5-1-1964

Diagnosis of bronchogenic carcinoma from routine chest radiographs

Darrel W. Siebert
University of Nebraska Medical Center

Let us know how access to this document benefits you
http://unmc.libwizard.com/DCFeedback

Follow this and additional works at: https://digitalcommons.unmc.edu/mdtheses
Part of the Medical Education Commons

Recommended Citation
Siebert, Darrel W., "Diagnosis of bronchogenic carcinoma from routine chest radiographs" (1964). MD Theses. 56.
https://digitalcommons.unmc.edu/mdtheses/56

This Thesis is brought to you for free and open access by the Special Collections at DigitalCommons@UNMC. It has been accepted for inclusion in MD Theses by an authorized administrator of DigitalCommons@UNMC. For more information, please contact digitalcommons@unmc.edu.
THE DIAGNOSIS OF BRONCHOGENIC CARCINOMA FROM ROUTINE CHEST RADIOGRAPHS

Darrel Wayne Siebert

Submitted in Partial Fulfillment for the Degree of Doctor of Medicine

College of Medicine, University of Nebraska

February 1, 1964

Omaha, Nebraska
# TABLE OF CONTENTS

I. Introduction .................................................. 1

II. Definition ...................................................... 2
   A. Routine chest radiograph .................................. 2

III. Data .......................................................... 3-8
   A. Mass survey studies ........................................ 3
      1. Population ............................................... 3
      2. Suspect cases ............................................ 4
   B. Hospital versus mass survey findings .................... 5
   C. University findings ....................................... 6

IV. X-rays ........................................................ 8-19
   A. Findings ................................................... 9-11
      1. Pulmonary shadows ....................................... 9
      2. Notching of shadow ..................................... 9
      3. Hilar prominence ....................................... 9
      4. Emphysema ............................................... 10
      5. Atelectasis ............................................. 10
      6. Calcification .......................................... 10
   B. Interpretation ............................................. 11-13
      1. Personal formula ......................................... 11
      2. Dual reading ............................................ 12
      3. Film size ................................................. 13
   C. Views ....................................................... 14
      1. Routine .................................................. 14
      2. Lateral .................................................. 14
D. Technique. ........................................... 16-19
  1. High kilovoltage ................................. .16
  2. Supervoltage ..................................... .16
  3. Fluoroscopy ..................................... .19

V. Discussion ......................................... 19-25
  A. Duration of bronchogenic carcinoma .......... .20
  B. Fallacies ........................................ .20
  C. Pilot study ...................................... .22
  D. Is the use of routine chest x-rays justified? .. .23

VI. Conclusion ........................................ .25
THE DIAGNOSIS OF BRONCHOGENIC CARCINOMA
FROM ROUTINE CHEST RADIOGRAPHS

INTRODUCTION

It is a well known and documented fact that the incidence of bronchogenic carcinoma has been increasing over the past half century. The incidence, mortality, rates, ratios, age factors and trends during the past ten years as given by O'Donnell et al. are given in Table I. 38 (Table I page 27)

As yet no known specific etiology has been identified, although some strong implications have been made, e.g. smoking, occupation, residence. With the incidence of bronchogenic carcinoma increasing, we must try and discover an earlier and better means of detecting this neoplasm.

The use of the mass screening procedure was employed as a means of detection and control of tuberculosis in the population at large, or to screen applicants for certain types of jobs. It was soon discovered, whenever large groups of supposedly normal people were studied in this way, that in addition to pulmonary tuberculosis an appreciable number of cases of disorders of the heart and mediastinum and especially nontuberculous lesions of the lungs were found.

To date the chest radiograph has been the most commonly employed tool in the diagnosis of bronchogenic carcinoma, especially while the carcinoma is still in its silent, asymptomatic phase, when the likelihood for "cure" seems the greatest.
It was my intention at the outset to review the literature and also hospital records at the University of Nebraska Hospital with respect to the diagnosis of bronchogenic carcinoma, specifically those discovered from routine chest x-rays. I will further discuss some of the factors involved in making such a diagnosis, and also other aspects related to this field whereby an earlier diagnosis or a larger percentage of detection would seem possible.

DEFINITION

In this paper, routine chest radiographs are basically of five types, although only two of these will be considered. They are: 1) Those that are taken at the time of mass chest roentgenography (usually these are tuberculosis case finding surveys, and neoplastic lesions are a secondary benefit derived from the survey); 2) Those taken routinely at the time of admission to the hospital; 3) Those taken by a practicing physician during the course of a routine physical examination; 4) Pre-employment chest radiographs, and 5) Those taken during the course of a pre-induction physical examination before entering the armed services. Much data is available pertaining to the first of the above mentioned examinations. Interest in finding cases of bronchogenic carcinoma from such material began especially in the post World War II period, when large masses of the population were being screened for tuberculosis.

Data on the finding of bronchogenic carcinoma from routine
hospital admission cases are not plentiful, but as has been shown in the past, (especially when the incidence of tuberculosis was higher) not only the finding of bronchogenic carcinoma but also other pathology makes the routine use of admission chest x-rays useful.

DATA

It has been shown in many of the surveys that the population screened is not the population in which the highest incidence of bronchogenic carcinoma will be found. The high risk population, i.e. males, forty five years of age or older, who have a long history of smoking, is the group that should be surveyed in particular. This would result in a higher incidence of detection. The detailed data of the largest single mass survey carried out in the Los Angeles area in 1950, gives us an example of the distribution one would expect to find. The city of Los Angeles had a high rate of detection of bronchogenic carcinoma. This was possibly because they had set up a registry which would record and follow all neoplasm suspects, and so a high index of suspicion prevailed. The distribution of the survey group by age and sex is given in Table II.¹⁹ (Table II page 28)

In comparison to Table II, Table III gives the distribution of the population in Los Angeles County fifteen years and older by age and sex.¹⁹ (Table III page 29)

From these tables it can be seen that although the distribution of the surveyed population correlates well with the
population distribution, we also see that only 252,623 men between the ages of forty five to seventy four had a chest radiograph taken. However, that segment of population has a total of 560,142 men, so that only forty five percent of the high risk group had their radiograph taken. It will also be seen that the younger age group are represented predominantly, and that this is the age distribution one would strive for in a tuberculosis case finding survey, it is not the distribution one would like to see in a neoplasm survey.

Table IV shows the proportion per 100,000 survey population of each age group and sex who were neoplasm suspects. (Table IV page 30)

It can be seen that the number of lesions detected increases with increasing age. It will also be seen that the number of female suspects is about equal to that found in males. However, it was later found that of a total of two hundred thirteen proven cases of bronchogenic carcinoma, one hundred sixty were found in males and only fifty three in females. Again the highest incidence was between forty five and seventy four years of age.

Loder 26, in an analysis of one thousand routine chest x-rays on patients being admitted to the hospital for surgery, found that one hundred sixteen films showed significant unsuspected pathology. Of these one hundred sixteen cases, three patients were found to have bronchogenic carcinoma. Siegal25 et. al. compared findings from routine chest x-rays of mass surveys, and
General Hospital Admissions.

First, they found that compared with the initial diagnosis of probably active tuberculosis, the rate of intrathoracic tumors is sixty percent higher in the general hospital program and fifty percent higher in mass survey programs, i.e. three cases of suspected tumor are found for each two cases of probably active tuberculosis. Their findings from a total of 1,076,506 x-rays in general hospitals compared to 1,069,715 x-rays in community surveys are given in Table V. (Table V page 31)

In most survey and hospital admission programs, the suspect cases are followed by a complete examination, (starting with additional x-rays) as will be discussed later. In general, however, approximately one case per one thousand will be interpreted as suspicious of neoplasm. Approximately ten percent of the patients with suspicious chest films will have a confirmed diagnosis of bronchogenic carcinoma. Boucot and Sokoloff have a series in which eighteen percent of males greater than forty five years of age with suspicious chest x-rays turned out to have bronchogenic carcinoma. All suspicious cases should be diagnosed immediately, and not followed by interval films. It has also been shown that waiting six weeks for the return of a positive Acid-Fast Bacillus test is only allowing the tumor to advance, as six to ten percent of patients with pulmonary neoplasms also have concomitant tuberculosis. Therefore, even when multiple positive sputa confirmed by culture prove the diagnosis of active tuberculosis,
radiographic evidence of tumor should indicate exploration in men over forty five years of age. Guiss\textsuperscript{20} points out that in ten percent of patients with early bronchogenic carcinoma, the lesion will not be noted on a routine photofluorogram. He\textsuperscript{22} further points out that of all people dying of bronchogenic carcinoma in the five year period following the 1950 mass Los Angeles survey, only twenty one and one half percent had a photofluorogram.

A review of two hundred consecutive routine admission chest x-rays at the University of Nebraska are shown in Table VI. (Table VIA and VIB pages 35 and 36)

Three unsuspected neoplastic lesions were detected by the routine chest x-rays. One, an osteochondroma, in a male over seventy years of age. Another was a bronchogenic carcinoma in a male fifty years of age, who was admitted for a surgical procedure. The other was also a bronchogenic carcinoma found in a male sixty seven years of age who had a cement block fall on his chest. He continued to have chest pain and so a chest x-ray was taken, revealing the neoplasm. One nonsuspected case of tuberculosis was supposedly found on x-ray, but subsequent tests did not reveal this to be tuberculosis.

Emphasis must be placed on detection and not diagnosis. Hypothetically, of one hundred unselected cases of lung cancer, sixty five cases will be operable, thirty resectable, and five will be without evidence of disease after three years. However,
of one hundred cases of lung cancer detected by routine chest x-ray and promptly treated ninety cases will be operable, ninety cases resectable, and thirty five will be free of disease three years post-operatively.57 It has more recently been shown that the three year survival rates of patients with bronchogenic carcinoma found on routine chest x-ray is higher than that of the patient coming to the doctor because of symptoms. It has also been shown that the resectability is improved in patients whose lesions are found on routine radiographs. However, the number that are truly asymptomatic when the lesion is discovered is not nearly as great as once thought. In the Philadelphia survey, seventy seven cases of bronchogenic carcinoma were discovered. In questioning these patients later, it was discovered that only seven of the original group were truly asymptomatic.7 This also has been found true in other surveys. In the Philadelphia Pulmonary Neoplasm Research Project in which males over forty five years of age are surveyed following a detailed history, twenty eight cases of bronchogenic carcinoma were found in three thousand six men, and one hundred percent of these were asymptomatic.

Surgery continues to be the only form of curative therapy. Overholt et. al.41 in studying one thousand one hundred cases of lung cancer found that only forty six (four and two tenths percent) were completely asymptomatic when x-rays showed the lesion. Twenty six (eighty seven percent) of these patients were explored. Twenty three (seventy seven percent) were resected, with a three
year survival of thirty percent. In the symptomatic group, sixty four percent had exploration, thirty eight percent were resected, with only a twelve percent three year survival rate.

In general, it can be said that at the present time, the overall three year survival rate of patients with bronchogenic carcinoma is approximately ten percent. Surgery is the only "curable" treatment available, and that radiation and chemotherapy are palliative only. The present indications are that the best chance of five year survival is the detection of the neoplasm by a routine chest radiograph.

X-RAY DIAGNOSIS:

The lesions leading to the diagnosis of bronchogenic carcinoma are quite variable. It must be emphasized that the manifestations of a pulmonary neoplasm may vary from time to time, so that there may be interval changes in the degree of the findings, i.e. a lesser or greater degree of emphysema or atelectasis is demonstrated. The majority of lesions of bronchogenic carcinoma arise in the hilar region, where they are most difficult to visualize. Frequently they give rise to secondary signs which might help us in making the diagnosis of bronchogenic carcinoma. Some of the radiographic signs of bronchogenic carcinoma will be listed below, but it must be remembered that these are signs, they do not make a definitive diagnosis of bronchogenic carcinoma, but merely suggest the possibility. The differential diagnosis is always difficult, because as it has been proven so many times, broncho-
genic carcinoma is a great masquerader of all diseases. The lesions
which may be seen, and arouse suspicion of neoplasm are: 4,49

1) The appearance of a pulmonary shadow not present on a pre-
vious film, especially in the individual past middle age. (This
points out the value of having previous films, and also that these
films should be studied as a series).

2) Any solitary pulmonary shadow.

3) Demonstration of a peripheral pulmonary mass or nodule in
the lung which shows an increase in size when compared with pre-
vious films.

4) Notching 47 or umbilication in the margin of the shadow.
This is seen best on laminograms and was once thought to be spe-
cific for a neoplastic process. It has since been shown that it
can also be seen in lesions other than neoplastic lesions.6

5) A change in the size and appearance of one hilus. (Here
again one must have old films and use them in order to detect the
subtle changes).

6) An infiltrative lesion: a) One that increases in size with
time, b) One with a nodular, beaded characteristic is highly sug-
gestive of carcinoma.

7) Pneumonic lesions, suspicious if: a) Process recurrent
or fails to heal, b) Laminograms reveal nodularity, c) There is
evidence of bronchial stenosis.

8) A solitary abscess, even rather small in size. Carci-
nomatous abscesses will usually show a protruding outer margin which
extends well beyond the area of the cavity itself. It must also be remembered that the carcinoma as it extends may invade an abscess. It has also been shown in some of the surveys that about ten percent of patients have concomitant bronchogenic carcinoma and tuberculosis.

9) Presence of segmental, lobar or unilateral emphysema, especially in the expiratory phase is indicative of bronchostenosis. This is especially apparent when studying both inspiratory and expiratory films. This may be one of the very first signs, especially if the lesion is intrabronchial. However, as the lesion grows, complete obstruction occurs. One then has the development of atelectasis.

10) Atelectasis will frequently give rise to the pneumonic process which when treated will respond, only to immediately recur again.

11) Changes in the bronchial lumen by laminography (bronchostenosis).

12) Superior pulmonary sulcus shadow.

13) Calcification within a mass as a rule makes one consider this to be a benign process, however as with the abscess, it must be remembered that the neoplasm may invade another lesion or glands that are calcified, so that in this instance, one could see a malignant lesion with calcification. Calcification can occur in a lesion primarily also, but this is very rare.

14) Carcinomatous enlargement of the hilum also tends to
obliterate the clear area between the major branches of the pulmonary arteries and the mediastinum. This usually does not occur with other types of hilar enlargement.

Although the lesions may be present, many are very subtle when first seen and are overlooked. There are many factors that come into consideration here, so we shall take a look at some of these. Victor⁶¹ states that the x-ray findings are usually present in the presymptomatic stages of the disease, and are almost invariably present after the onset of symptoms.

Spratt et. al.⁵⁷ tested the diagnostic acumen of radiologists in two ways: one by using a lucite ball and the other by re-examining films interpreted as normal which actually showed a tumor. They found that ten to twelve millimeter opacities are located when in the intercostal spaces and contrasted to normal aerated lung, and that three millimeter opacities could not be distinguished from anatomical pulmonary opacities. Six millimeters was the size of the smallest tumor initially interpreted as an abnormal shadow. This would then indicate that the tumor may have an opportunity to metastasize before it could be detected.

Reading error may also be a factor, and the reading should certainly not be done by the most inexperienced readers on the staff. In fact, in large surveys, the Public Health Department has its own specialists to interpret the photofluorograms. It has been shown that fatigue, mood, and attitude of the reader are very important. Garland,¹⁵ after conducting a series of studies,
felt that the attitude of the reader is the most important factor in the diagnosis of the truly positive films and rejection of truly negative films.

It has been found that the dual reading of films, the reading of films by two radiologists independently, or by the same radiologist on two different occasions favorably increases the number of lesions found. Yerusholmy found that they increased the number of lesions found about thirty four percent when either of the above methods of dual reading was used. This would mean a decreased number of false negative films, films diagnosed as negative that are positive, under-reading. Not only are the number of lesions found increased, but in addition, the number of false positives (negative films interpreted as positive, over-reading) is also increased. However, it is felt that it is more advisable to have a few more false positive films, than to ignore a number of cases with true pathology. Guiss and Kuenstler felt that most photofluorograms were grossly under reported, and that there is much inconsistency in reporting, therefore indicating a need to set up scientific criteria for reading, interpretation and reporting.

Why are lesions missed? Garland gives the following:

1) Location: The lesion may be hidden by or merged with a rib or heart shadow.

2) Density: A lesion of faint or small type may be overlooked.

3) Type: A slender infiltrate may resemble a blood vessel or artefact.
4) Quality of film: Poor focus, low contrast, poor processing or extraneous shadows.

The task of interpreting and reporting of mass survey films is large, but it has been shown repeatedly that these films have more significance if they can be compared with previous films. It is only by studying the series of films that such subtle changes as slight hilar enlargement or the early peripheral lesions are first noted.

The size of the film has come under criticism at times, but it has been shown by Guiss and Kuenstler, and Garland that the size of the film is less of a factor than the human factor. They contend that it is the best screening method now available, especially one that is adaptable to mass survey. Some hospitals also have photofluorography equipment with which they take their initial routine chest x-rays. All authors agree that if the photofluorogram is suspicious, then multiple views, fourteen by seventeen inches in size should be obtained for follow-up study. If only the larger hospitals are considered (more than two hundred fifty patients), one half of all United States hospitals have facilities for routine chest x-rays, but if all hospitals are considered, less than twenty five percent of the patients have this facility available.

The matter of what views to use has been discussed at length. Although all authors agree that multiple views should be taken if the screening examination is interpreted as being suspicious of
neoplasm, it is quite evident that not all of these views (posterior-anterior in both inspiration and expiration, left oblique, right oblique, lateral and buccy films) can be taken during the course of a routine screening examination. The screening procedure is a preliminary detecting examination that is applicable primarily to the asymptomatic individual. The single posterior-anterior projection in full inspiration is the most commonly used. However, Ross has recommended that three films, a posterior-anterior in both inspiration and expiration and a lateral should be taken routinely to make an earlier diagnosis of bronchogenic carcinoma.

As has been pointed out previously, it is frequently not the tumor mass itself, but the secondary manifestations of the tumor mass that give rise to the earliest radiographic sign of the neoplasm. Segmental emphysema is one of these manifestations, especially if the lesion is an early intrabronchial lesion. The emphysema is best studied with both inspiratory and expiratory posterior-anterior films. As the bronchus becomes stenotic, the lung becomes atelectatic instead of emphysematous, and this too is best studied by the use of both inspiratory and expiratory films.

In past years, only the deep inspiratory posterior-anterior film was used for routine admission films, but the lateral view has become more of a routine measure in recent years, especially routine hospital admission films. When and why is the lateral film of added value? It is especially helpful if there is a hilar
prominence. In addition, on the lateral view one can see portions of the lower lung fields hidden by the diaphragm, a portion of the left lung obscured by the heart, and the mediastinum, spine, and retrosternum are not superimposed on a lateral as they are on a posterior-anterior view.

In a study of one thousand consecutive routine hospital admission films, Adler found seven cases (seven tenths percent) in which the pathology could be seen on the lateral view only. There were thirty (three percent) additional cases in which the pathology could be seen on the posterior-anterior view, but the lateral definitely helped in arriving at a diagnosis. There were also nine (nine tenths percent) cases in which the lateral helped in arriving at the anatomical position but not a diagnosis. This would then indicate that the lateral view was of any help in only four and six tenths percent of the cases in this particular study.

We have now considered the fact that the posterior-anterior, inspiratory film, usually in the form of a photofluorogram is the best mass screening procedure that we have available. However, we have also seen that the early manifestations of bronchogenic carcinoma will probably not be seen on this film. It must be stressed, however, that all suspicious cases should be followed immediately so that a diagnosis can be arrived at, or carcinoma excluded. This patient should then have all of the above mentioned views for further evaluation. These cases should not merely be followed by repeat photofluorograms every three months.
Not only are the views taken important, but the technique is also important. Of especial importance is the routine use of high kilovoltage, or supervoltage techniques.

High kilovoltage is the use of more than one hundred kilovoltage in the taking of x-rays. With this technique it is possible to record a long range of differential absorptions. It is also possible to use shorter exposure times, thus greatly decreasing the amount of blurring produced by movement within the chest, and thus to bring out more detail or increase the sharpness of the detail. Bone detail is actually decreased, however, detail under the ribs becomes more distinct.10,53

This technique can be used by most hospitals with the equipment they have available, and has also been used in mass screening surveys. However, it does not record detail within the mediastinum so one is still faced with the problem of using multiple views in order to visualize all of the structures in which we are interested.

More recently, supervoltage has been experimented with. This is the use of megavoltage, or more than one million volts. This has been used in hope of trying to develop a technique that would reasonably lead to the early diagnosis of bronchogenic carcinoma. It has been shown that the disparity between the absorption of irradiation by various tissues, especially bone and fat, is high at lower qualities of irradiation, and is gradually reduced as the kilovoltage is increased until the differential tissue absorption
ratio closely approximates unity at one thousand kilovolts. At this point the shadows of bone on films are barely visible and the air containing structures stand out clearly. From this it can be seen that soft tissue densities overlying soft tissues, or calcified lesions in the lung fields are best seen at low kilovoltage. Soft tissue lesions overlying bone are most likely to be demonstrated with high kilovoltage technique, because of the absorption of soft tissues relative to that of bone increases as the kilovoltage is increased.

Skeletal structures overlie approximately seventy percent of the projected area of the thoracic cavity on the chest radiograph. Thus it is quite obvious that many of the small lesions will be obscured by the bony thorax on a routine chest radiograph.

Tuddenham et al. demonstrated that at seventy six kilovolts a five and six tenths millimeter density could be seen over the lung fields while at the same kilovoltage the density would have to be forty millimeters in size to be visualized over the spine. At one thousand kilovolts these densities become four and two tenths and seven millimeters respectively. It is obvious that the advantage gained over the lung fields is minimal, while that gained in the hilar region is greatly increased.

McDonnell et al. feel that the supervoltage films should be used only to supplement studies already available, except that the supervoltage film might replace laminography now employed.

Tuddenham et al. believe that the development of a
Single exposure chest radiograph which would demonstrate both the lung fields and the mediastinum would be of great value in the early detection of bronchogenic carcinoma. This could be accomplished by the use of supervoltage technique. The advantages that they feel this offers are: 1) It consistently demonstrates mediastinal structures, including the larynx, trachea, main stem bronchi, aorta and mediastinal portion of the lungs; 2) Deformities, constrictions and filling defects in the tracheobronchial tree are better shown than in conventional studies; and 3) Emphysematous bullae, air filled cavities, and areas of abnormal ventilation in the lung have been better demonstrated than in conventional studies. One disadvantage is that parenchymal details, though they lie within the optimal density range, are somewhat blurred in supervoltage studies by the motion of the anatomic parts during exposure.

Bucot and Sokoloff concluded in their discussion on "Pre-clinical Bronchogenic Carcinoma", that unless supervoltage survey techniques become feasible, it is unlikely that three quarters of the bronchogenic carcinomas that arise in the major bronchi can be detected radiographically until secondary signs have developed. They also stated that in only one fourth of the cases can early detection of peripherally located cancers be anticipated because of their favorable position, being surrounded by air bearing parenchyma. Even these lesions, when small are easily overlooked on single photofluorograms.
Although supervoltage technique is still in the experimental and developmental stage, it appears as though it has a great deal to offer in the earlier diagnosis of bronchogenic carcinoma.

Meanwhile, the routine use of high kilovoltage has greatly improved upon earlier techniques, and applying its use along with multiple views in all suspicious cases should certainly lead to an earlier diagnosis of bronchogenic carcinoma.

Fluoroscopy has no place in the mere screening of individuals, especially in the private office, for bronchogenic carcinomas. In the first place we are looking for a small lesion in a large field, so that we must consider the radiation hazard. Secondly, it is insensitive and will not pick up the small lesion as well as a routine fourteen by seventeen inch chest x-ray. Third, we have no permanent record of what has been observed as one does when an x-ray has been taken.

However, once there is an area on which to localize, fluoroscopy is of great value in observing the lesion. One can especially look for emphysema or fixation which is not as evident on the film as at the time of fluoroscopy.

DISCUSSION

We have seen that the incidence of bronchogenic carcinoma is increasing, and that survival rates in bronchogenic carcinoma are rather dismal. It does seem logical to think that earlier detection should lead to a better prognosis. Rigler et al. have studied radiographs retrospectively of patients who had proved
bronchogenic carcinoma. They found one patient in which the earliest roentgen evidences of the disease were recorded as long as nine years before the death of the patient, and as long as four and a half years before the onset of symptoms. He then concluded that bronchogenic carcinoma has a greater duration from its inception until death than was hitherto considered. He further states in one series, that more than fifty percent of the cases exhibited radiographic evidence of the disease process more than two years prior to either the appearance of symptoms or the determination of a definitive diagnosis. The fact that this is a retrospective study is important. It is also significant that at least ten percent of all lesions are overlooked on the routine chest x-ray. This all points to the fact that early detection is very difficult. It also points out the fact that in order to be of any benefit, the studies must be serial, and that at each study, the films should be read in sequence. Furthermore, all films should be dual read. It is only by employing these techniques that we can hope to detect the largest possible number of lesions.

There are also some common fallacies or pitfalls which must be avoided: 1) Repetitious diagnostic procedures-It is possible to do a grave disservice to the patient by repetitious x-ray studies, bronchoscopies, and cytologic examinations, and by placing unreasonable emphasis on necessity for a biopsy or even a cytologic diagnosis before any surgery is undertaken; 2) "Virus" or atypical
pneumonia—What Overholt refers to as the "red herring" of virus or atypical pneumonia has resulted in many outstanding examples of delay while the effect of observation and antibiotic therapy is being studied. It is important to remember that merely because a suspicious pulmonary lesion regresses during this period does not absolutely establish the diagnosis of viral or atypical pneumonia, since the obstructive pneumonitis often associated with bronchogenic carcinoma may do likewise, at least temporarily. Therefore, one should consider the facts of the individual case, but an unexplained pulmonary lesion in a male over forty-five years of age is carcinoma until proven otherwise; 3) The "old" pulmonary shadow—Comparison with previous chest films both for the presence of the lesion and any possible change over a period of time is often helpful. Yet the very fact that the lesion is of long duration, and that it may not have changes significantly, does not always positively exclude carcinoma. The retrospective studies of Rigler et. al. tend to confirm the fact that lung cancer may be considerably more "chronic" than is generally realized. The asymptomatic, solitary, circumscribed, "coin lesion" has been found to be malignant in a relatively high percentage of patients, especially in older age groups; 4) Calcification—Calcification in an unexplained pulmonary lesion increases the likelihood of its being benign. However, calcification has been found in cases of lung cancer both pathologically and roentgenographically. Here again, one must consider the individual
It is interesting to note that most of the surveys have been done on either the mass of the population, routine hospital admission films on all patients, preemployment examinations, or preinduction to the armed services. It would be interesting to see a serial study done in one selected city, on all males over forty-five years of age, with a history of smoking at least one package of cigarettes per day for twenty years or more. These would have to be studied over a period of time, having repeat radiographs every six to twelve months. The bronchogenic carcinoma found would be treated by the same methods as are in general use. These findings could then be compared with the stage of the disease when detected, and survival rate of all other males greater than forty-five years of age. Another problem that would be answered is the fact that in the first survey one will find many advanced cases of carcinoma. Would this also occur if the survey were repeated every six to twelve months? It would seem that the cases detected on subsequent surveys should be earlier lesions, which should theoretically, at least, lead to a better resectability rate, and a better prognosis. Although the five year survival of resectable cases is better, the overall five year survival rate at present is approximately ten percent, it would almost seem certain that the overall survival rate should be improved if we are detecting the lesions earlier. The current trend at least indicates that the prognosis for a particular case is
best if it is discovered while it is still asymptomatic.

It must also be pointed out that the natural course of the disease is such that it is important to follow all suspicious cases immediately, until a definitive diagnosis is known or pulmonary neoplasm can be ruled out with certainty. It has been pointed out that if this is not done, then the advantage gained by early detection is lost. Ninety eight percent of the bronchogenic carcinoma lesions can be seen on a radiograph. In eighty five percent of these cases, additional radiographs will give a presumptive diagnosis of bronchogenic carcinoma. Cytology may give a positive diagnosis in fifty to ninety percent of cases. Bronchoscopy with biopsy may give a positive diagnosis in thirty four to forty percent of cases. Exploratory thoracotomy may be necessary for positive diagnosis in ten to twenty percent of cases.

One must also consider whether the number of cases found by routine chest x-rays justifies their use. In the mass surveys, slightly less than two tenths percent of the total population will have their films interpreted as being suspicious of neoplasm. Of this group five to ten percent will be found to have bronchogenic carcinoma, i.e. one ten thousandth percent, of the total surveyed population have bronchogenic carcinoma. Seventy three percent of all chest radiographs taken at the University Hospital were interpreted as within normal limits. Fourteen percent showed some cardiovascular disease, either congenital or arteriosclerotic, but in all instances the findings were suspected. Two per-
cent showed suspected lesions. Eight percent showed suspected infectious disease other than tuberculosis. One percent, two cases, of unsuspected bronchogenic carcinoma were found. In addition, three cases of suspected neoplasm were confirmed, and one x-ray showed unsuspected tuberculosis in a twenty-one year old female, however, this diagnosis was not confirmed by subsequent studies.

We must consider the fact that many of the patients at the University Hospital are referred patients, and so one would anticipate a higher incidence of pathology than one would in another type of institution.

Although the use of routine x-rays is well established, the finding of unsuspected pathology in only one and five tenths percent of patients would cause one to consider whether it would not be more efficient for the clinician to decide whether the patient needs the x-ray, than merely having this as a routine. Another alternative it seems, would be to limit the routine chest x-rays to those patients who are over forty-five years of age.

The opinion as to the continued use of surveys is somewhat debatable, however, a pilot study as mentioned above would give much information as to their value. Overholt et al. in the light of their recent experiences with one thousand one hundred cases of lung cancer, favor the continued use of routine surveys, but also feel that the hospitals and the private physician should have an active part in these surveys, i.e. patients coming in for
yearly check-ups. On the other hand, Vincent et. al.⁶ feel that the surveys have made but a small contribution in improving survivorship from this highly fatal disease. More recent statistics, however, seem to favor the former feelings more than the latter.

CONCLUSION

Although routine chest x-rays are not very satisfactory in the early detection of bronchogenic carcinoma, it is the only means available to us now by which we can hope to detect the disease process in the earliest possible stage. The use of mass surveys, however, I do not believe are warranted. The number of actual cases is small, and the number of false positives per case of bronchogenic carcinoma is higher than for the selected group. One then would want to study that segment of the population which is most susceptible to have the disease, males, over forty five years of age, who have a history of smoking at least one package or more of cigarettes per day for twenty years. By this process, we would undoubtedly be screening the great majority of people most likely to develop bronchogenic carcinoma. The x-ray should be repeated at least yearly. However, we must also be careful not to lull the people into a false sense of security because they have had one negative examination. It is important to emphasize, that these studies must be repeated.⁶

If a suspicious case is found, this should be followed by additional studies, and if a definitive diagnosis of bronchogenic carcinoma is made, immediate surgery should be done.
It must also be emphasized that the x-rays studied, should be studied serially and independently. In addition, they should be dual read. This is important because bronchogenic carcinoma may masquerade so many other diseases, and vary from time to time.

In addition we also need to reevaluate our interpretation of films. There are many variables in interpretation and we need to set up scientific standards which may be applied to all films by any reader.

We need to continue to strive for better radiographic or other means, which would lead to an earlier detection of neoplasms. Although supervoltage x-rays are being experimented with, it is hardly an examination which could be applied to the survey of the high risk population and would be available in medical centers only.

Although the use of routine admission chest x-rays is well established, it would probably be well to reevaluate our present views by some scientific means.

From a public health point of view, community surveys over the years have been important in finding unsuspected cases of tuberculosis, but the detection of a case of bronchogenic carcinoma has less impact on the health of the total community. The results are purely personal, although there may be community concern from an economic viewpoint.
<table>
<thead>
<tr>
<th></th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incidence:</strong></td>
<td>38,000 new cases per year</td>
<td>6,700 new cases per year</td>
</tr>
<tr>
<td></td>
<td>14.7% of male cancer incidence</td>
<td>2.2% of female cancer incidence</td>
</tr>
<tr>
<td><strong>Mortality:</strong></td>
<td>32,400 deaths per year</td>
<td>5,100 deaths per year</td>
</tr>
<tr>
<td></td>
<td>22.2% of male cancer</td>
<td>4.1% of female cancer</td>
</tr>
<tr>
<td><strong>Rates and Ratios:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence per</td>
<td>42.1</td>
<td>6.2</td>
</tr>
<tr>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality per</td>
<td>35.3</td>
<td>6.0</td>
</tr>
<tr>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant Increase</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>beyond age:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than 75%</td>
<td>50-70</td>
<td>50-70</td>
</tr>
<tr>
<td>occurs between:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trend Past Ten Years:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence:</td>
<td>120.6%</td>
<td>33.2%</td>
</tr>
<tr>
<td>Mortality:</td>
<td>102.7%</td>
<td>25.8%</td>
</tr>
</tbody>
</table>

Bronchogenic Carcinoma Statistics from O'Donnell, Day and Venet.
### TABLE II

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>NUMBER</th>
<th>PER CENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Under 25</td>
<td>175,954</td>
<td>189,529</td>
</tr>
<tr>
<td>25 - 34</td>
<td>199,585</td>
<td>213,519</td>
</tr>
<tr>
<td>35 - 44</td>
<td>172,455</td>
<td>130,347</td>
</tr>
<tr>
<td>45 - 54</td>
<td>125,951</td>
<td>144,660</td>
</tr>
<tr>
<td>55 - 64</td>
<td>82,704</td>
<td>100,592</td>
</tr>
<tr>
<td>65 - 74</td>
<td>43,548</td>
<td>54,066</td>
</tr>
<tr>
<td>75 - 84</td>
<td>12,141</td>
<td>13,544</td>
</tr>
<tr>
<td>Over 84</td>
<td>1,185</td>
<td>845</td>
</tr>
<tr>
<td>Unknown</td>
<td>2,352</td>
<td>2,561</td>
</tr>
<tr>
<td>Total</td>
<td>816,305</td>
<td>909,461</td>
</tr>
</tbody>
</table>

**Los Angeles Chest X-ray Survey**

Surveyed Population by Age and Sex
<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>NUMBER</th>
<th>PER CENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Under 25</td>
<td>230,676</td>
<td>262,540</td>
</tr>
<tr>
<td>25 - 34</td>
<td>347,935</td>
<td>375,243</td>
</tr>
<tr>
<td>35 - 44</td>
<td>326,374</td>
<td>336,183</td>
</tr>
<tr>
<td>45 - 54</td>
<td>261,514</td>
<td>270,384</td>
</tr>
<tr>
<td>55 - 64</td>
<td>139,071</td>
<td>213,371</td>
</tr>
<tr>
<td>65 - 74</td>
<td>111,027</td>
<td>146,769</td>
</tr>
<tr>
<td>75 - 84</td>
<td>39,788</td>
<td>61,344</td>
</tr>
<tr>
<td>Over 84</td>
<td>6,602</td>
<td>11,955</td>
</tr>
<tr>
<td>Total</td>
<td>1,520,465</td>
<td>1,679,469</td>
</tr>
</tbody>
</table>

**Los Angeles County Population**

**Fifteen Years and Older by Age and Sex**
## TABLE IV

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 25</td>
<td>40.4</td>
<td>26.9</td>
<td>33.4</td>
</tr>
<tr>
<td>25 - 34</td>
<td>61.9</td>
<td>69.8</td>
<td>65.9</td>
</tr>
<tr>
<td>35 - 44</td>
<td>143.2</td>
<td>116.6</td>
<td>129.3</td>
</tr>
<tr>
<td>45 - 54</td>
<td>232.2</td>
<td>257.2</td>
<td>273.5</td>
</tr>
<tr>
<td>55 - 64</td>
<td>542.9</td>
<td>482.1</td>
<td>509.6</td>
</tr>
<tr>
<td>65 - 74</td>
<td>769.6</td>
<td>717.6</td>
<td>749.9</td>
</tr>
<tr>
<td>75 - 84</td>
<td>764.7</td>
<td>849.1</td>
<td>809.2</td>
</tr>
<tr>
<td>Total</td>
<td>209.2</td>
<td>197.0</td>
<td>202.8</td>
</tr>
</tbody>
</table>

**Los Angeles Chest X-Ray Survey Follow-up of Neoplasm Suspects**

Proportion of Surveyed Population of Each Age Group and Sex Who Were Neoplasm Suspects
### TABLE 15

<table>
<thead>
<tr>
<th>AGE and SEX</th>
<th>HOSPITAL</th>
<th></th>
<th>MASS SURVEY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Rate</td>
<td>Number</td>
<td>Rate</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,199</td>
<td>4.4</td>
<td>392</td>
<td>2.5</td>
</tr>
<tr>
<td>MALE</td>
<td>673</td>
<td>8.2</td>
<td>243</td>
<td>3.2</td>
</tr>
<tr>
<td>FEMALE</td>
<td>426</td>
<td>2.5</td>
<td>149</td>
<td>1.9</td>
</tr>
<tr>
<td>UNDER 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MALE</td>
<td>95</td>
<td>2.5</td>
<td>63</td>
<td>1.9</td>
</tr>
<tr>
<td>FEMALE</td>
<td>117</td>
<td>.9</td>
<td>43</td>
<td>.8</td>
</tr>
<tr>
<td>OVER 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MALE</td>
<td>564</td>
<td>13.6</td>
<td>160</td>
<td>7.1</td>
</tr>
<tr>
<td>FEMALE</td>
<td>313</td>
<td>6.9</td>
<td>103</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Number of Persons with Initial Diagnosis of Intrathoracic Tumor and Rate per One Thousand Persons for Whom Roentgenographs Were Made.
<table>
<thead>
<tr>
<th>Findings</th>
<th>Under 15</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>Over 74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>6</td>
<td>16</td>
<td>15</td>
<td>9</td>
<td>10</td>
<td>14</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unsuspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Neoplasm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unsuspected</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Skeletal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious (Other)</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

### TABLE VIB

<table>
<thead>
<tr>
<th>Findings</th>
<th>Under 15</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>Over 74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>19</td>
<td>4</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unsuspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Neoplasm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Unsuspected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Skeletal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Infectious (Other)</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

BIBLIOGRAPHY


43. Pate, J. W., Campbell, R. E. and Hughes, F. A., Unsuspected Bronchogenic Carcinoma, Dis. of the Chest 37:56, 1960.


