients (28%), chronic obstructive pulmonary disease or asthma in 183 (27%), diabetes in 164 (24%), congestive heart failure in 82 (12%), and malignancy in 79 (12%). The presenting complaints of the admitted patients are presented in Table 2 and include chest pain in 141 (20.8%), dyspnea in 79 (12%), weakness in 74 (10.96%), fever in 59 (9%), abdominal pain in 54 (8%) and a neurologic complaint in 50 (7.5%). Physical examination of the chest was normal in 585 (87%) of the cases and abnormal in 90 (13%). Examination of the heart was normal in 518 (77%)

**Table 1.** Findings on the routine admission CXR of the study patients

X-ray finding	No. of patients	Percentage
Normal	260	38.6
Congestion	74	11.1
Infiltrate	46	6.8
Increased cardiothoracic ratio	31	4.6
Bony changes	11	1.6
Chronic obstructive pulmonary disease	10	1.5
Effusion	9	1.3
Mediastinal abnormality	7	1
Nodule	6	0.08
Chronic changes	5	0.07
Hilar abnormality	3	0.04
Other diagnoses	81	12.0
Not applicable	132	19.6

**Table 2.** Performance of routine admission CXR in patients with various presenting complaints

Complaint	Total no. of patients	Patients with CXR (n=545)	Patients without CXR (n=130)
Chest pain	141 (20.1%)	120 (85%)	21 (15%)
Dyspnea	79 (11.7%)	79 (100%)	0
Weakness	74 (11.0%)	71 (96%)	3 (4%)
Fever	59 (8.7%)	59 (100%)	0
Abdominal pain	54 (8.0%)	54 (100%)	0
Neurologic complaints	50 (7.4%)	50 (100%)	0
Syncope	8 (1.2%)	8 (100%)	0
Anemia	8 (1.2%)	8 (100%)	0
Confusion	8 (1.2%)	8 (100%)	0
Chemotherapy	7 (1.0%)	7 (5.3%)	0
Gastroenteritis	7 (1.0%)	7 (5.3%)	0
Headache	5 (0.7%)	5 (3.5%)	0
Other*	175 (25.9%)	112	63 (4.4%)
Total	675 (100%)	545	130

\* Includes diagnoses present in fewer than 5 cases each

and abnormal in 129 (19%). No details on cardiac examination were available in 28 cases (4%). The findings on the admission CXR are summarized in Table 1. The CXR was normal in 38.6% and revealed pulmonary congestion in 11.1%, an infiltrate in 6.8%, or other findings. In 19.6% (132 cases) a CXR was not done despite the hospital's policy of performing routine CXR in every admitted patient. Most of these cases (100/132, 76%) who were admitted without a CXR were patients who presented with diagnoses such as anemia or gastroenteritis [Table 2] for which the admitting physician considered CXR to be redundant.

Almost no patient with dyspnea, fever, abdominal pain, an acute neurologic complaint or weakness was admitted without CXR and 85% of patients who presented with chest pain also had an admission CXR [Table 2]. As mentioned in the Methods section, the patients' medical charts were reviewed independently by two senior physicians from a different department and assigned a category for their contribution to patient management.

Of the 545 patients who had a CXR performed, in 128 (23.5%) the CXR made a major positive contribution to the diagnosis and management of the patient, in 153 (28%) a major negative contribution, and in 61 (11.2%) a minor positive contribution. In as many as 203 (37.2%) there was judged to be no contribution by the CXR to the diagnosis and management of the case [Table 3]. The correlation between the estimated contribution of the routine admission CXR and varied clinical variables are shown in Table 3 regarding those variables significant in univariate analysis. Univariate analysis of the four types of contribution of the CXR to management with independent variables showed significant correlations for age, gender, chest examination, heart examination, and indication for performing the X-ray. There was no correlation for major presenting complaints, smoking or chest X-ray findings. Logistic regression analysis was performed for the four contributions to management [Table 4]. The independent variables that were included in the multivariate analysis were those found to be significant in the univariate analysis.

The chest X-ray made a major positive contribution to management in patients for whom there was an indication for performing the X-ray (odds ratio 10.3,  $P < 0.0005$ ) and those in whom there was a finding on auscultation of the chest (OR 1.63,  $P = 0.110$ ). The effect of increased age was still marginally significant. For a major negative contribution of the chest X-ray to management, the indication for the investigation was again very important (OR 72.9,  $P < 0.005$ ). The indication for the examination was not important for a minor negative contribution (OR 0.26,  $P < 0.005$ ). When patients with either a clinical indication for performing a CXR or an abnormal chest examination were excluded, 329 patients of the 545 with a CXR remained (60%) but the routine admission CXR contributed to patient management in 12 cases only (3.6%). Thus, performing a routine CXR made a major positive contribution to the management of patient care when there was a clinical indication for its performance, or when patients had abnormal findings in the examination of the chest or heart.

## DISCUSSION

Our study addresses the prevailing policy of performing a CXR routinely at each patient's admission. Our results clearly show that despite significant changes in patient characteristics and in morbidity profiles over recent years, there is very little value in performing a routine chest X-ray on all admissions to an

**Table 3.** Correlation between the estimated contribution of the routine admission CXR and varied clinical variables

	Major positive (n=128)	Major negative (n=153)	Minor positive (n=61)	None n=203	P
Mean age (yrs)	70.2	63.0	70.0	63.9	<0.005
Female (%)	45.3	29.3	57.1	46.5	0.001
Positive indication for CXR (%)	89.3	97.7	25.9	9.9	<0.005
Auscultatory findings (%)	27.4	15.7	10.7	10.3	0.001
Heart examination abnormal (%)	31.6	16.4	12.5	15.7	0.012
Abnormal CXR (%)	18.8	12.1	12.5	10.3	0.188

**Table 4.** Results of the final regression models for four dependent variables

<b>Model 1: Major Positive</b>					
Variable	B (regression coefficient)	SE	P	OR	95%CI
Heart exam	0.698	0.28	0.130	2.00	1.160–3.481
Auscultation	0.489	0.30	0.110	1.63	0.896–2.968
Indication	2.332	0.33	0.000	10.3	5.407–19.618
Age	0/021	0.08	0.008	1.02	1.00–1.037
<b>Model 2: Major Negative</b>					
Variable	B	SE	P	OR	95%CI
Age	-0.016	0.00	0.025	0.98	0.97–0.99
Indication	4.290	0.59	0.000	72.9	22.7–234.6
<b>Model 3: Minor Positive</b>					
Variable	B	SE	P	OR	95%CI
Heart exam	-0.596	0.46	0.198	0.055	0.22–1.36
Indication	-1.341	0.32	0.000	0.26	0.137–0.499
Age	0.021	0.01	0.036	1.02	1.001–1.042
<b>Model 4: No Contribution</b>					
Variable	B	SE	P	OR	95%CI
Auscultation	-0.97	0.42	0.819	0.90	0.39–2.07
Indication	-3.82	0.31	0.000	0.22	0.012–0.04
Heart exam	0.302	0.36	0.413	1.35	0.657–2.788
Age	-0.24	0.008	0.004	0.976	0.96–0.99

internal medicine department. The admission CXR provided a significant yield only if there was a clear clinical indication or abnormal findings on examination of the chest or heart. When patients with either a clinical indication for performing a CXR or an abnormal chest examination on admission were excluded, 329 patients remained (60% of the 545 who had a CXR). In this large group, the routine admission CXR contributed to patient management in 12 cases only (3.6%).

These results are consistent with those of similar studies. Sagel et al. [1] found that the majority (68%) of hospitalized patients who had a routine chest X-ray had no abnormal findings. This low diagnostic yield has been confirmed in

pediatric patients, healthy pregnant women, hospitalized patients with asthma, preoperative patients, veterans, and other groups [1-10,12-15]. Not all of these studies showed a low diagnostic yield [16-18]. In 1981, a veteran's hospital study of 113 admission chest radiographs found abnormal findings in 46% [16]. There was, however, no information as to whether these changes were acute or chronic, or if the findings led to changes in treatment. Furthermore, the finding of pneumonia or the CXR findings may have resulted in the admission. A similar low yield has been reported in primary care [19]. Many of these studies were performed in the 1970s and early 1980s. The hospitalized patients of the 21st century are different in several respects. First, the AIDS epidemic has resulted in hospital admissions for previously little-seen diagnoses such as *Pneumocystis carinii* pneumonia, and there has been an upsurge in the incidence of tuberculosis, including multidrug-resistant TB [20]. Second, many more patients admitted today are immunosuppressed following organ transplantation, potent chemotherapy or immunotherapy. In addition, in Israel over the last 15 years the number of admissions has increased, but the length of admission and the number of beds per population have decreased [21].

The life expectancy of the population has increased. In 1970, 6.7% of the Israeli population was over the age of 65 and 1.1% over the age of 80. In 2005, 9.9% were over 65 and 2.4% over 80. In addition, the number of general hospital beds decreased from 3.0/1000 in 1980 to 2.1/1000 in 2005, and the average length of hospital admission decreased from 8.6 days in 1970 to 4.2 days in 2005. The general occupancy rate increased from 89.9% in 1980 to 95.9% in 2005 [22]. Similar trends have been reported in other countries. Also, many patients who would have been admitted are now being treated at home, primarily due to cost containment considerations. As a result of these changes patients admitted to the internal medicine wards today are older and more acutely ill than their counterparts in the past.

The strengths of our study are the large number of patients and the fact that the cases were reviewed by two highly experienced clinicians who had no knowledge or involvement with any of the cases. Since our hospital is a major referral center in the area, its patient population reflects all of the current trends discussed above. Moreover, our results are quite unequivocal. The routine CXR contributed to management in the patients who had a clinical indication for its performance and/or a relevant finding to the chest or heart on clinical examination at admission. Only 3.6% of all the patients studied were an exception to this rule. The main limitation of the study is the 19.6% incidence of chest X-rays that were not done on admission, despite the hospital policy of routine CXR. However, patients in whom CXR was not performed had different characteristics from the other patients. Many

of them were admitted after chemotherapy protocols, or for relatively minor illnesses such as headaches or gastroenteritis. It is likely that these patients would have had a normal chest X-ray, reinforcing our conclusions even more. The multivariate analysis we performed showed that only in those patients in whom there were abnormal findings on physical examination, or in those patients who had a clinical indication for the performance of the CXR, was it likely that the chest X-ray would have an impact on patient management.

In conclusion, our analysis of 675 patients with unplanned admissions to the department of medicine reveals that the yield of a routine admission chest X-ray and its impact on patient management is small. It appears that unless there is a clear clinical indication for performing a chest X-ray, or findings on heart or chest examination, there is no need for a CXR. Given that 112 million chest X-rays were performed in the USA in 2000 and a typical hospital charge for a CXR in the U.S. is more than \$225, the possible savings are immense. The American College of Radiology recommends that routine admission and preoperative chest radiographs not be performed unless acute cardiopulmonary disease is suspected on the basis of history and physical examination or there is a history of stable chronic cardiopulmonary disease in an elderly patient without a recent CXR in the past 6 months [23].

Our findings have not yet resulted in a change of protocol at our medical center, or in the concept of routine admission CXR as a marker of the quality of care in all HMO hospitals. Such a change may not be appropriate on the basis of a single study, especially due to the possible medico-legal consequences of any incidentally missed diagnoses. However, our study should stimulate an objective discussion of the subject by the relevant professional societies and lead either to updated guidelines or to further research as may be deemed necessary.

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HMO = health management organization

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