FIVE THOUSAND ACUTE CARE/EMERGENCY DEPARTMENT CHEST RADIographs: COMPARISON OF REQUISITIONS WITH RADIOGRAPHIC FINDINGS

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Abstract — Five-thousand portable or posterior-anterior-lateral radiographs of acute care emergency department patients were interpreted. They revealed serious disease in 35% of patients with chest symptoms, in 27% of all patients examined, and in 18% of patients with noncardiorespiratory symptoms. The highest incidence of abnormal radiographs (42%-79%) occurred in patients with symptoms of congestive heart failure, dyspnea, hemoptysis, dysrhythmia, and hypertension. Asthma (14%) and trauma (8%) presented the lowest incidence of significant findings.

Radiographs of patients suspected of having pneumonia were abnormal in 25% of cases, and in those patients with either cough or fever alone, the incidences of pneumonia were 13% and 18%. Whereas 24% of patients with dyspnea alone had radiographic findings of congestive heart failure, 52% of those with congestive heart failure diagnosed on clinical grounds had abnormal radiographs.

The chest radiograph continues to be a significantly important examination in the diagnosis of disease, the prevention of overtreatment, and the redirection of clinical investigation in the acute care emergency department unit.

Keywords — thorax, radiography; lung, radiography; heart, radiography; efficacy study

INTRODUCTION

The report of the World Health Organization Scientific Group on the Indications for and Limitations of Major X-ray Diagnostic Investigations stated that "radiology accounts for 6% to 10% of health care expenditure" and that chest x-ray examinations account for "up to 50% of diagnostic radiology." The use of the chest radiograph as a screening procedure has been evaluated in general hospitals, veteran's hospitals, and in preoperative, psychiatric, and prenatal patients, as well as in children and adolescents.

In 1983 the Food and Drug Administration recommended that chest radiographs not be ordered solely for hospital admission. In 1985 Hubbell et al reviewed the literature on routine chest radiographs in various categories of patients, adding their findings of patients on internal medicine wards at a Veteran's Administration hospital. They concluded that although abnormalities were detected in 36% of 294 patients, the findings resulted in treatment changes in only 12 (4%). This evoked an avalanche of angry replies referring to special situations and the clinical value of a "normal" finding.

To analyze the diagnostic importance of the normal finding, Gorry et al pointed out that it is imperative to know the difference in frequency of occurrence of normal findings among various diseases. Our study was directed at two specific groups of acute care emergency department patients; those with cardiorespiratory symptoms, and those with other symptoms. We compared their symptoms with the radiographic findings.

SUBJECTS AND METHODS

Five-thousand radiographs of the chests of patients 16 years old or greater entering the medical center through the emergency department acute care unit were reviewed. One third of the examinations were single-film portable anterior-posterior (AP) projec-
tions. The other two thirds were posterior-anterior (PA) and lateral projections performed in the adjacent radiology department. All of the examinations were interpreted by the author over a period of 18 months. Patients examined during the author’s absence were not included in the study.

Radiographs technically uninterpretable amounted to less than 0.1% and were not included in this study. Many of the portable examinations were suboptimal and were accompanied by statements in the report such as “no gross disease,” “possible pneumonia,” “unable to rule out congestive heart failure.” These cases were allocated to the most likely diagnostic category for this study, and the clinicians were advised to request a better examination when the patient’s condition permitted.

Every examination had a hand-written requisition containing historical information. The requisitions were initiated by various house staff physicians, although the actual writing on the requisition was often done by nurses or clerks. No attempt was made to determine if the wording on the requisitions was that of the physician or the interpretation of a nurse or clerk. The basis of this study was to categorize findings based on the information supplied to the radiologist regardless of its source.

CLASSIFICATION OF REQUISITIONS

The requisitions were divided into 18 groups according to conditions, symptoms, or groups of symptoms (Table 1). When the statements were complex, the cases were assigned to that category subjectively considered to be most significant.

**Known Chest Disease**

In separating the cases into clinical groups for analysis, 104 cases (2%) fell into the group “known chest disease.” These were mainly patients with known primary tumors, metastases, or those who had had recent surgical procedures. Even though the examinations were often performed to rule out new superimposed disease, the interpretations were so complex and the known disease was usually so extensive that these cases were eliminated from the study and were not used in the categorical statistical analysis.

**Noncardiorespiratory Symptoms**

This comprised a group of patients in whom chest radiographs were obtained incidentally to noncardiorespiratory complaints (such as abdominal distress, central nervous system symptoms, or skeletal trauma). Many examinations in this category were obtained prior to surgery for acute processes.

**Miscellaneous**

The patients assigned to this category had diagnoses that appeared infrequently but were felt to be relatively important with respect to an association with radiographic findings. Such conditions included “smoke inhalation,” “palpitation,” “digitalis toxicity,” “rule out pneumothorax,” and “rule out foreign body.”

**Dyspnea**

This category included all patients with requisitions on which were written “SOB,” “dyspnea,” or “shortness of breath.” Combinations of dyspnea with other symptoms were often present. Dyspnea plus fever and dyspnea plus cough were included in this category. No attempt was made to separate the various causes of dyspnea as given in the history, such as “COPD” (chronic obstructive pulmonary disease) or “mitral heart disease.” If “dyspnea” was listed with “asthma,” the case was assigned to the asthma category.

**Chest Pain**

These cases were assembled from requisitions when no other suspected cause was indicated. Those patients with cough or dyspnea in addition to chest pain were separated for comparison with other categories.
Chest Pain and Dyspnea
This group was collected to afford comparison with those patients exhibiting either symptom alone.

Fever
This group included "sepsis" and "fever" when these designations were not modified to suggest pneumonia.

Cough
This group had no modifying information to indicate the suspected cause. It could then be compared with combinations of fever and cough or cough and chest pain.

Fever and Cough
This combined symptomatology was separated to compare it with fever alone, cough alone, and pneumonia.

Cough and Chest Pain
This group was compared with the individual symptoms.

Pneumonia
These cases all had the word "pneumonia" or "rule out pneumonia" with or without other symptoms, such as cough and fever.

Congestive Heart Failure
These words, the abbreviation CHF, or "rule out CHF" appeared on the requisition with or without other symptoms, such as dyspnea, cough, or chest pain.

Asthma
These cases included "wheezing" or "asthma" as the presenting information.

Hemoptysis
All such cases, irrespective of symptoms, were included on the requisition.

Trauma
These cases were patients with direct chest trauma in which information other than simple rib fracture was sought.

Syncope
This group always had this as the single word on the requisition.

Dysrhythmia
This included only patients without other symptoms such as "CHF" or "chest pain."

Hypertension
This group always had this word or the abbreviation "HBP" (high blood pressure) as the single word on the requisition.

INTERPRETATION OF FINDINGS
Written "preliminary" interpretations were made on all studies by radiology residents in various stages of training. Previous radiographs were retrieved from the archives for comparison at the resident's discretion. These were made available to the author for final interpretation. The author's findings were not checked by other radiologists and, for this study, no attempt was made to determine the accuracy of the interpretation by follow-up of the patients. Interesting or problem cases were, of course, followed individually to verify the radiologic impression. However, the first impression remained as the radiographic diagnosis for analysis in this study.

When more than one finding or diagnosis was present, the most serious (congestive heart failure vis-à-vis enlarged heart) or the most pertinent to the symptoms (pneumonia vis-à-vis aneurysm) was listed. Only a single final diagnosis or finding was submitted.

Normal
A "normal" chest radiograph might have had one or more of the following findings:

1. Mild to moderate calcification, dilatation, or tortuosity of the aorta.
2. Calcified cardiac valve, annulus, or coronary arteries.
3. Calcified granuloma(s) in lung or node(s).
4. Congenital anomalies such as azygous lobe or cervical rib.
5. Old fractures or foreign bodies.
6. Minor blunting of costophrenic angles or apical pleural thickening.
7. Bone changes in known sickle-cell disease.
8. Variations in diaphragmatic regularity or height.
9. Scoliosis, kyphosis, or arthritis of the spine.

Non-Serious Conditions

These were grouped together for statistical purposes and consisted of the following abnormalities:
1. Blebs and bullae (few or small)
2. Scars
3. Postoperative changes
4. Valve prosthesis
5. Old, apparently inactive tuberculosis
6. Calcified pleura
7. Hiatus hernia
8. Enlarged thyroid

Serious Conditions

The following serious diseases or conditions were analyzed individually for comparison with the initiating symptoms on the requisitions.
1. Enlarged or abnormal heart
2. Pneumonia
3. Congestive heart failure or pulmonary edema
4. Pleural effusion
5. Pulmonary embolus or infarct
6. Primary tumor
7. Metastatic tumor
8. Chronic obstructive pulmonary disease or emphysema (moderate to severe)
9. Interstitial disease (more than minimal)
10. Active tuberculosis
11. Aortic aneurysm
12. Miscellaneous (sarcoid, abscess, atelectasis, pneumothorax, etc)

SPECIFIC ANALYSIS

Serious Disorders

Table 2 shows the incidences of serious disorders to range from 5% to 79%, with the highest associations being the categories congestive heart failure, dyspnea, hemoptysis, dysrhythmia, and hypertension. Many of the disorders found were a confirmation of the suspected diseases. The high incidence (18%) of serious abnormalities in the noncardiorespiratory systems category, as well as unrelated serious findings in the other categories, shows the importance of the chest radiograph in this clinical setting. Of no less importance is the large number of normal examinations with the clinical pattern of pneumonia, fever, cough, chest pain, or asthma. The “normal” interpretation prevented overtreatment and redirected diagnostic skills.

Pneumonia

In the acute care emergency department setting, the single complaints of either cough or fever had significant association with the diagnosis of pneumonia (13% and 18%), but the combination of the symptoms or the diagnosis of pneumonia or “rule out pneumonia” on the requisition had associations of 21% and 25%, respectively (Table 3). Chest pain occurring with cough was not associated with a higher incidence of pneumonia.

Congestive Heart Failure

Findings of congestive heart failure were found in less than 2% of patients being routinely examined for other diseases (noncardiorespiratory symptoms) and in 2% of patients in the asthma group (Table 4). This
Acute Care/Emergency Chest Radiographs

Table 3. Correlation of Symptoms and Pneumonia

<table>
<thead>
<tr>
<th>Diagnosis on Requisitions</th>
<th>Radiologic Diagnosis of Pneumonia Incidence Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>90/358 25</td>
</tr>
<tr>
<td>Fever and cough</td>
<td>11/52 21</td>
</tr>
<tr>
<td>Fever</td>
<td>30/166 18</td>
</tr>
<tr>
<td>Cough and chest pain</td>
<td>3/30 10</td>
</tr>
<tr>
<td>Cough</td>
<td>9/72 13</td>
</tr>
<tr>
<td>Noncardiorespiratory symptoms</td>
<td>40/2322 1.7</td>
</tr>
</tbody>
</table>

Table 4. Correlation of Symptoms and CHF

<table>
<thead>
<tr>
<th>Symptoms on Requisitions</th>
<th>CHF on Radiographs Incidence Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF</td>
<td>80/155 52</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>85/353 24</td>
</tr>
<tr>
<td>Chest pain and dyspnea</td>
<td>12/94 13</td>
</tr>
<tr>
<td>Dysrhythm</td>
<td>8/66 12</td>
</tr>
<tr>
<td>Cough</td>
<td>4/70 6</td>
</tr>
<tr>
<td>Chest pain</td>
<td>33/629 5</td>
</tr>
<tr>
<td>Asthma</td>
<td>5/228 2</td>
</tr>
<tr>
<td>Noncardiorespiratory symptoms</td>
<td>39/2322 1.7</td>
</tr>
</tbody>
</table>

Table 5. Incidence of Abnormal Heart or CHF According to Presenting Symptoms

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Radiologic Finding Incidence Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF</td>
<td>111/155 72</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>131/353 37</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18/48 37</td>
</tr>
<tr>
<td>Dysrhythm</td>
<td>24/66 36</td>
</tr>
<tr>
<td>Chest pain and dyspnea</td>
<td>24/94 26</td>
</tr>
<tr>
<td>Syncope</td>
<td>23/91 25</td>
</tr>
<tr>
<td>Chest pain</td>
<td>104/629 17</td>
</tr>
<tr>
<td>Noncardiorespiratory symptoms</td>
<td>263/2322 11</td>
</tr>
</tbody>
</table>

Table 6. Primary Lung Tumor

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Radiologic Findings Incidence Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoptysis</td>
<td>1/27 3.7</td>
</tr>
<tr>
<td>Cough and chest pain</td>
<td>1/30 3.3</td>
</tr>
<tr>
<td>Fever and cough</td>
<td>1/52 1.9</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>5/353 1.4</td>
</tr>
<tr>
<td>Asthma</td>
<td>3/228 1.3</td>
</tr>
<tr>
<td>Chest pain</td>
<td>5/629 0.8</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3/353 0.8</td>
</tr>
<tr>
<td>CHF</td>
<td>1/155 0.6</td>
</tr>
<tr>
<td>Total with chest symptoms</td>
<td>20/2574 0.8</td>
</tr>
<tr>
<td>Noncardiorespiratory symptoms</td>
<td>21/2322 0.9</td>
</tr>
</tbody>
</table>

Attest to the ability of clinicians in the triage to differentiate "true" asthma from "cardiac" asthma. Whereas 24% of patients in the dyspnea category had radiographic findings of congestive heart failure, 52% of those with clinically diagnosed congestive heart failure had positive radiographs. Chest pain or cough were associated with an incidence of only 5% to 6% of congestive heart failure.

Abnormal Heart or Congestive Heart Failure

It is not surprising that the incidence of either "abnormal heart" or "congestive heart failure" as interpretations was greatest in those patients in the congestive heart failure (72%), dyspnea (37%), hypertension (37%), and dysrhythmia (36%) groups (Table 5). Patients with syncope had a surprisingly high incidence of diagnostic findings—25%, and those with chest pain 17% as compared with the 11% incidence noncardiorespiratory symptoms.

Lung Tumor

Forty one (0.8%) unsuspected presumed primary lung tumors requiring further workup were detected and were found as frequently in the noncardiorespiratory symptoms category as in the patients with chest symptoms (Table 6). Thirty-five (0.7%) patients had metastatic lung tumors not indicated on the requisitions by the triage team. These also appeared as frequently in the noncardiorespiratory symptoms category as in the patients with chest symptoms.

Hemoptysis

There were only 27 case requisitions for hemoptysis, half of which had "normal" chest films. The other had a wide variety of abnormalities (Table 7). Only one case was associated with findings suspicious for primary tumor.

Pulmonary Emboli

This finding was suspected 30 times; 11/155 (7%) were found in conjunction with symptoms of congestive heart failure, 11/629 (1.7%) were seen in patients with chest pain, and 4/353 (1%) in patients with dyspnea.

A quarter of chest-pain patients (159/629) had serious findings while one-third of those with combined chest pain and dyspnea (32/94) or symptoms of congestive heart failure (10/30) had significant findings.
Table 7. Findings in 27 Cases Presenting With Hemoptysis

<table>
<thead>
<tr>
<th>Finding</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>13</td>
<td>48</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Active tuberculosis</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Sarcoïdosis</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Enlarged heart</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Pulmonary infarct</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Primary tumor</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Metastases</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Aneurysm aorta</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Old tuberculosis</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

CONCLUSIONS

As might be expected, patients with cardiorespiratory symptoms had a greater incidence of serious findings on chest radiographs (35%) when compared with patients with other symptoms (18%). The latter number is still significant when one considers that those findings were probably unanticipated and were pertinent to the general care of the patient.

Whereas many of the pneumonias were correctly diagnosed clinically, 76% of suspected cases did not have radiographic findings of pneumonia. Many cases of pneumonia (148) did not present with clear-cut clinical findings and might have gone undiagnosed. Forty of these (1.7%) were found in patients without chest symptoms.

The clinical examination seemed to differentiate true asthma from the dyspnea of congestive heart failure, and chest x-ray studies revealed serious abnormalities much more frequently in patients with symptoms of the latter. The symptoms chest pain and syncope had incidences of serious abnormalities of 25% and 30% and these were generally unanticipated.

It is highly recommended that portable or PA-lateral chest radiographic examination continue to be part of the routine care of the selected group of patients in the acute care emergency department arena.

REFERENCES