THE USE OF RONTGEN RAYS IN INTRA-THORACIC DISEASE, WITH NOTES AND RADIOGRAPHS ON A SERIES OF CASES.

Thesis for M.D. (Edin.)

By

Arthur Leonard Anderson.
### SYNOPSIS

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PART I.

INTRODUCTION

In introducing the subject of the use of Röntgen Rays in intra-thoracic diseases, the best plan to me seems to be to aggregate some of the more authoritative or striking statements in the literature as to apparatus, as to the general utility of the rays in this aspect of medicine and as to special points relating to radiography of the thorax.

Before doing this, I think that a word as to nomenclature may not be out of place. According to the literature of the Röntgen Rays, the technical terms seem more or less interchangeable and to be used somewhat loosely; thus skiagram seems to be synonymous with skiograph, and so on. The term photograph is, I find, used widely. Its suitability, however, is certainly open to doubt. The British Medical Journal for February 4th, 1899, gives the appended table from the Chronique Médicale.

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APPARATUS AND METHODS OF EXAMINATION

Walsham (1) in Present Day Skiagraphy at St. Bartholomew's. Apparatus used for exciting the tube is principally either (1) the coil, or (2) the influence machine.
The coil must be capable of giving a spark not less than 12 to 14 inches long. Its disadvantages are chiefly in screen work, when the ordinary break causes the fluorescence of a tube to be very flickering.

Again, the influence machine is very cumbersome. It, however, gives steady fluorescence of the tube, and needs no accumulators that require re-charging.

The tube must be of sufficient hardness, that is, of high vacuum or penetrative power.

Methods of examining chest by X-Rays. (1) by screen or radioscopy; (2) by plate or radiography;

There is also the stereoscopic method of Dr. Guilleminot; or kinematoradiography. (This comes under the heading 2.)

Whether one uses the screen or plate, the following subdivisions should be noted as alternative means of examination, (a) from the front; (b) from the back; (c) lateral oblique—right or left—anterior or posterior, as the case may be.

Williams (2) in 1901, said he made use of a static machine with eight plates, each six feet in diameter. With such a machine, the heart of a man could be seen 15 feet away. Apparatus should have an adjustment for readily turning the light up and down. Objects are often made out in a moderate light when they would escape observation in a very strong one. The adjustment is especially necessary when the chest
is examined for signs of early tubercle.

In examinations of the chest, the patient should be seated in a suitable chair or should lie down. The light should always be at a distance of about 3 feet from the fluorescent screen, and at a point where a line joining the nipples crosses the median line of the body. So observations made at different times or by different observers could thus be compared. Fluorescent screen is better than radiograph for such work.

Williams (3) If the recumbent position be reported to, the patient should be on a canvas stretcher six feet long, 20 inches wide, and supported about 4 feet above the floor.

The tube should be placed so that the rays fall as perpendicularly upon the screen or plate as possible.

Out-patients and others well enough to walk may be examined if desired in either the sitting or the standing posture.

Before examining a patient the observer must remain ten minutes in the dark room, or else wear darkened glasses for 20 minutes before entering the X-ray room.

Methods for recording the appearances as seen on the fluorescent screen:

(a) Without removal of clothing. By placing a metal rod covered with rubber over the sternum and other pieces of metal over the nipples.
screen is covered with a thin sheet of glass or film of celluloid, and placed on the chest. The shadows of the points of reference are first drawn in with a lithographer's pencil, and afterwards the appearance the observer wishes to recall.

(b) With removal of clothing. Tracings upon the skin. A mark with a radiographic pencil is made over the sternal notch, and another over the ensiform cartilage. The screen is held sufficiently above the surface of the body to allow the hand to move freely while tracing upon the skin the appearances observed upon the screen.

After having obtained the lines of organs, etc., the next step is to copy these lines on to tracing cloth.

The measurements made on the chest may be referred to blanks. The outlines drawn on the chest may be measured, reduced and transferred to the blanks.

As regards the screen Williams says a tungstate of calcium screen is better for examination of thorax than is the platino-cyanide of barium. The screen should be 25 by 30 inches, or better 30 by 35, so that both sides of the chest may be seen at once.

Walsham emphasises the value of the lateral-oblique method of Mignon. While the lateral examination is useless, a three quarters view shows
much. The screen shows what Mignon calls the retro-
cardiac triangle bounded below by the convex shadow
of the diaphragm - in front by the heart - behind by
vertebral column. This last or posteiior boundary
includes shadows of aorta, vena cava and oesophagus.-
Another clear triangular space in front of the heart
shadow corresponds to the anterior mediastinum. The
anterior triangular clear space is seen readily enough,
but the shadows in the retro-cardiac triangle are
more difficult; but "I have seen this space filled up
with shadow in the case of enlarged mediastinal
glands."

Walsh (5). quotes Dr Campbell Thomson, the
Medical Registrar of the Middlesex Hospital, writing
in the Lancet for October 10th, 1896. The observer
said that he found the screen quicker and better for
clinical purposes, that by its use one could clear
up many difficulties.

"In order to secure a record of what is seen in
the fluoroscope, he fastens to the back of the flu-
crescent screen, a sheet of white paper through
which the rays would, of course, pass. He then slides
a flat metallic pen or pencil between the chest and
the paper, and on the latter he traces the outline as
projected on the fluoroscope. It need hardly be added
that to carry out this manoeuvre, the observer would
have to continue looking at the screen, so as to
ascertain and control the movements of the opaque
c pencil."
Walsh (5a) says the cryptoscope or fluoroscope is used instead of a dark room. It consists of a dark chamber, shaped like the body of a photographic camera. At one end is fixed the fluorescent screen, and at the other is an aperture through which the observer looks. The trouble of holding it up makes its use compare unfavourably with that of screen and dark room.

Mignon (6) refers to the methods of examining mediastina. (1) The anterior, (2) the posterior, (3) the lateral oblique. He says the shadow extending up and out from each side of the manubrium sterni towards the axilla, corresponds to the great vascular trunks, (Others say it is due to the anterior axillary fold.) as ascertained by stereoscopic examination, - Lancet, Note, 12. 1. 01.

Under the anterior method Mignon says the thymus shadow may be seen up to three years of age. The Lancet says the best part of Mignon's paper is on his examination by the lateral oblique method, either anterior or posterior. We thus see the retro-cardiac triangle of Mignon as described in Reference 4. Mignon says if the aorta be the seat of aneurism, the anterior border of this shadow is not regularly vertical.

The Lancet states that others think the stereoscopic method (of Mackenzie Davidson) in giving a third dimension of space is more valuable.

Williams (7) devised an instrument called the
densitometer, in order to measure the density of any part of the thorax.

Crane in Walsh (7a) describes an instrument devised by himself and says: "The skiameter is an instrument to measure intensity of shadows and linear distances.

Some general references to the use of the rays in intra-thoracic disease.

Moullin (8) in an Address to the Röntgen Society in 1899, said "There is scarcely any change in connection with the lungs, heart and great vessels that cannot be seen and photographed, and scarcely any disease of the chest or the organs which it contains concerning which the most valuable information cannot be obtained. To such an extent has the fluorescent screen been improved, and so easy has investigation with it been made, that I am convinced that some day, and probably at no very distant date, examination of a patient's chest with it will be considered as much a matter of routine, and as little to be neglected in all doubtful cases, as an examination with the stethoscope is at the present time. Valuable as are the indications given by the ophthalmoscope, in obscure diseases of the brain, they are not to be compared with those that can be obtained by systematic and skilled use of the fluorescent screen in diseases of the heart and lungs."
Walsh (9) "A great deal can be done in the thorax in the way of demonstrating changes in the outline of the heart and aorta, as well as in substance of lungs, mediastina and pleura."

"It should be borne in mind that fluoroscopy is an art that requires patient study, the education of the eye to recognise objects of varying opacity on the screen can be obtained simply and solely as a matter of practice. A similar observation is to a less extent true of the reading of ray-photographs. Nor is it less obvious that the physician who wishes to avail himself of this branch of diagnosis must make himself familiar with the screen appearances of the heart and great vessels, and their relations to the chest walls and midriff, as above described. He must also learn to appreciate the variations of shadow produced by shifting the focus tube or the patient."

"The causes of dyspnoea will sometimes be revealed by the rays when not ascertainable by other methods."

Grane in Walsh. "Appearances in disease result from two simple factors - shadow and motion." An X-ray examination of the chest should be preceded by ordinary physical examination - "the two methods supplement and correct each other. "The information obtained by palpation, percussion and auscultation is not in each case co-extensive with the information obtained by fluoroscope, skiamater, and radiograph."
Crane institutes an interesting comparison between some of the leading methods of medical and physical examination and the X-ray method. Thus:—by palpation we feel rhonchi, friction fremitus and vocal fremitus. Rhonchi and friction fremitus give no signs in radioscopy. Vocal fremitus is greater over consolidated areas and less over emphysematous areas. In this, palpation agrees with radioscopy. But where the vocal fremitus is greater there is not always increased density in the shadow and vice versa, namely, in pleural effusions vocal fremitus is lessened or absent, while the fluorescent shadow is dense. This is also true of pleural thickenings, of filled cavities, and consolidations with occlusion of large bronchi. Vocal fremitus is greater in dense walled cavities, which would give a ringed area of light reflex on screen. So in these results palpation is not parallel to radioscopy. It is the narrow limits of palpation (of which only positive data must be considered) by which this is to be accounted for.

Between percussion and radioscopy the comparison is closer. The same features which determine X-ray shadow, determine characters of percussion note. But radioscopy is more precise and delicate.

The auscultatory field is in many ways wider than pulmonary radioscopy. The cardiac sounds, affections of bronchial tubes denoted by râles, and inflammations of pleura denoted by friction sounds are beyond the province of the rays.
Williams (10) in concluding the thorax says that, broadly speaking, a darkened apex suggests early pulmonary tubercle; a darkened area in middle of lung pneumonia; a darkened area in lower portion of lung pleurisy with effusion or empyema; but that there are many exceptions.

The X-rays aid in recognition of an encapsulated and an interlobar fluid — in distinguishing between empyema and a multiple abscess of the liver. They also help in the differentiation between a pericardial effusion and an encapsulated empyema.

In acute processes the general screen appearance would, as a rule, vary after an interval of a week or so — whereas in chronic processes these appearances would not so vary in this length of time.

X-ray examination should be made by trained physicians, preferably chest specialists. X-ray examination ought to become part of routine physical examination.

Williams (11) in 1901 said, the dangers of X-rays lie in faulty methods and wrong inferences, and are not inherent in the method. (Comment: The use of the word inferences suggests that Williams is referring to diagnostic pitfalls as well as to physical dangers attendant on use of rays) Among the thousand examinations he has made in the Boston City Hospital and in private practice, he has not seen one case of X-ray dermatitis. Williams is evidently referring also to the use of the rays in diagnosis, as
He further says the use of rays needs experience, and that no mode of diagnosis is more difficult, because of time concerned and experience needed to interpret. A physician examining a thousand cases by physical signs and X-rays would find himself much improved. He regards the use of X-rays only as an auxiliary method.

**RADIOGRAPHY**

Sydney Rowland (12) in 1896, showed a skiagraph of a child, of three months, taken in 14 minutes. Heart and liver seen. William Anderson, Professor of Anatomy at Royal Academy, and Lecturer on Anatomy at St. Thomas's, referred to this, and a copy of the photograph was shown in the British Medical Journal.

Bougardé (13) at the Biological Society of Paris, said, in suggesting radiography as a means of verifying death, that a photograph taken during life - even when the breath is held - makes the outlines of the organs in the thorax dim and not sharply marked off from one another (owing to pulsation, etc.). A post-mortem photograph showed well-defined edges to outlines and was quite different.

Dr. Cowle (14) of Berlin, in 1899, devised a method by which photograph is taken only during inspiration, and so a clearer negative obtained - he used the make and break induction system. According to his pictures he obtained good results. It does not seem clear whether his method is used much or not.

Walsham (15) in a pamphlet on stereoscopic skiagraphy (in 1899), said this method was much better
than the older method, and that in taking a skiagram of pulmonary tuberculosis one saw (by the older method) varying degrees of transparency mixed up with tracts of shading. In the Lancet for October 15th, 1898, Walsham expressed the opinion that these tracts of shadow were due to consolidated lung tissue, and partly perhaps to pleural adhesions. By ordinary skiagraph of chest, it was quite impossible to distinguish between the two. It is only by getting the third dimension in space that the one can be distinguished from the other. Dr Walsham writes: "It occurred to me that this problem might be solved by a stereoscopic view of the chest. He had always been in doubt as to whether pleural adhesions were or were not transparent to the X-rays. From the clearness with which cavities situated at the apex of a lung came out in the negative, one would be disposed to think that pleural adhesions were transparent to the rays, especially as this is the position in pleura where they are found oldest and densest at a post-mortem examination of a person dead of pulmonary tuberculosis. The stereoscopic method will perhaps settle the question." In referring to an example of a cavity at the right apex, Walsham writes: "What pleural adhesions there may be at this apex - and from experience we feel sure that such adhesions exist - must be quite transparent to the rays." He also thinks the stereoscopic method will be useful for showing more accurately the aortic arch than the
ordinary X-ray examination of chest can show it.

His method is as follows: - "The patient lies on a couch in the prone position, with the chest resting on the photographic plate enclosed in an opaque envelope, the arms being extended and hanging over the end of the couch. The focus tube slides on a horizontal graduated bar placed above the chest of the patient. The middle of this bar is marked zero; and a centimetre scale extends right and left of this zero point. The tube is brought to zero on the bar, which has been made accurately horizontal by a spirit level. A plumb line is now dropped from the anticathode of the tube to the spine of the patient. This being done, the tube is displaced 3 c.m. to the right of zero point, and an exposure given of about 2 minutes 50 seconds. The current is then switched off, and another plate is slipped under the chest of the patient, care being taken to have it exactly in the same position as the former one; the tube is now displaced 3 c.m. to the left and another exposure given at the same time. We have now obtained two skiagrams of the chest, taken from two different points of view, 6 c.m. apart - that is the average distance between the eyes. Negatives are developed and printed in the usual way. When the prints are placed before a reflecting stereoscope, and their images are made to accurately superimpose - a stereoscopic effect is obtained."

"Much still remains to be done in this department
of physical diagnosis. 'I think that' - 'I believe I have good reason to suspect' - 'I seem to see' - are the strongest forms of speech which ought to be used over a matter as yet so little elaborated.

Walsham (16) said, in an address to the Rontgen Society, February 1900, for photograph one can obliterate shadow of scapulae by making the patient lie with chest on plate, with arms extended in front of him. The anterior axillary fold seen when patient is photographed with extended arms (especially if the patient be muscular) should be noted.

Walsham and Beale (17) in a paper before the Medical Society of London, in referring to photography, said the tube should be 2 - 3 ft. away from the chest.

Professor von Rieder, of Munich, (18) took an instantaneous radiograph of the thorax. The film was exhibited by Dr. Isenthal at the Rontgen Ray Society, in January 1901.

Walsham (19), in a paper of thoracic aneurism read before the Rontgen Ray Society on June 6th, 1901, in referring to radiography, said that the patient lies on a couch prone or supine, with front or back of chest resting on the plate (the plate, to prevent its being broken, being placed on a board of equal superficial dimensions). The tube, in a suitable holder, is placed in position above the chest, with the anode at right angles to the plane of the
Walsham (20) in *Present Day Skiagraphy at St Bartholomew's*, in 1901, said the exposure, time and distance of tube from the photographic plate are important. The time of exposure depends a good deal upon and the patient's age, sex, muscular development, fatness or thinness of patient, all having to be considered. Young people and women need shorter exposure. As a rule for thin adults (when one is working with such an apparatus as is described in reference 1.) one minute 50 seconds will probably be sufficient. For a very muscular patient 3 or even 4 minutes may be required. With regard to the height of the tube above the photographic plate, more stringent rules can be laid down. The nearer the organ to be photographed to the plate, the sharper will be its outline, and the less its magnification and vice versa, the tube being immovable. A good height for chest work is four feet above the surface of the plate. Nearly any rapid gelatine plate will do, the more rapid the better - a good size for chest work is 10 x 12 inches.

Walsh (21) writes: "Dr Hackintyre, who was the pioneer of deep tissue work in this country, has laid down the following rules: (1) a powerful current of 30 to 33 amperes, is necessary, so as to take the photograph instantaneously. (Comment: So far as I can ascertain from the literature and otherwise, I do not think it is anybody's habit to take X-ray photographs instantaneously)."
(2) The transformer needs a large coil, so as to give a 6, 8, or 10 inch spark.

(3) It is best to use a small focus tube, which may require prolonged heating.

(4) Rapid exposure is absolutely necessary.

(Comment: one would have supposed that the word "instantaneously," as used in Rule 1, would have implied a tolerably rapid exposure, so the meaning of Rule 4 is not quite obvious).

(5) A mercury interrupter is useful instead of a spring.

He usually placed the lamp about three feet from the sensitive plate. This distance gives a well-defined shadow, but requires a strong light.

Walsh also writes "Dr Campbell Thomson, Clinical Registrar of the Middlesex, gives several valuable hints upon chest radiography. To get a fixed location point he suggests a metallic button placed over the nipple, to which it may be secured by a piece of sticking plaster."

Walsh says that the exposure should be from half up to 3 or 4 minutes.

Again he says "The future development of internal photography by Fontgen methods will greatly depend on the quickening of processes. The wide-spread movements of respiration affect more or less the whole contents of thorax and abdomen, while the heart and great vessels, normal and abnormal, are in a state of intermittent activity. Instantaneous photo-
graphy, were it possible, would enable one to ascertain the exact position of any movable internal part at any fractional time within its periodical range of movement."

Walsh has sometimes, as regards the difficulty of photography, partly eliminated the difficulty caused by the movements of respiration, by causing the patient to fix the part to be photographed by leaning it against a chair or other firm object. Thus a patient with an asthmatic lung, sat astride a high backed chair, against which one side of the thorax was pressed.

Williams (22) The method for photographing heart or lungs. The patient lies (Comment: I suppose supine or prone, as necessary, is meant) with photographic plate on the chest, and pressed squarely against it by a weight placed on a cross-piece of wood. The ends of the cross-piece are supported on blocks which are set on strips of thin, fine board that lies on the horses, one on each side of the stretcher.

The screen is often more convenient than taking a Röntgen photograph; the screen gives results directly, and where an organ is movable, the amount of movement and changes under different respiratory conditions may be studied. Therefore for the thorax the screen is generally better.

Time of exposure. Where apparatus of considerable power is used and tube is of low resistance
(giving good light), that is, with the light of such shadow a quality that does not diminish much in brilliancy on fluorescent screen when hand is examined at a distance of five feet from the tube, as compared with that seen when hand is examined 18 inches from the tube. Then 4 to 5 minutes is a good time for exposure of the chest (the tube being 26 inches from the plate, and resistance of tube about one-eighth of an inch — a fluorometer may be used to estimate the amount of rays issuing from the tube)
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3. 60, 65, 69, 74, 77, 102, 56. Williams
4. Edinburgh Medical Journal, April, 1901.
5. Walsh, 105.
5a. " 46
7. Williams, 105.
7a. Walsh, 284.
11. Medical Record, 26. 1. 01.
19. See 16.
20. See 1.
21. Walsh, 184.
22. Williams, 45, 99.

Walsh means "The Rontgen Rays in Medicine".
Williams means "The Rontgen Rays in Medicine and Surgery".
PULMONARY DISEASES.

Before proceeding to discuss the use of Röntgen Rays in reference to Pulmonary diseases, I propose to quote various authorities as to general points associated with the Lungs, Diaphragm etc. These references chiefly concern what is normal, but after recording them, I propose to reproduce facsimiles of two most excellent charts by Crane (1). Relating chiefly as they do to disease these charts may not seem quite in harmony at this place but I think they will come in better here than elsewhere. They are certainly too graphic and valuable to be ignored altogether. (pp. 26 and 27).

Walsham (2). In a picture of a normal chest, the pulmonary image is quite clear from apex to base, with the exception of a few ill-defined shadows to the right of the Heart shadow. These cardiac lines seem more or less pronounced in all skiagraphs of normal, healthy chests, and must, therefore, be considered normal. Walsham thinks they are not due to lower divisions of larger bronchi, but to junction of pericardium and pleura. (3) He also states shadow of unexpanded lung is as opaque as surrounding tissues, except bone. (4) He also states the dead lung outside the body casts a very distinct shadow, although transparent in the living condition. Occasionally in women there is an ill-defined shadow from large mammary glands.

Williams (5). The lungs are lighter in full in-
expiration than in expiration, as he showed experimentally in 1896. Lungs are lighter in thin than in stout people. Right apex normally darker than left (he has not investigated as to whether this is so in left-handed people). One must get used to the wide range of what is normal, according to size of chest and density of wall, etc.

Walsham (5a). With increasing years, lung transparency is somewhat lessened, affecting the whole lung equally. (Béclère definitely says the same) Transparency is greater in thin than in muscular people - in men than in women.

Williams believes right lung normally a little less transparent than left, but Walsham cannot detect any difference in normal chest.

Nathan Raw (6) Post mortem investigation, shows lungs transparent to rays, and not seen above clavicles.

Immellmann (7). Vertical shadows seen to the right of spine are those of right bronchus branches and mediastinal glands, especially of latter enlarged.

Blake (8). On the relation of trachea and bronchi to chest walls in cadaver; he hardened with formalin and injected a metallic alloy into trachea and bronchi. Conclusion: trachea lies in right sternal line at its bifurcation, a point that corresponds with right side of disc between fourth and fifth dorsal vertebrae. The point is influenced by respiratory movements and by movements of head and
neck in front, it is just internal to the junction of the lower border of the second costal cartilage with sternum in adults and under right part of sternum at level of third costal cartilage in children.

Gardiner (9) in a paper on X-rays as a diagnostic agent in pulmonary phthisis, states that "in older persons the lungs are not so clear as in younger, and naturally in a muscular individual the rays pass less readily; consequently, allowances have to be made in these cases. The significance of a faint loss of translucency is undoubtedly difficult to determine; and here experience, coupled with a prolonged, careful and, if necessary, repeated examination, is the only safeguard."

(Crane (10). The thorax is well adapted for X-ray examination.

Normal lungs are clear spaces, perceptibly darkening and lightening with deep inspirations. This respiratory change is most in lower half of lungs; Pluron is denoted by a delicate tracery of shadows following the outline of the heart and great vessels. In pulmonary and pleural affections examine patient lying down as well as standing up.

DIAPHRAGM

Walsham (11). Diaphragm does not, as physiologists state, become flat on inspiration. Its curve is always maintained unaltered; it plunges up and down piston-wise.

Williams (12) investigated diaphragm excursion in 28 healthy men.

Average normal excursion of diaphragm he found
to be 6.8 c.m. on right side and 7.1 c.m. on left side between full inspiration and expiration.

In 16 of these the diaphragm moved during quiet breathing 1.7 c.m. on right side, and 1.5 c.m. on the left side.

In 15 of these diaphragm was raised during forced expiration 2 c.m. higher than in ordinary expiration on right side and 2.3 c.m. on left side.

In 458 normal adults (31 men and 324 women) the average excursion of diaphragm was greater in younger adults than in older. In quiet breathing average excursion is 1½ c.m. if both lungs normal; if one lung is diseased, diaphragm on well side has to move more. In tall people with long thorax, diaphragm excursion is longer than in short with deep chest.

Williams (13). Diaphragm Lines. Diaphragm excursion in quiet breathing should be noted; then extent to which it extends in forced inspiration and forced expiration noted. It is best to mark results on skin or on celluloid covering the screen. One set of measurements sometimes corroborates or supplements the other, namely, when excursion of diaphragm from expiration to deep inspiration shortened on one side, the excursion during quiet breathing is often also diminished on this side, or diaphragm may rise much higher than normal during forced expiration above the line of quiet expiration on this side.

Gardiner (14). Repeated examinations of average normal diaphragm movement in the adult showed the excursion to be 2¾ inches on the right and 2½ on the left. (See Ref. 3)
Crane (16) the diaphragm cannot be disregarded in radioscopy of the lungs, its visibility, position, form, and motion are factors of the highest importance in estimating the extent and severity of a pulmonary disability. It is the vital barometer of the lungs and may give the first signs of the coming storm.

Its visibility depends upon the contrast which its heavy shadow makes with the thin shadow of the lung. It is a dome of muscle which rests upon the liver, on the right, and is visible across the whole extent; on the left, it rests upon the stomach and is visible across the outer half, the inner half being obstructed by the shadow of the heart. In forced inspiration, however, the diaphragm becomes also visible below the heart; the shadow line of diaphragm becomes more visible in forced inspiration because the lungs contain more air, and because the diaphragm being flatter, intervenes more tissue in the path of the rays. Conversely, the diaphragm lines become less distinct in forced expiration because the lungs contain less air, and because the diaphragmatic dome being more arched interposes more tissue in the path of the rays.

Diaphragm may be indistinct in (a) oedema (b) hypostatic congestion, (c) partial consolidation of the lower lobe, (d) or thickened pleura around the base. (a) gives a general shadow of even density
while in (b), (c), (d) the upper areas of lung may be normal. These latter three are not separable on physical grounds alone.

The position of diaphragm largely determines the form; it is flattened when low and arched when high. In diaphragmatic hernia the form is irregular.

The motion of the diaphragm is of great concern. We may recognize the range of movement in ordinary and forced respiration. By marking the middle point in ordinary respiration, we may observe the upper and the lower half of a forced respiration. As a rule, in health, the range of ordinary and forced respiration is slightly greater on the right than on the left side. A restriction in the range of movement is a sign of some disablement. A very marked restriction in the motion of diaphragm, or its immobilisation, is a grave sign.
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<td>Local</td>
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<td>General</td>
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<td>Bright or light</td>
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**Pneumothorax**

- Emphysema
- Bronchial stasis
- Local emphysema
- Pneumothorax

**Emphysema**

- Pneumothorax
- Bronchial stasis
- Local emphysema
- Pneumothorax

**Consolidation**

- Pleural thickening
- Oedema
- Cirrhosis

**Partial consolidation**

- Pleural thickening
- Oedema
- Cirrhosis

**Total consolidation**

- Pleural thickening
- Oedema
- Cirrhosis

**Infiltration**

- Pleural thickening
- Oedema
- Cirrhosis

**Effusion**

- Pleural thickening
- Oedema
- Cirrhosis

**Collapse**

- Pleural thickening
- Oedema
- Cirrhosis

**Atelectasis**

- Pleural thickening
- Oedema
- Cirrhosis

**Consolidation**

- Pleural thickening
- Oedema
- Cirrhosis

**Pleuritic effusion**

- Pleural thickening
- Oedema
- Cirrhosis

**Gangrene**

- Large filled abscess
- Large tumours
- Large hydatid cyst

**Large filled abscess**

- Large tumours
- Large hydatid cyst

**Large tumours**

- Large hydatid cyst

**Large hydatid cyst**

- Large tumours

**Infarcts**

- Large tumours

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**Pleuritic effusion**

- Pleural thickening

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- Large tumours
CHART II.

(Increased
(Spiration
(Emphysema
(Pneumothorax

Expiration
(Oedema
(Consolidation of lower lobe
(Thickened pleural base
(Pleuritic effusion
(Exudation

Position
(Emphysema
(Asthma

(Cirrhosis
(Tuberculosis, etc.

(Difference of the two sides to be noted)

(Arched
(When high

(Flat
(When low

(In diaphragmatic hernia
(Hepatic abscess beneath D.

(Ordinary
(General
(Respiration range

(Restricted
(Tuberculosis, etc.
(Pleurisy

(Compen-
(sating
(Emphysema

(Exaggerated
(Emphysema

(Motion

(General
(range

(Exaggerated
(Compens-
ating
(Emphysema

(Emphysema

(Exaggerated
(Compens-
ating
(Emphysema

(Emphysema

(Exaggerated
(Compens-
ating
(Emphysema

(Tuberculosis, etc.
(Pleurisy

(Lower
(half

(Compens-
ating
(Emphysema

(Exaggerated
(Emphysema

(Upper
(half

(Tuberculosis, etc.
(Pleurisy

(Compen-
(sating
(Emphysema

(Difference of the 2 sides to be noted)
EARLY PULMONARY TUBERCULOSIS

In this section diagnosis is chiefly referred to.

Some of these statements may not seem to actually apply to early pulmonary tuberculosis, but I have tried, under the above heading, to group such classes of cases of pulmonary tubercle as the Rontgen Rays would, in skilled hands, seem likely to be useful in. Prognosis is referred to separately.

The more advanced or clinically very obvious cases are grouped separately, as far as possible, and in this way I have, relatively speaking, tried to separate the useful from the merely picturesque - the wheat from the chaff.

The diaphragm is referred to in a separate section as its importance seems to merit.

Prof. Bouchard (16), about the end of 1896, stated that tuberculous diseases of the lung in a state not giving percussion or auscultation signs, may be recognised by a cryptoscopic screen.

Bouchard and Claude (17), at the Paris Congress of Tuberculosis, 1898, read a paper on the diagnosis of Pulmonary Tuberculosis. At the outset the lesions consist of are tubercles, isolated or agminated, and offering an obstacle to the penetration of air - and of congestion of greater or less intensity.

The screen then shows at one or both apices,
sometimes at several places in lungs, small spots, ill-defined at their circumference. Or screen shows a slight mistiness veiling one apex; in other cases a kind of stippling of small shadows on a less dark ground.

The authors conclude that the use of X-rays makes it possible in certain cases, to discover commencing changes in the lungs at a period when other methods of clinical investigation give no indication. In other cases, it defines the extent or reveals the importance of a lesion insufficiently disclosed by auscultation or percussion: again, it enables the practitioner to reject the hypothesis of tuberculosis in cases where symptoms and clinical signs of doubtful import puzzle the clinician, while, at the same time, it often enables him to trace to their true cause general disturbances which clinical observation has failed to detect.

Radioscopy is not merely a method of control, correcting or supplementing the ordinary methods, but it yields new indications. By making visible the working of the respiratory apparatus, it shows the functional value of one lung. It discloses the pleural adhesions, the paresis or ankylosis of the diaphragm which limit the movements of extension. In a word, it makes the evolution of the disease visible to the eye. Moullin (18) in 1899, said the earliest stages of tuberculous lesions in lungs can be recognised by X-rays, partly by the curiously
stippled shadows which they cast; partly by the visibly impaired movement which accompanies them - a fact which has not escaped the notice of some of those connected with Life Assurance work."

Béclère, Paris Congress of Tuberculosis, 1898, said radioscopy and radiography should be used simultaneously. They stated their results, firstly, in latent tuberculosis of lung.

Here the patients often show every appearance of perfect health and no sign or symptom of disease, as in soldiers who died of other diseases and in whose lungs are found, post-mortem, foci of tubercle. Kolsch examined radioscopically 124 people admitted to hospital in October and November 1897, and all cases in which pulmonary tuberculosis could be diagnosed by ordinary methods were excluded. In 73 absolutely negative results. In 51 various abnormalities were indicated, as - lessened transparency of apices - enlargement of bronchial glands - opacity of pleura - diminished movement of diaphragm. These appearances Kalsch considered characteristic of tuberculosis. He adds that the screen by allowing, as it were, a pathological examination of the lung to be made during life, confirms the conclusion to which he has been led by post mortems, namely that, in young persons latent tuberculosis exists in two or three of every five cases. X-rays also identify tubercular lesions disguised as anaemia, chlorosis, dyspepsia, neurasthenia.
Secondly, results in suspected tuberculosis. If disease attacks the lung suddenly, radioscopic examination shows a diminution in the clearness of the image at the apex, and a pushing down of the diaphragm on the affected side.

Tuberculosis may begin by an attack of diaphragmatic pleurisy, the symptoms of which may be so slight that the only proof that pleura is involved and that the case is not merely one of intercostal neuralgia, is supplied by the X-rays, which show thickening, diffusion, and immobility of the diaphragmatic shadow. If the case is one of dry pleurisy or stitch in the side, but without any decisive physical signs, radioscopic examination shows superficial opacities quite close to the thoracic wall.

In cases of effusion, the condition on the affected side of the apex in regard to transparency must be carefully investigated; even a slight degree of opacity in the region of the apex is important in regard to prognosis.

It is interesting to note that three years later, at the British Congress of Tuberculosis, Béclère stated that his views had hardly at all, if at all, been changed or elaborated.

Williams (20), Paper on Incipient Pulmonary Tuberculosis, in 1899. In five cases the X-ray examination had given notice of changes in lungs before the physical signs. A lung the seat of tubercle, of-
fers ten times more resistance to X-rays than the healthy lung. The diagnosis of tubercle was not made by X-rays alone, but in some instances the rays had certainly earlier given notice of a departure of lung from normal than the physical signs. The X-rays, taken with the history of rational symptoms, afforded a valuable means of an early diagnosis. In cases of pulmonary tuberculosis, the X-rays showed the apex of lung darkened and the excursion of diaphragm shortened. In 2000 examinations, he had seen no ill effects from the rays. He also stated that he had demonstrated consolidation by the rays, although not even moist rales could be detected on auscultation.

Stubbert (21), in 1899, stated he had yet to see an incipient case of tuberculosis that cannot be diagnosed with X-rays which, are especially useful in scattered tuberculous foci throughout the lungs, where signs liable to be equivocal.

Beale and Walsham, in January 1901, in a paper before the Medical Society of London, said that it had long been recognised that advanced tuberculous changes show definite shadows, but that the very earliest deposits of tubercle did not yield any appreciable shadow. They quoted and exhibited cases showing that tuberculosis could be detected before any physical signs. In cases of "unilateral" disease a shadow sometimes to be found at the other apex also, and in many such instances the extent as well as the presence of disease, could be clearly
defined.

Lewis Jones (23), in January 1901, said photographs of the chest of extreme value in early phthisis. He also stated he would rather, in a doubtful case of early pulmonary tuberculosis, have a sketch than the opinion of the best auscultators.

Bonnetévén, Paris, at the British Congress of Tuberculosis, 1901, read a paper on the X-rays for Diagnosis of Pulmonary Tuberculosis. By the screen he could make a precise diagnosis in 98 per cent of cases, even at the beginning of the disease.

On the same occasion Espina y Capo, Madrid, read a paper on X-rays as a means for the early diagnosis of phthisis. He regarded X-rays as essential. In open tuberculosis, X-rays serve only as a means of settling topography of lesions. Where doubtful is the point. In glandular tuberculosis is often the commencement of pulmonary tuberculosis, and is always a companion, and the X-rays have been of much value in this aspect. The tachycardia has been verified by X-rays. A new point was that the tachycardia was not the rhythmical. X-rays also emphasise the small-size of tuberculous heart. This the author stated to be a true cardiac atrophy. The heart signs are easier of record by radiography than by radioscopy.

The intercostal spaces, often of peculiar space, being narrow, and hence causing difficulty of percussion.

Walsh (25) "in all tuberculous subjects" writes
Dr Bouchard, "examined by the phosphorescent screen, I have established pulmonary lesions by a shadow the area of which corresponded with that mapped out by other methods of physical examination, and the intensity of which was in relation to the gravity of the lesion."......"In another patient the general symptoms pointed to early phthisis, but no tubercle bacilli were in the sputum, and the physical signs were indecisive. The skiascope showed that the apex of one of the lungs was less permeable to the rays, and in a few days both auscultation and bacteriological examination of the sputum yielded positive results."

Walsh (26) says"tubercle of the lungs may sometimes be found by Rontgen Rays in an early stage, when it would not be detected by ordinary means." This is obviously very important because treatment is now much better. Rays often show disease to be more extensive than physical signs indicate. When Koch's tuberculin test was on its trial, Walsh recalls a case in which tubercle of right apex diagnosed, but careful and repeated examination revealed none in left lung. "The injection of the drug was followed rapidly by the appearance of a dull area at left apex. Had the focus tube been available in that instance, there can be little doubt that the early invasion of the left lung could have been equally well demonstrated." Comment: I suppose Walsh means there would have been no occasion to use the tuberculin test.
Béclère, Oudin and Barthelemy, Paris (27) 1901, have by radiography diagnosed pulmonary tuberculous infiltrations hitherto unrecognized by percussion and auscultation. Later on they showed a case at the Hospitals' Medical Society, Paris, in which Rendu had obtained only very indefinite results on physical examination, in which X-rays showed a dark patch at apex of lung, and another about the middle.

Bouchard (28), in December 1896, discussed a case whose general symptoms pointed to phthisis, but in which physical signs were absent. The rays proved one apex more solid than the other, and in a few days tubercle bacilli and physical signs appeared. At the same time Bouchard expressed hope that rays would be as useful in medicine as in surgery.

Williams (29) defines incipient tuberculosis as meaning a young person with anaemia, irregular rise of evening temperature of about 1 degree, digestive symptoms, general symptoms, but no lung physical signs. In many such, an abnormal condition of lungs has been found accidentally by X-rays, namely, an X-ray examination in a patient with a weak, rapid post-diphtheritic heart, showed a slight shadow of apex and a shortened excursion of diaphragm on that side. Tuberculin test confirmed the X-rays.

X-ray examination should always be made. If darkened areas be seen by screen they should be indicated on skin or celluloid. They may be better seen
in full inspiration than in expiration. The two sides must be carefully compared as to the comparative distinctness with which clavicles and first and second ribs stand out in contrast to the lighter areas of intercostal spaces on the two sides. Comment: This last statement well indicates the delicacy of observation and patience needed in detecting by X-rays slight pulmonary lesions.

General diminution in clearness of chest outline should be looked for. Sometimes in pulmonary tuberculosis can see shadows of bronchial glands. These should always be looked for.

Position of heart should be noted. May be

A second X-ray examination later on required, when if indications observed at first examination should be made are persisting, search for other indications (which often develop later) of pulmonary tuberculosis should be made.

Sometimes when screen shows signs at one apex photograph shows that apex darker, but sometimes photograph fails to show this difference. On the whole Williams has found screen better for early tuberculosis. Instantaneous photography may make a difference.

X-ray examination is a new aid to the early diagnosis of pulmonary tubercle without risk or discomfort to patient. If one be going to use tuberculin test, it is well to precede it by X-ray examination, to estimate extend of diseased lung, and to
see how much tuberculin it is wise to give.

The diagnosis is not made by X-rays alone. Shaded apex and shortened diaphragm excursion, while they are seen in pulmonary tuberculosis, may also point to recent pneumonia of upper lobe or movement of lung might be restricted by pneumonia with pleurisy causing adhesions. Therefore we must proceed with care and consider history and whole case. But shaded apex and shortened diaphragm excursion make one think of an early pulmonary tuberculosis or of an old and healed tuberculosis.

The final diagnosis of pulmonary tuberculosis cannot be made by X-rays; but test for tubercle bacilli cannot be resorted to until cough and expectoration begin. Therefore no test in early stage is without question.

Classes of cases of pulmonary tuberculosis in which X-ray examination of value.

A. As an aid in diagnosis.

1. No, or very doubtful, physical signs.
2. Slight physical signs only.

Sometimes rays find abnormality where physical examination had revealed nothing, and then a more careful examination of area indicated by rays has shown slightly more marked expiratory murmur, or slight dulness, or slightly increased tactile fremitus. It is much easier to find these physical signs where X-ray examination has suggested where
they should be looked for. Sometimes tactile fremitus increased or slight dulness present or respiration slightly harsh on one side as compared with the other, but yet within normal limits - where X-ray examination confirms doubtful signs, there is additional reason to suspect the apex in question.

In many cases where disease indicated in one lung by usual signs, X-rays have shown disease in both.

Williams has been over 30 cases of incipient pulmonary tuberculosis, where slight or no physical signs, but where X-rays showed signs of tubercle. In all X-rays examinations confirmed by the finding of tubercle bacilli or by tuberculin test.

In 22 cases he has diagnosed incipient pulmonary tubercle by means of X-ray examination in conjunction with other indications of tuberculosis, but tubercle bacilli were not found (were they looked for, or was there no expectoration) and tuberculin test not used, and so Williams does not ask others to accept the diagnosis.

3. Where emphysema, bronchitis, pleurisy or pneumonia disguising tubercle.

Here pulmonary tubercle may be unsuspected or not readily recognisable and X-rays often prove of value.
(a) Tubercle with emphysema. Increased density of tubercle may be so obscured by as to be emphysema not recognisable by physical signs. But emphysema, aids rather than retards X-ray method of examination, as the darkened patches of tubercle show well against the increased whiteness of emphysema.

(b) Tubercle and bronchitis. Perhaps it would be more correct to say that such cases are cases of tubercle that have been mistaken for bronchitis. The point is that rays indicate their tuberculous character.

(c) Tuberculosis and pleurisy with effusion. Some cases by X-Ray examination give evidence of increased density at apex of one lung, though not detected by physical signs. Confirmed by tubercle bacilli being found or by tuberculin test.

4. Physical signs indicating pulmonary tubercle not confirmed by X-rays.

Signs afforded by X-rays are not pathognomonic; not every patient with these signs has phthisis, nor is every person with good movement of the diaphragm and clear lungs necessarily free from tubercle. X-rays good for warning us of this disease or for indicating reconsideration of an unfavourable diagnosis.

Caution should be exercised as to weight to be attached to negative indications by
X-rays, where history suggests tubercle or some physical signs indicating its presence.

Williams hesitates to speak of this class of case unless he should seem to claim too much for rays. But in some cases symptoms and physical signs indicated pulmonary tubercle but X-ray examination showed normal lungs and caused Williams to say patients probably not suffering from this disease, and subsequent history or tuberculin test indicated that this interpretation was correct. The patients were enabled to settle at home instead of going away. In such cases X-ray examinations should be frequent and reliance placed on them only by people familiar with pulmonary tubercle in all its forms, as well as with use of rays. Comment: Williams seems to me to almost contradict himself at the beginning of this paragraph. At the outset he seems to be casting slight suspicion on X-rays in some cases of pulmonary tubercle and then, without any warning, to begin a glowing eulogy.

5. Where tubercle elsewhere, see if pulmonary tubercle also.

B. In old lesions of tuberculosis.

Old lesions can be seen and so one is put on guard in view of the possibility of the disease lighting up afresh. We cannot
by a single examination of the rays say whether the tuberculosis is old or recent. This needs to be learned by other means - but if disease is progressing successive examinations will indicate the fact.

C. For determining existing conditions more closely.

X-Rays may give unequivocal signs when percussion and auscultation signs are not frankly marked. The greater accuracy of X-ray examination being confirmed by autopsy.

D. For determining the progress and extent of disease.

(1) Sometimes rays show at interval of a week advance not indicated by physical signs.

(2) Sometimes patients are improving in their general condition but rays show advance.

E. In determining the extent of disease.

By rays Williams has been enabled to see that one lung was more involved than physical signs suggested, and also that the other was involved, and so has been able to save a patient from the expense and pain of going away from home on a fruitless errand. Comment: One cannot help wondering whether this course could not have been as well indicated by other means.
F. In acute miliary tuberculosis.

This is sometimes difficult to diagnose, and may be confounded with other disease, namely, enteric. Sometimes when no pulmonary (auscultation and percussion) signs, X-ray examination will show lungs are abnormal and indicate marked signs. X-rays also indicate when disease is diffuse - when localized or disseminated - and how extensively lung or lungs involved.

Williams says it is probable that shadows past upon the screen in pulmonary tubercle are due in part to congestion. He experimented with a much congested piece of lung 2 1/2 c.m. thick (it did not sink in water) He found it cast a shadow corresponding to that thrown by water 2 1/2 c.m. deep. Again, the improvement in pulmonary tubercle, as indicated by diminishing of screen shadow at intervals of a week, could hardly be due to any greater improvement in the tuberculosis than a diminution of congestion. In passive congestion or oedema of lungs in mitral disease the lower portions may be darker than normally without giving signs to percussion and auscultation, but soon become clear after rest and digitalis. In persons with debility and not reacting to tuberculin one may find a dark area in lungs clearing up after a rest of a week or two.
In another part of his work (page 388) Williams refers to 11 cases of anaemia in young women. In 6 lungs showed no marked departure from normal. In 5 appearances varied from normal.

Of these latter, in one, upper part of left lung was darker than normal and excursion of left diaphragm shorter than that of right. Four days later excursion of diaphragm had increased and darkened area in left lung was less marked. Ten days later darkened area in left lung had disappeared, and excursion of left diaphragm greater than that of right.

In another case, on both sides diaphragm showed limited excursion. Only one examination was made. In another, debility and pregnancy was diagnosed when patient entered hospital. X-rays showed whole left lung darker than normal. Excursion of diaphragm not to be made out. On right side excursion of diaphragm only 2 c.m., and upper portion of right lung as far as third rib darker than normally. Appearances suggested phthisis, but temperature was normal and patient did not react to tuberculin. Twenty seven days later appearances were very much improved. Right diaphragm showed excursion of 7 c.m., left 4.7 c.m. Only a slight shading of upper part of left lung remained.

Williams says it is impossible to distinguish between the shadow of increased density of lung and that cast by increased amount of blood in lung, or between shadow of a tuberculous process and that of
an acute process as pneumonia. His experience suggests some of lung changes indicated on screen are due to temporary presence of more than usual amount of fluid or some semi-solid substance capable of absorption. If a congestion recognised it may be valuable as an early warning of commencing tuberculosis, where suspicion excited by first examination or where first examination leaves one in doubt, another X-ray examination may verify or disprove, especially as various conditions may give rise to signs similar to those of pulmonary tubercle.

In conclusion, Williams emphasises importance of where general symptoms in young (as anaemia, loss of flesh, dyspepsia, etc.) which may anticipate any of usual signs of chest - of making careful X-ray examination. "With the use of X-rays in connection with other methods of examination, tuberculosis in its early stage will be less frequently overlooked than formerly." He uses all methods available, and says we need all our methods, but strongly emphasises the value of this method in affording indications of pulmonary tubercle in its earliest stage.

Williams says we have two methods of examining heart and lungs, auscultation and percussion; each requires much training and experience, sometimes one and sometimes the other being of more value; oftener both when used together. To these there is now added X-ray examination. Comment: Williams speaks as
though he had never heard of inspection (which, of course, some distinguished observers claim to be most important of the four classical clinical methods of examining the lungs - this recalls to my mind a statement made by Dr R.W. Philip in his class on Physical Diagnosis, 1897, to the effect that if he were limited to one only of the four methods in question, he would choose inspection). No doubt Williams is well acquainted with all four methods (I recall one place in which he refers to tactile fremitus), but it seems a pity that so able a pioneer of X-rays in medical work should speak in the loose way referred to.

Dr von Beust (30) mentions a case of doubtful phthisis, with severe and prolonged catarrhal symptoms and fever, bacteriological evidence being negative. The X-rays showed a dark shadow of whole left lung, probably due to hyperaemia, and a darker shadow in the centre and towards the apex of the same lung: where two weeks later bronchial breathing made its appearance. Both the dark shadow and bronchial breathing disappeared on convalescence. Prof. Pernel, of the Physical Laboratory of Zurich, exhibited the skiagram. *Comment:* This seems to be another of the cases where X-ray shadows need careful interpretation - one can only suppose the case was something in the way of sub-acute pneumonia.

Bouchard (31) referred, about the end of 1896, to two cases where physical signs diagnosed cavities, but nothing abnormal was seen by X-rays.
Gardiner (32) on the whole finds screen much more satisfactory than photograph, unless for record of grosser lesions.

In a large series of cases, phthisis, or suspected phthisis, he examined, the points specially considered were: - (1) loss of translucency in any part of the lung; (2) alteration in the shape of the heart; (3) slope and movements of the ribs; (4) position and movements of diaphragm.

He emphasises the importance in early cases of having a faultlessly working apparatus; "too great flickering or an imperfect, irregular interruption on the coil may absolutely vitiate results." He speaks highly in favour of the use of X-rays in phthisis pulmonalis, especially in early cases.

Walsham (33) in an address on the Rontgen Rays in diagnosis of diseases of the chest, delivered before the Rontgen Society in 1900, quotes Prof. Clifford Allbutt as having said "Although the Rontgen Rays can indicate rarer spaces in an excavated lung and denser in consolidated parts, it would seem that the super-position of denser upon rarer tracts may neutralise any distinctions of value; still, the trials of Bouchard, Walsham and others encourage us to hope that early foci may thus be made manifest." Walsham said he thought all physicians would agree that there were no means of detecting early tubercle and that when classical signs of early phthisis are found, the case is really advanced and
care doubtful. As to the use of X-rays in this relation, Walsham quoted cases. In one left lung appeared by physical examination unaffected - the rays showed it to be affected. In a case of very slight physical signs, the rays had revealed nothing and the patient was probably free from tubercle. In one doubtful case said to have had haemoptysis, rays gave no definite signs of infiltration, and this so far justified prognosis. In a different relation Walsham quoted a case with small cavities at each apex giving no evidence on auscultation.

At the British Congress on Tuberculosis, 1901, Walsham (34) said X-rays would not disclose the earliest stages of pulmonary tubercle, but they will definitely show tubercle in the lungs, and that at a comparatively early date.

Walsham (35), in an address on Present-day skisography at St Bartholomew's Hospital, said, in reference to X-ray photography in pulmonary tubercle, over-exposure may make lung look clear when screen shows it is not - but under-exposure is worse than over-exposure. In diagnosis of tubercle, screen and photographic plate are probably as useful, the one as the other. Sometimes screen shows an indefinite shadow while plate brings shadow out very definitely. We occasionally see by plate shadows missed by screen. On the same occasion Dr Walsham said one often hears crepitations in some part of pulmonary area in mitral stenosis. Probably stethoscope will fail to show
in these cases whether lungs affected by tubercle or not. Here the rays would probably differentiate.

Immelmann, Berlin, (36) in discussing the question whether by aid of Rontgen Rays we can recognise tubercular disease of lungs at an earlier time than is possible by the methods of investigation hitherto employed, said that development of muscle and fat affect transparency of lungs, (namely trapezius, pectoralis major and in women! ) but patients with tuberculosis are not often muscular, and shadows from this cause can be altered by raising and lowering patient's arm. He thinks screen more important than photographic plate. Pneumonia, gangrene, tumour, tuberculosis, and pleuritis will give shadows on screen, and X-ray diagnosis is one of exclusion. Better to examine with screen before examining clinically, so as not to be biassed. Comment: One would think the danger of being biassed would cut both ways.) "We are in a position to give a definite diagnosis by clinical methods only when the tubercular foci of disease disintegrate and open into the bronchi, and the possibility is offered of finding tubercle bacilli in sputum."

**EXPERIMENT RESULTS**

(1) In eleven cases in which tubercle bacilli were first, found a short time before disease showed as dark places.

(2) In eight patients with lung catarrh, no
were
T.B., apices of lungs less transparent than normal —
and after three or four months four of the cases have
now T.B. and sputum.

(3) In seventeen patients with lung catarrh —
whose lungs appeared normal — thirteen now healthy
after three or four months, while in four others the
apices are now opaque. Comment: A more definite ref¬
erence to physical signs than that perhaps implied by
the words lung catarrh would seem to be needed in esti¬
mating the real value of this experiment. The re¬
sults under heading 3 do not seem to prove much for
or against the rays. I do not know Immelmann's
opinion of the results.

When the transparency of apices is reduced, when
they do not take their full share in breathing, or
are so shrunken that they do not appear above the
clavicle — and when we remember that tubercle usually
begins in upper third of lungs — we probably can
certainly diagnose phthisis, especially if we find
physical signs. Comment: I cannot speak very
definitely, but my own experience suggests that one
must not expect by X-rays to see much of a normal lung
above the clavicle. The receding of the lung seems
to make it more difficult to see above the clavicle.

In some cases, he has with rays fixed seat of
disease, and then by percussion and auscultation
found physical signs he had before missed. The small
heart is also evidence. No doubt mistakes occur.

Stubbert (37) in a paper entitled Comparative
Diagnosis in Pulmonary Tuberculosis by Rontgen Rays refers to 73 cases showing Rontgen Rays accurate agents for diagnosing tuberculous changes of lungs in various stages, not only as corroborative of auscultation and percussion but sometimes as discovering foci not recognisable by ordinary means. Also fluoroscope shows more accurately the position and limits of diseased areas (as yet no satisfactory photograph has been taken of these images).

To obviate bias notes of physical signs made by different physicians prior to fluoroscopy and vice versa. In addition laymen were asked to look into fluoroscope and report on the relative density of transmitted light in different regions. Blue pencil marks were made by their direction and coincided with professional examination. "The first thing noticed may be a comparative haziness or indistinctness of outline of clavicle on affected side." Where slight infiltration of one or two apices, haziness or fog between the light and observer is often to be noted—sometimes the "clavicle appears to have a gauzy veil thrown over it." Much depends on steadiness of light, and therefore a motor generator better than a vibrator which gives a flickering light. Considerable practice is needed to appreciate fully the finer differences of shades and outlines. Stubbert's summary of this part of the subject is that slight haziness whether associated or not indicates the beginning of tubercular infiltration. A practised eye
needed to discover incipient foci.

**MORE ADVANCED LESIONS**

Prof. Wassermann at Vienna Medical Club, (38) about January 1897, showed a case of phthisis in right lung where the cavernous signs could not be elicited by percussion and auscultation. Under the rays the left chest appeared clear and healthy, while the right exhibited diffused shadows representing infiltration; in one place a clear area, which to all appearances corresponded to a cavity, was brought out by the tube applied either to the front or back of the right lung.

Stubbert (39) in Comparative Diagnosis of Pulmonary Tuberculosis by Rontgen Rays, in 1897, said: Where there is marked consolidation the transmitted light is relatively less, edges of clavicle indistinct, or that bone may be invisible. When double disease present, the rays readily show which lung more affected. Comparative apical shadows generally best seen from back, the patient holding shoulders forward to separate the scapulae.

A metal rod moved up and down until its outline becomes more distinct will indicate upper and lower border of consolidation. Can mark with pencil, and then percussion will show impairment in between pencil lines.

Where complete dulness, say to 2nd space, and relatively less dulness below, a dark shadow corresponds to the dulness, - a haziness to the relative dulness. In one or two cases haziness has been seen
where there were no corresponding physical signs, but where the latter have subsequently appeared. Where a single cavity, can see a bright reflex amidst shadow. In one case of multiple cavities, there were dark streaks winding between spots of bright reflex. In one case fluoroscope showed a cavity when there were no percussion or auscultation signs, owing, no doubt, to obstruction of outlet. Some pleuritic adhesions were seen as very dense shadows, denser than cardiac shadows. Summary of this part of the subject. (1) Decided shadows indicate consolidation of such an extent as to be in direct relation to shadow thrown on fluoroscope. (2) Circumscribed spots of bright reflex surrounded by narrow dark shadow rings, or located in midst of area of dense shadow, indicate cavities. (3) In tense darkness, especially at lower part of lung, indicate pleural thickenings over consolidated lung tissue.

Walsham (40) in October 1898, showed double cavities in a boy of fifteen, and stated that cavities can be smaller than physical signs suggest. In referring to the particular case in question, Dr Walsham said "The cavities are well marked in the skiagram as two more or less round clear spaces surrounded by a dark shading." The lower parts of the lung showed varying degrees of shadow. Shading corresponds with consolidated lung tissue, but perhaps partly also with the pleural adhesions.
Bouchard and Claude (41) in a paper on Pulmonary Tubercular Diagnosis at the Paris Tuberculosis Congress, 1898, stated that confluent pulmonary infiltrations with a tendency to softening and ulceration, give rise to almost complete opacities; these are darker in lobular infiltrations, lighter in lobular. The intensity of the shadow is in proportion to the defects of penetration of air into lung; if lesion form a complete voluminous mass impenetrable by the air, the darkness shown on screen is complete; or if there be a number of little nodules separated by parts, still permeable by the air, the general opacity is less intense, and on the dark ground are to be seen deeper shadows corresponding to points completely caseated.

The formation of cavities reveals itself on radioscopic examination as on the plate, sometimes by an absolute opacity, sometimes by zones of relative transparency surrounded by spots of variable opacity. Absolute opacity is met with in cavities full of pus, or when the cavity is deeply situated and surrounded by pulmonary tissue stuffed with tubercles, or when a covering of dense adhesions prevents the passage of the light rays. If the cavity is superficial, empty, and has a light thin wall, it shows as a clear zone against the parts of lung more deeply shaded, is oval in shape and sometimes ribs in front of it are visible. When the cavity fills up, the clearness marking its situation diminishes, and there is only a large
shadow, rather less deep in one point than in the rest of its extent. Every degree of variation is possible, but essential character of all forms of radioscopic image of cavities is the presence of a very dark zone encircling a more or less annular in outline and certain in the region relatively clear or altogether transparent, whilst the rest of the lung in the neighbourhood is in shadow. It is the sharp contrast between the two elements of the lesion. The spots relatively clear, showing on a ground frankly dark, a shadow fining off at the circumference and sharply cut round the central clear zone - that is characteristic of a cavity.

The pneumonic confluent form of acute phthisis reveals itself on the screen by complete opacity of the diseased parts; this is explained by the lung being no longer permeable to air.

(42) Dr Haughton, at the Royal Academy of Medicine in Ireland, stated that he was unable to obtain any good photographs of tubercular consolidation in the apex on the lungs, owing to movements of respiration. He found caseous material rather transparent, and more so than pus, which is nearly as opaque as water.

Moullin (43) in address to Rontgen Society, July 4th, 1899, stated that cavities in the lung whether containing air or pus could be detected at once, and their position and depth from the surface accurately mapped out, so that the question of advisability of drainage and operation was once more coming
to the front.

Immelmann (44): advanced tuberculous patches give dark shadows. Cavities, superficial or deep, give light patches clearer even than the surrounding lung tissue.

Beale and Walsham (45) in a paper read before the Medical Society of London, January 14th, 1901, said the more advanced the disease the darker the shadows, especially when caseation in progress. Cavities indicated by light areas in the midst of dense shadows. Fibroid changes and adhesions only gave rise to a shadow after they had obtained a definite density, and the shadows differed considerably from those thrown by tubercle.

Walsham (46) at Tuberculosis Congress in London, July 1901, stated that in a well-developed case of pulmonary tuberculosis, the pulmonary image was obscured by flocculent shadow, punctate in parts. "On what do these shadows depend? Are they due to consolidation or to patches of congestion, or caseation, or pleural adhesions or what?" The shadows cast by are nothing like so dense grey and yellow tubercle, as those cast by caseation. (47)

Walsh quotes Bouchard as stating that in two instances the appearance of clear spaces pointed to cavities, a diagnosis verified by auscultation, but that in a third case where auscultation led one to suspect the existence of cavities, nothing of the kind was visible on the screen.
Walsh (48) "In tuberculous cases the collar bone is often partly, or even at times altogether, obscured. A cavity shows as a clear space!... "The progress of the disease in the lungs can be accurately noted, and it will be possible to say with confidence whether the tubercular area has increased or decreased in size. A valuable graphic record of events can be preserved in the shape of a series of Röntgen photographs, or, failing that, of charts, mapping out the results of periodical screen examinations."

Crane in Walsh in "The Rontgen Rays in Medicine" says a large cavity shows a bright reflex, which if cavity is centrally located may be surrounded by a dark or black shadow, or if peripherally located may be partly surrounded. Limits of a large cavity are never sharply located unless on the lower side, when partly filled with sputum.

A small cavity gives a light reflex; a large cavity nearly full gives a light reflex.

If it be a small cavity it will lie in the midst of a dark or black shadow, and so should be called light because of the contrast it presents to its surroundings. It may be encircled by a narrow ring of dark or black shadow if walls are calcified, - this healing process occurring in small cavities only.

If it be a large cavity nearly full, the light reflex will rest upon a dark or black circumscribed shadow, unless surrounding consolidation obscures shadow of mass of sputum. If the patient be ex-
amine lying down the cavity may empty and the shadow largely disappear - or the light reflexly disappear because the mass of sputum is now spread out.

Tuberculous infiltration may be noted by a light shadow which also may mean (a) a congestion; (b) an atelectasis or (c) a thickened pleura. There is no shadow distinction between tubercular infiltration and (a) and (b); (c) may sometimes be distinguished if its shadow be plainly visible, say from the front, and nearly or quite invisible from the back. But an infiltration or small consolidation lying close to one side would simulate this appearance.

Partial consolidation is indicated by a dark shadow which also indicates (a) a small tumour; (b) an infarct; (c) a cirrhosis; (d) oedema, but here shadow is diffuse and of even density. A general cirrhotic lung would give a less even shadow and would displace heart - other physical signs, too, are easily differentiated. (a) (b) and (c) give similar shadows, but (c) likely to be located near apex, (a) near the hilum, and (b) in the periphery of lung. A partial consolidation has very indefinite borders, shading out into normal lung tissue.

A small, filled cavity is associated with some consolidation, and appears as a dark spot in the midst of a dark shadow.

Crane in Walsh (Diagnostic in Radioscopy is a matter of reflex shadow and motion. A bright reflex indicates a large empty cavity or a large pneumo-
thorax. If it be a cavity bright reflex may be centrally located and surrounded by a dark or black shadow, or peripherally located and partly surrounded. The limits of a large cavity never sharply defined.

Williams (50) says that one of the uses of the X-rays in pulmonary tuberculosis is in showing cavities in the lungs.

Cavities with fluid or mucus often appear as dark areas on screen - cavities filled with air as light areas, if surroundings are suitable. That is, recognition of a cavity depends much on its size as compared with thickness of encompassing dense lung.

Williams (51) Appearance of Radiograph in Pulmonary Tuberculosis. (a) uniformly darkened apex, (b) mottled apex; (c) whole lung mottled. Less marked on screen.

Please see 57 a.

**DIAPHRAGM - ITS MOVEMENT AND POSITION IN PULMONARY TUBERCULOSIS.** Williams (52) speaking of incipient pulmonary tuberculosis at Annual Meeting of American Climatological Association held in New York City May 11th, 1899, said in pulmonary tuberculosis excursion of diaphragm is shortened. In early tuberculosis excursions of diaphragm are shortened on the affected side.

Bouchard and Claude (53) Paris Congress, 1898, say even slight tuberculous changes in the pleura affect the mobility of the diaphragm.

In general terms it may be said that in pulmonary tuberculosis there is a diminution in the move-
ments of ascent and descent in the diaphragm; this change may be observed on one side or on both sides.

Walsham (54) British Tuberculosis Congress, 1901, Diaphragm of great importance in diagnosis of pulmonary tubercle. The movement of the diaphragm on the affected side is much less than on the non-affected or less affected side, and this when the disease is limited to one apex. Why this should be so it is hard to explain, but the fact remains. Comment: The words "less affected side" hardly seem compatible with the words "and this when the disease is limited to one apex."

On the same occasion Léon Bonnet said that in very early stages the diagnosis can be made by observing the diaphragm and inspiratory muscles. From anomalies in the synchronism or the amount of displacement in the two halves of the diaphragm, one might almost always diagnose a predisposition to tuberculosis or a commencing tuberculosis. In this way had a number of persons apparently in good health become suspected, in whom some months or years afterwards unmistakable evidence of the disease had manifested itself.

On the same occasion Dr Espino y Capo, Madrid, said diaphragmatic excursion in pulmonary tubercle is neither rhythmical nor symmetrical.

Walsham (55) in an address to the Rontgen Ray Society on Rontgen Rays in diseases of the chest, February 1st 1900, said diaphragm stands much higher
on the more affected side and moves much less. He was referring to pulmonary tuberculosis.

Crane in Walsh (56) If right lung seat of tubercle, the diaphragm on right side is usually higher, and on the left side lower, than usual, on account of compensatory changes.

A restriction in range of diaphragm motion probably means tuberculosis, if not pneumonia or pleurisy, but it may mean almost any affection of lungs or mediastinum.

"When in addition to the shadow-free lung we find a natural movement of the diaphragm, we may feel assured that, although tubercle bacilli are present in the sputum, the lung substance is not yet seriously affected. Such cases may be laryngeal or bronchial.

Williams (57) Diaphragm is restricted on affected side or sides, and usually in the lower part of its excursion.

When one lung is partly or wholly diseased, some suggestion of the amount of disease present may be obtained by noting excursion of diaphragm on abnormal side, but also that on well side during quiet breathing. The normal excursion, about 1.2 cm., is increased if one lung be obliged to do more than its normal amount of work; Later on in his book, p. 268 he refers to tuberculosis and unequal excursion of diaphragm. In early, one-sided pulmonary tubercu-
loss in the heart at full inspiration may be drawn and pushed toward affected side. This may be due to contraction of the lung, or may result from increased diaphragmatic excursion on one side— for if there be a marked difference in movement on the two sides of chest, the effect would be to push heart more towards diseased side than it would go were both sides of diaphragm acting normally. Later in disease right side of heart may be enlarged, owing to obstruction of circulation in lung.

Walsham (57a) in an address on the Rontgen Rays in diagnosis of diseases of the chest, in 1900, before the Rontgen Society, London. From the rays he believed sounds produced in a cavity are conducted by the surrounding consolidation far beyond the actual limits of cavity. He showed a case with small cavities at each apex giving no evidence on auscultation. All cavities do not come out with equal distinctness. To come out clearly a cavity must be largely emptied of secretion, and not too deep in lung. (Omission from p. 58.)
THE USE OF X-RAYS IN PROGNOSIS OF PULMONARY TUBERCULOSIS

Béclère (58) at the Paris Congress of Tuberculosis, 1898. In declared tuberculosis, the lesions are plainly shadowed on the screen. In such cases radioscopy is more valuable for prognosis than for diagnosis; it will show where both apices are attacked when clinical examinations appear to warrant conclusions that one apex is intact, or when lesions extend lower down than detected by ordinary methods. The X-rays are particularly useful in detecting central lesions which, because of their depth, are apt to be overlooked.

Walsham (59) discussed the case of a boy of 11, who was in the City of London Hospital for Diseases of the Chest under Dr Sainsbury. Physical signs suggested cavity at right apex, left apex free. Skiagram showed massive consolidation of apex at right upper lobe - no evidence of cavitation as suggested by physical signs. The left apex free, according to physical signs, but skiagram showed distinct evidence of consolidation there. Patient improved considerably in hospital as to weight and temperature, etc. The physical signs indicated some clearing up of right apex, and were still absent at left apex. A second skiagram was taken and was, from a prognosis point of view, very unfavourable. It showed a steady progress of the disease downwards in the left upper lobe and also in the right lower lobe (notwithstanding that the auscultation signs on left
side were negative) Afterwards the boy continued to go down hill, and some weeks subsequent to the taking were of the second picture, physical signs found at left apex on auscultation, while the X-rays had shown the disease there some weeks previously.

Immelmann (60) As regards prognosis some day we may expect a perfect cure when we can diagnose disease as having just begun at apices. In advanced cases rays will decide whether patient will be sent South or to a Home for Consumptives. Comment: One would have thought that simpler means might have done this; but I suppose the point is that X-rays were seen to be capable of detecting a rapid advance better than physical signs or temperature seem capable of doing.

MILIARY TUBERCLE

Walsham (61) in an address to the Rontgen Society in 1900, stated that no doubt X-rays were capable of distinctly showing miliary tubercle in lungs. Dr David Walsh had shown a very beautiful example at the last meeting of the British Medical Association at Portsmouth (it is probably a reduction of the same photograph that appears in Walsh's book). It is important because this may mean diagnosis of a doubtful case, when decision hovers between miliary tubercle and enteric fever. Walsham in Present-day Skiagraphy at St Bartholomew's Hospital, quoted a case of Dr Eustace Smith's where X-Rays had diagnosed
miliary tubercle and excluded enteric fever when clinical means had failed to do this (no reference to Widal). Photograph showed a stippling of both lungs from apex to base.
OPPOSITION TO THE VALUE OF X-RAYS IN DIAGNOSIS OF
PULMONARY TUBERCLE.

Von Dr Med Georg Rosenfeld, 1897, (63) Phthisis
appearances much less distinct than might have been
expected and careful inference needed.

Kingston Fowler (64) January, 1901, Medical
Society of London, referred to cases where X-rays
were of considerable value in pulmonary tuberculosis,
but said he thought that sometimes the first rib came
in the way of diagnosing pulmonary tubercle at apex.

Williams (65) quotes the cases of two people with
undoubted pulmonary tuberculosis not satisfactorily
recognised by the Rontgen Rays. This may be ex-
plained perhaps because of distribution of tubercle,
or perhaps because of lack of experience on the part
of Williams as to a new method, or perhaps it means
that some cases are better recognised by other
methods. (He does not give the date of this experi-
ence)
TREATMENT OF PULMONARY TUBERCULOSIS BY RONTGEN RAYS

E. Ausset (66) applied rays to abdomen in case of advanced abdominal and pulmonary tuberculosis. General condition improved, then because no apparatus available, further treatment was stopped and child went steadily down the hill. Post mortem revealed extensive pulmonary tubercle and miliary tubercle in peritoneum. February 1897. (This case is only referred to because the statement that the general condition was improved was taken to imply that possibly the lung condition was improved).

Francis Pott (67) from a series of experiments made on action of the X-rays in tubercle bacilli, had concluded that the improved condition of tubercular subjects treated by X-rays, was not due to action of rays on T.B. but to some other action on the part of the rays.

Von Dr. Sinapius (68), 1898, Twelve cases of phthisis were said to be cured by application of the rays to chest. The chest was bared and the rays allowed to fall perpendicularly. After 10 minutes' exposure to a definite area, the rays were thrown upon another part of chest. Each sitting lasted an hour. The sittings continued for three weeks or longer, if necessary. In all cough and expectoration were lessened and sometimes completely arrested and physical signs (auscultation and percussion) much improved. All the patients gained in weight and their appetites increased. Dr Sinapius thinks the benefit not due to
destruction of tubercle bacilli but to increased metabolism. In all the patients, no harm resulted beyond reddening of the skin.

Chapteloube, Descomps, and Roullies, 1897, (69) Case. A woman, aged 22, subject of acute and rapidly spreading pulmonary tuberculosis, treated by the rays. and Cavity at right apex, right lung infiltrated generalised extension to left lung. Many T.B. present. Medical treatment of no avail. Patient was losing ground showed well marked hectic. Medicines stopped and rays tried. During the first fortnight of applications, which were much resented by patient, general conditions were worse. At eighth application a kind of crisis, with fall of temperature, occurred. Temperature, however, was up to 103.2 by the end of a fortnight. At this time some improvement was noted in right intraclavicular fossa. For next month rays used from behind twice a day. Resulted in marked fibrosis, diminution of cough and expectoration and almost complete disappearance of T.B. General condition still grave and ulcers appeared on exposed parts. Rays stopped during the next three weeks; much improvement all round. (Temperature kept up to 101 in the evening, but this probably due to bacillary action on some part other than lungs) Authors conclude "without discussing cure" 30 X-ray applications had almost healed lung with acute tuberculosis, no other medicinal agents being employed.
Bergonie, of Paris, and Mongour, of Bordeaux (70) experimented on action of rays on Tuberculosis. Results not very favourable. Two cases of acute phthisis, aggravated by alcohol and privation, gave negative results. In three chronic cases of pulmonary tuberculosis, there was in one, during six weeks, general and local improvement; but afterwards a fresh development and severe gastric trouble occurred. In one there was no difference. In the third there was general but not local improvement. Three other cases ran their course uninfluenced by rays. Authors consider that under rays pulmonary parenchyma probably becomes better able to resist inroad of tubercle bacilli.

Bergonie (Paris) (71) and Tessier report on their own experiments and those of Lortet and Genuod, Florentini and Lureschi, Mükam, Rodet and Bertin-Sans and others. Animals infected with tuberculosis in various ways showed no evidence of appreciable benefit from treatment with the rays.

In man (pulmonary tuberculosis). If in some favourable cases abatement of fever, improvement of general state and sometimes, though more rarely, modification of the local condition, have been observed to follow the use of the rays, these good effects have not been lasting; the disease has gone on, and the fatal result not been retarded. In some cases acute pneumonic processes have been set up which if not certainly traceable to the rays were in very close relation to the time of their application. Serious digestive disturbance has also been observed after the treatment. Authors sum up their conclusions by statement that
result is negative. Disease not checked nor stopped. Applications if not dangerous, at any rate useless therapeutically.

R. A. Schölefield (72) in a paper on Lupus treated by X-rays says "Still further, the most important element is the penetrative power of the X-rays, and the conclusion cannot but be drawn in the case in question that if dermal tuberculosis may be cured, why not pulmonary? "May we not thus hope to go even a step further than the fresh air treatment towards the cure of phthisis and supplement it with either concentrated sunlight or exposure to concentrated X-rays?"

Walsham (73) British Tuberculosis congress, 1901, said it might be hoped that the means of detecting an early tuberculous shadow brought a little nearer the day when internal tubercle might be treated with chemical rays, as external tubercle, lupus, was now treated. Perhaps in future one may be able to say of pulmonary tubercle "it comes as a shadow, so departs."

E.B. Hazleton of Sheffield (74) has used X-rays for pulmonary tubercle. Most suitable cases are those where only one apex affected. He used a coil giving a ten inch spark, and the X-rays were focussed on the seat of the pulmonary lesion for an hour or longer each morning and evening. He gives no statement of result:

Lortet and Genoud (75), 1897, experimented on guinea-pigs to see whether the tube rays had any
restraining effect on acute tuberculosis. In eight guinea-pigs inoculated with tubercle culture, three were submitted to the action of X-rays three times a day. At the end of 6 weeks the latter showed difference from the five left alone. Those exposed to action of rays had no abscess at point of inoculation, their glands were well defined and their general condition good, with increase of weight. The others showed abscess at point of inoculation, enlarged glands, and bad general condition, with loss of weight (no reference made to the lungs in any of the eight guinea-pigs.)

Williams (75a) Hahn reports a case of pulmonary tubercle exposed by Riever to X-rays, with no encouraging results (Fortschritte a.d.Geb. d.Röntgenstr., B. III, H. I. p. 36)

In reporting on cases by Sinapiis, Williams (75b) says that the diagnosis is not proved and cases not convincing.

Rendu (76) in 1897, discussed the case of a man, aged 20, who had typhoid symptoms followed by typical infective pneumonia. Pure cultures of staphylococci found in sputum. After complete defervescence fever returned and signs of suppuration in lung or pleura developed. Examination of sputum showed a few tubercle bacilli, but the parts played by tubercle bacilli and staphylococci respectively could not be determined. After being six weeks ill, with hectic
temperature, etc., the patient appeared to be dying. He was then exposed to Rontgen Rays for 55 minutes every day. After the fourth exposure temperature fell and never rose again, and the patient was soon well. This may have been a coincidence, but probably not. After ten applications erythema and ulceration of skin appeared, probably due to trophic changes in tissue, etc. Du Castel thought the success of treatment pointed to the staphylococcus being the cause of illness, since all attempt to prevent tuberculosis by the same means had failed. 

(76a) Mr Brunton Blakie, of Edinburgh, in 1896, found rays had no visible action on the growth of tubercle bacilli in cultures.

(76) cannot be said to refer specially to the treatment of pulmonary tubercle, but seems to be better associated with that rather than with any other part of my subject.
PNEUMONIA

Bouchard and Claude (77). There is complete opacity of part corresponding to lesion. This opacity varies in extent and limits from day to day. Movements of diaphragm are diminished on affected side. 1898.

Williams, 1899, (78) said some signs demonstrable by X-rays in some cases after the patients have been discharged as cured.

Moullin (79), address to Rontgen Society, July 4th, 1899, said patches of central pneumonia have been seen and shown with great distinctness and accuracy.

Williams, January 1901, (80) showed a photograph of a case of pneumonia at the seventeenth day. It when was taken several physicians had failed to detect any physical signs remaining, and showed a decided increase in density of the affected side.

Williams also said that in central pneumonia it was practically always possible by X-ray examination to make out the increased density of the centre of the lung, even though this cannot be determined by percussion and auscultation.

Walsh (81), Varcot and Chicolet have reported a case of a central pneumonia in a child of 9½, revealed by X-rays and not recognised by ordinary methods of auscultation and percussion.

Walsh (81) "The various stages of pneumonia can be seen by the rays - consolidation, collapse,
pleuritic effusion, displacement of the heart, impaired respiratory descent of the diaphragm. The gradual clearing up of the disease process can also be followed." He also says that in pneumonia the return of the normal rise and fall of the diaphragm is a more delicate test than the opacity of the lungs.

Williams (62) The abnormal condition is shown on the screen, not only by shadow but by restricted diaphragm excursion.

Appearances seen in pneumonia on the fluorescent screen: Dense lobes cast a shadow on the screen, strongly contrasting with areas of normal portion of lung. All pneumonia area on one side and much of the lung on the opposite side may be in shadow, which is nearly or quite as dense as liver shadow — and this whether lung density is peripheral or central. In this way X-rays show advantage over percussion.

(2) Diaphragm lines: Excursion of diaphragm is shortened, and as a rule on its lower side on one or both sides of chest, owing to failure of lung or lungs to expand well because of their increased density, and sometimes because of pleuritic adhesions. Sometimes diaphragm lines are a more delicate test than shadow cast on screen by consolidation. If pneumonia process is extensive, diaphragm lines may be obliterated on one or both sides of the chest.

(3) Displacement and enlargement of heart: If distribution of pneumonia such as to allow of outline of heart being followed, that organ seems to be en-
larged, especially on its right side, where sometimes a much enlarged auricle can be made out. Where the pneumonia is on one side only, there is apt to be dis-
placement of heart. If lower part of left lung be the seat of disease, the right border of heart is sometimes seen farther to the right than in health - partly because the heart is often enlarged in pneumonia and partly because it is pushed over a little. When one can see heart through active stage of the disease its size and position change, the enlargement lessening, and heart approaching nearer and nearer to nor-
mal position and size as lung improves.

Usual region affected: The middle portion of lung, that is part between 2nd and 4th ribs, is the commonest site if disease be not extensive. The apex and base are often comparatively free.

In pneumonia the screen is superior to X-ray photograph.

Comparison of X-Rays with physical signs and of screen with X-ray photograph. Case quoted in this connection.

Double Pneumonia. Signs observed on left side by X-ray examination were more marked than those of percussion and auscultation; the appearance on both side was more marked on screen than X-ray photograph.
EXTENT OF DISEASE

X-rays show the extent of disease, whether or not limited to one lobe, or whether including the whole of one lung and part of the other. The outline of pneumonia is sharply defined.

PERSISTENCE OF X-RAY SIGNS

As patient improves dark areas seen on screen become lighter, diminish in extent, and finally disappear. The diaphragm excursion which has been restricted and restricted on the lower side, gains length as lungs clear up. Pneumonic process may be followed on screen when there are no longer signs by auscultation and percussion.

Pneumonia with obscure physical signs: A pneumonia in its early stage, or even throughout its course, may give no signs of percussion or auscultation. In some of these, a doubtful case made more certain by X-rays. This is especially so in central pneumonia.

DIFFERENTIAL DIAGNOSIS

A familiarity with appearances of disease in pneumonia is necessary for diagnosis between this disease and some other diseases.

(a) Pleuritic effusion. In some cases physical signs may leave us in doubt as to whether the case be one of pleuritic effusion or pneumonia. But if area of diseased lung is not sufficient to prevent us seeing outline of diaphragm on full inspiration,
namely if screen shows a light area below the dark pneumatic one, no fluid is present unless in the uncommon condition of being encysted and much above diaphragm. If a change in the position of patient shows difference in shape of shadow, fluid is probably present. An extensive pneumonia one side displaces heart less than fluid does. The enlargement of heart in pneumonia should not be overlooked.

(b) Pneumonia or tuberculosis. The history and ordinary methods are usually sufficient for distinguishing between the two, but there are exceptions in which the rays may help. Screen may aid in discriminating between pneumonia and tuberculosis where patient has had an apical pneumonia some weeks before of which the physician gets no history. If the disease be pneumonia, successive examinations by the rays at intervals of a few days or a week, would be likely to show lessening of shadow, while if disease were tubercle there would be less rapid improvement.

Pneumonia with "la grippe". Sometimes X-rays after influenza show appearances suggesting pneumonia, although there are no physical signs by percussion or auscultation. Later, however, diagnosis has been confirmed by the physical signs of the progress of disease. That is, sometimes influenza is accompanied by pneumonia with physical signs at first, or sometimes throughout, not sufficiently marked for diagnosis, and leucocytosis may be absent.
EMPHYSEMA

Bouchard and Claude (83), Paris Congress of Tuberculosis, 1898, say that in simple emphysema the permeability of the lung to air is increased, and thus the transparency is exaggerated, and the ribs are less distinct. Moreover the emphysematous lung is larger than natural, and extends into the pleural sacs, so that the transparent surface corresponding to the organ extends more upwards towards the mediastinum, and particularly more downwards towards the abdomen. When the subject is examined at the back, there is seen below the diaphragm a transparent surface of much greater extent than that in the normal state.

Williams, (84) 1899, The movements of the heart are interfered with in emphysema. Again, in 1899, (see Ref: 20) he said emphysema can be represented easily and certainly with aid of X-rays.

Schuster (85), 1899. In emphysema the determination of the size of heart is of great value.

Beale and Walsham (86) in 1901. Emphysema is indicated by exceptional translucency of the affected parts of lung.

Williams, (87) 1901. In emphysema the thorax throughout is lighter than normally, and the excursion of the diaphragm is much more limited and restricted. In such cases the heart changes its position very little between inspiration and expiration.

Walsh (88). "In emphysema the diaphragm descends lower towards the abdomen than in health, and does
not rise to so high a point as it should, while the lung area is brighter than normal."

Crane in Walsh. True emphysema gives a light reflex like a small pneumo-thorax allowing layer of air to surround the lung. In both the movements of diaphragm are restricted, and the line of diaphragm is low and the form of diaphragm is flattened. But emphysema is bilateral, unless when due to some disease on one side producing a compensatory condition on the other.

In emphysema diaphragm becomes very distinct, as also in (a) pneumo-thorax without effusion. But emphysema is either bilateral or else compensatory, and attended by disease on the opposite side. But (a) will show shadow of partially or wholly collapsed lung.

In emphysema the diaphragm lies very low; in cirrhosis of lung diaphragm lies very high.

In true emphysema, as in pneumo-thorax the respiratory movement is restricted in its upper half. In compensatory emphysema the respiratory movement is increased, both in its upper and lower half, and this is important because a compensatory emphysema on one side means an impairment of the lung on the opposite side.

(Walsham, in address to Rontgen Society, Feb. 1st, 1900, in referring to the low diaphragm, vertical heart, and the horizontality of the ribs in emphysema, said he thought that vertical heart had more to do with
the obliteration of cardiac dulness and production of epigastric pulsation than had the emphysematous lung covering the heart, and thus separating it from the chest wall. Comment: The emphysematous lung covering heart can hardly be credited with producing epigastric pulsation, and I suppose Dr. Walsham means that he thinks the vertical heart, rather than any dilatation of right heart, or any pushing down of heart by lung, explains epigastric pulsation.

Williams (89) Appearances seen on the fluorescent screen in emphysema. The pulmonary area is more extensive and brighter than in health, reaching lower down and higher up in the chest. "The diaphragm is lower in the thorax and its excursion is restricted, and is restricted in the upper part of its usual movement." Sometimes diaphragm is so low during full inspiration that it has a peculiar outline, with two curves on each side, and follows outline of some of the organs directly under it. In quiet breathing it may be low down in thorax, but may be brought much higher up in health during a forced expiration. The cardiac outline stands out with unusual clearness on screen, as do the outlines of the ribs and clavicles. The heart changes its position far less than usual during deep inspiration, is lower down in the thorax and is more vertical, than in health and, seen from the side, is farther from the sternum than in health. Heart may be pushed forwards in emphysema. Right ventricle and right
auricle are often seen enlarged and the latter is more clearly seen, because the lungs are brighter and auricle larger than normally.

Utility of the rays in Emphysema.

"In emphysema X-rays may be specially useful. They let us diagnose emphysema without the aid of physical signs, and sometimes let us recognise it when it has been overlooked by physical examination," they also eliminate the question of a large amount of emphysema and indicate extent of heart's enlargement.

A second X-ray examination should be made in a week or two in a question of diagnosis, so as to be sure whether or not the appearances are due to emphysema. In some cases of bronchitis, the excursion of diaphragm may be low down in chest and much shorter than normal, as in emphysema, but in bronchitis the lungs are not clear, and as their condition improves, excursion of diaphragm does not increase. If, therefore, bronchitis were present with emphysema, bronchitis would diminish the brightness of lungs due to the emphysema and the latter might be missed at first examination, the abnormal excursion of diaphragm being put down to bronchitis only. But a second X-ray examination would correct this if the bronchitis had meanwhile improved.

Physical signs of tuberculosis hidden by emphysema. Abnormal condition of lungs are seen by X-rays; for sometimes the rays show lungs perfectly clear, although auscultation and percussion suggested
pulmonary tuberculosis.
BRONCHITIS

Bouchard and Claude (90) Congress of Tuberculosis, Paris, 1898, said that acute and sub-acute bronchitis show little or no departure from normal state - no change in respiratory movements of diaphragm. They thought this might be important negatively.

Walsh (91) quotes a case in which Lévy Dorn examined with the screen the chest of a patient suffering from chronic bronchitis and asthma. The left half of the diaphragm fell rapidly at each inspiration, while it rose by slow successive stages. The right half of diaphragm was from the first absolutely fixed in a position of extreme inspiration; only to rise at the end of the attack with the expectoration of viscid mucus. Comment: The patient was evidently suffering from an attack of spasmodic asthma. One can only trust that he regarded the observer's proceedings as treatment.

Crane in Walsh. Rhonchi give no corresponding and perhaps radioscopy signs, Crane implies bronchitis not to be diagnosed by rays.

Williams (92) has examined about 25 cases. Appearances on fluorescent screen: Sometimes whole chest is less clear than normally, the ribs and outlines of organs being less clear than in health.

In 15 cases excursion of diaphragm was about normal: in 9 cases it was more or less limited on both sides. No record of diaphragm in twenty fifth case.
In bronchitis, especially when acute or sub-acute, or when following measles, a shortened excursion of the diaphragm and restriction of its movement to lower part of chest, may be due to obstruction of the smaller air passages; and the somewhat shaded pulmonary area to a marked pulmonary congestion, or increased secretion of bronchi. Therefore, in making a diagnosis in a case where such acute conditions are present, one should try the effect of coughing on the movements of the diaphragm; if, after the passages have been relieved of mucus diaphragm excursion increases, indications are more in favour of bronchitis than of emphysema. But two or three X-ray examinations at intervals may be needed.
DRY PLEURISY AND PLEURAL ADHESIONS

Immelmann (93), 1900, in an article on early diagnosis of tubercle (Comment: I do not feel sure whether he means with effusion or without it), says pleuritis will give a shadow.

Bécîère (94). Dry Pleurisy shows nothing on the screen or plate.

Beale and Walsham (95), January 1901, in Address to the Medical Society, London, said early dry pleuritis shows only a very faint shadow.

Crane in Walsh (96) Friction fremitus gives no sign in radioscopy.

Pleurisy, especially diaphragmatic, apparently forms an exception to the general rule of extreme seriousness, of very marked restriction or immobilisation in movements of diaphragm. But if patient is encouraged, the diaphragm moves although pain results. (Comment: One would have thought that immobilisation of the diaphragm amounted to complete inability to move it; but apparently this is not so.)

Crane implies pleurisy is not to be diagnosed by rays.

Moullin (96a) in Address to the Rontgen Society, 1899, implied adhesions could be seen.

Williams (96b) said pleuritic adhesions not in themselves visible, but may be inferred by restricted excursions of the diaphragm.

Walsh (96c) When the shadow is extremely dark
it is usually due to pleuritic thickening and adhesions.

Williams (97) Pleuritic adhesions may affect the excursions of diaphragm. Even a very small amount of fluid will flow into the space between outer end of diaphragm and chest wall; therefore, if the diaphragm lying on the given side can be followed, and this angular space seem to be clear by the X-rays, we may infer no fluid present in the pleura unless encysted higher up. But though absence of fluid is easily proved, it is harder "to distinguish between the presence of pleurisy with very small effusion, on the one hand, and a thickened membrane, or a lung increased in density in its lower portion, on the other.

If the above-mentioned angular space be not clear, change of the patient's position from a standing to a reclining posture, with affected side uppermost, may there be show whether fluid free in pleural sac, or thick adhesions or greater density than normal in lung. If the patient be lying down with affected side uppermost, dark area may be drawn in on the skin and process repeated with patient standing. If a change in position of darkened area occur, it might be sufficient to indicate the presence of fluid and absence of dense lung. If the dark area be unaltered by change of position, evidence favours the dark area being caused by something other than fluid.

In one case where movement of the right diaphragm was limited and had an unusual curve (moving less
freely in its middle portion, the outer part of its line not being seen) there was probably a small amount of fluid on right side, but there were probably also adhesions limiting movements of diaphragm, especially in its outer portion. Whether darkened areas result from much thickened pleura without effusion, or whether from a small amount of fluid and adhesions, needs careful consideration.

A pain or stitch in the side after exertion or coughing, or attacks of pain in the side at irregular intervals, sometimes shown by X-rays to be associated with pleuritic adhesions: thus, in one case the heart was apparently drawn to the left side by adhesions which also limited excursions of right diaphragm.

Adhesions do not show on fluorescent screen or in X-ray photographs unless there be great thickening of the pleura - a thickness of 3 m.m. would not be seen unless pleura were calcified, but presence of adhesions may sometimes be inferred as well.

An adhesion may modify the appearance of pleurisy with effusion, for it fastens part of one lung to the chest wall, and the dark area of fluid may at this point be divided into two parts, separated by a light area of normal portion of the lung. In this case, the outline of fluid would be different from the usual one seen by fluorescent screen.
PLEURISY WITH EFFUSION

Walsh (98) refers to paper read by Professor Bouchard on December 7th, 1896, before the French Academy of Sciences, on Pleurisy in man, studied by the help of the Rontgen Rays.

In a right-sided pleurisy with effusions, Bouchard found a darker shade on the affected side of the chest as compared with that of the sound. Further, the shadow indicated the upper limit of the effusion, as proved by percussion and other ordinary means of physical diagnosis. The tint moreover grew deeper from the upper border, where the layer of effusion was thin, to the lower part, where the shadow merged into that of liver. In three cases he also noted to the left of vertebral column a triangular shadow, the base of which was continuous with the heart. This he explained as the mediastinum pushed over sideways to the left by the effusion. In a fourth case, retraction of the affected side had drawn over the mediastinum to the right.

In a further communication to the Academy (Dec. 14, 1896) the Professor remarked that in most of the cases of pleurisy with effusion previously described, he had noticed with the fluoroscope that the lighter area increased from above downwards as the effusion lessened. In one case, however, the apex of the chest retained its shadow. This fact suggested consolidation of the lung at that spot, a suspicion confirmed...
by percussion and auscultation. In other instances tubercular deposits were localised by the same methods.

Béclère, Oudin and Barthélemy (99) have by radiography recognised a suppurating interlobular pleurisy in a child, aged 3 years, who had been supposed before examination to have phthisis. 1897. The same three observers (100) at the Paris Hospitals Medical Society, 1897, showed skiagrams of effusion before paracentesis and after paracentesis - the affected side being clear in a second skiagram.

Bouchard and Claude (101), Paris Congress of Tuberculosis, 1898, Effusion of base shown by a thick shadow hiding the diaphragm and lost below by the obscurity of the abdominal mass, and limited above by a zone of penumbra directed from above down, from the axillary region to the vertebral column, or in the shape of a curve, concave at the upper border. Examinations at intervals of a few days will show the variation as to the extent of liquid effusion, by variation in the extent and form of shadow. An intense opacity of generally rounded outline occupying the middle of a lung in which the upper and lower parts have almost retained their normal clearness, suggests an interlobar effusion. Here again the variability of the shadows at different times is a help to diagnosis. Dense and extensive adhesions of the pleura, on the other hand, manifest themselves by shadows less dark but constant in their form. In such a case it is often impossible to distinguish
the condition of parenchymatous lesions by radioscopic examination alone.

Walsham (102), in 1898, said pleural effusions give a darkening of the whole of the affected side, quite unlike the mottling of tubercle. Probably with X-rays we would be able to distinguish between serum and pus—so far he had no opportunity of testing this point. He doubted if rays would distinguish between consolidation of the lower lobe in an effusion into the pleura.

Williams (103), in 1899, stated he could see and trace the extent of pleural effusions imperceptible by ordinary methods. Comment: I suppose it is the presence of effusions and not their extent which were imperceptible—his fault of course implying his second condition.

The presence of effusion can be seen before it can be detected by ordinary physical methods, and after these have ceased to afford evidence of its persistence.

Moullin (104) in an address to the Pontgen Society, July 4th, 1899, said the alteration of the level of pleural effusion in different positions of the body can be shown with the greatest clearness.

Bergonie and Carrière (105) discussed in Archives de Electricité Médicale, 15, 7. 96. (1896 is a mistake, but it is the year given in the reference) the question of the X-rays in relation to pleuritic effusion. They referred to Bouchard's work (see ref. 98)
On Dec. 28th, 1896, one of the authors in a communication to the Academy of Sciences, confirmed Bou-chard's results, namely that in left effusions heart is seen displaced to the right, even where displacement is not demonstrable by percussion.

In December 1897, the authors communicated to the Academy of Sciences their researches in solving the problems of the displacement of the heart in left-sided effusions. Since then M. Béclère, before the Hospitals Medical society, contributed a paper on the subject.

A good resume of the subject, there is nothing new in it, contributed by M. Mignon (Paris, 1897-1898).

Bergonie and Carrière's investigations, Very careful notes were taken, and sometimes the authors were in darkness for hours, so as to observe better. The results of physical examination, and screen examination, were most carefully recorded. There results are summed up by the authors and translated in reference.

The interesting deductions to be made, specially in relation to clinical facts noted. It has been shown that effusions do not allow rays to pass through them, and that the hemi-thorax affected presents a very marked opacity on the fluoroscope. This opacity seems directly in proportion to the amount of the effusion.
When there is a collection of pus in pleura, the opacity seems less complete than when there is an effusion of serum. In the case of pus there is only a dimness, more or less considerable according to the amount of effusion. The lower boundary of effusion is but little defined, specially on the right side where it blends with the liver opacity. Above the boundary is generally very clear and sharp, and presents variable appearances, while it may coincide with curve if

(1) it may coincide with Damoiseau

(2) It may be concave above (the opposite to 1)

(3) It may be horizontal.

When the upper surface presents both to percussion and screen, the classic curve of Damoiseau, the convex part corresponds to a hyperaemic or atelectic area; for on the patient's coughing violently or taking four or five deep inspirations, the surface becomes horizontal instead of convex.

Often upper margin is horizontal, even when the line of dulness is convex.

Lastly in some rare instances the upper limit is concave.

Explanation: The lung more or less adherent to costal parietes, dips more or less deeply into liquid, and upper part of effusion, occupied also by lung, is partly transparent, and this margin of opacity seems to be concave above.

One often sees alterations in the shape or situa-
tion of upper surface, and these are sometimes synchronous with the pulsations of heart. They are oftener caused by inspiration or expiration. The surface is lowered by the former and raised by the latter, because in expiration the cavity of the thorax is contracted and the compressed effused liquid is raised.

Displacements of whole collection of fluid with changes of position of patient, demonstrated by percussion, are still more evident on fluoroscope. In dorsal decubitus fluid collects in posterior thoracic grooves, so that there is no limit to the opacity, and all the side is opaque. It is the same in ventral decubitus.

It is in displacement of the heart that the fluoroscope gives best help, since percussion or phonendoscope gives only negative indications. In right small effusions, little or no displacement of the heart's apex beat occurs in dorsal decubitus. With the patient sitting or lying on his left side, sometimes a displacement towards the left is from 3-5 c.m.

In a healthy man, heart is not displaced in this way, but it is lowered 2 or 3 c.m. in inspiration; with considerable right effusions there is often displacement of heart to the left, a change in the position of the patient making little difference.

Bouchard (Société de Biologie, 22. l. 98) demonstrated opaque area to the right of spine disappearing on expiration. He thought it due to dilatation
of right auricle. Bengonie and Carrière have seen it in one case, but often noted the existence of a triangular opaque area to the right of the spinal column, increasing in size at expiration and decreasing in inspiration. It is probably due to displacement of mediastinum. During expiration the pressure in left pleura, when it encloses the effusion, attains its maximum, and the only one of all parts bounding the thorax which is movable and passive during expiration, is the mediastinum (the diaphragm being contracted). It is consequently drawn to the right in expiration. Fluoroscope also lets one study movements of diaphragm in pleuritic patients. The half of the arch corresponding to effusion scarcely executes any movement, whilst the other's movements are exaggerated.

"Lastly, we may add, by the aid of Rontgen Rays we may pretty accurately form a prognosis in cases of pleuritic effusion."

"When the thorax above the effusion is uniformly transparent, the prognosis is good; there is no fear of pulmonary tuberculosis." It is quite different and when opacity of more or less irregular shape, not disappearing on inspiration, as found above the liquid. There is a question of bacillary infiltration, and our prognosis must be guarded.

Béclère (see 94) X-rays show empyema.

Walsham and Beale (106), Medical Society of London
January, 1901, Serous effusions cause faint blurrings of rib shadows, but do not obliterate them, but the upper margin of the effusion frequently shows a clear line of demarcation. Purulent effusions cause very dark shadows. A tube of pus removed from the pleural cavity gives a shadow almost as dark as that of bone, and very much darker than the shadows cast by a similar amount of fluid blood or serum.

Williams (106a). If an X-ray examination shows the outlines of the diaphragm readily on both sides, one can be sure there is no pleuritic effusion present; if, on the other hand, these outlines are indistinct on one side, it is probable that the partial obscuration is the result of such an effusion, though it might result from other causes.

Empyema, following pneumonia, is often overlooked, but if an X-ray examination were made such an error would not be likely to occur.

Walsham (107) X-rays show pleural effusion and distinguish between serum and pus. Clinically it is often difficult to detect fluid, specially in a child, therefore X-rays of use.

Case I. Case of Dr Beale. Boy, aged 6 - no cardiac displacement - no percussion dulness - no sternal resonance - only bronchial breathing left base behind. X-rays at once cleared any doubt between consolidation and effusion. Skiagraph from the back showed on left side a moderately dense uniform shadow, with a well defined curved margin extending downwards.
and inwards from near the apex to the articulation of the 7th rib, where the shadow became continuous from spine to ribs, until it merged into the shadow of the diaphragm. The shadow was not sufficiently dense to obliterate any of the ribs, but it was sufficiently dense to obscure the outline of the heart, which was not displaced to the right. On looking at the ribs on the affected side, an alteration in their normal curve was seen as compared to the opposite side. They had suffered a rotation upwards and outwards. A clear, oval space between the well-defined edge and the spine, corresponded no doubt to the compressed but not altogether airless lung. Diagnosis of fluid in chest was made and 30 oz. of serum withdrawn. Skiagraph showed no evidence of tubercle. After-history quite justified the opinion expressed at the time the chest was tapped, that the effusion was a simple one and not complicated by any tubercle in the lung or pleura.

Case II. A man, aged 19, admitted to City of London Hospital for Diseases of the Chest with diagnosis of empyema of right side. Skiagraph showed whole of right chest occupied by very dense uniform shadow, completely obliterating the outline of ribs on that side, and blending with the heart shadow which was displaced to the left. Chest tapped and pus withdrawn. After convalescence another skiagraph was taken; it showed striking difference from the first one. The heart had returned to its normal position - the right
chest was nearly as clear as the left, but not quite—some pleural thickening remaining as the shadow and showed—a curved line showed the sinus. Again skigram showed no sign of tubercle. Patient still doing well. Therefore X-rays will in doubtful cases be able to show whether fluid present or not, and if so whether serum or pus.

Crane in Walsh (108). Pleuritic effusion gives a black shadow, which also indicates—(a) consolidation; (b) gangrene; (c) large filled abscesses or cavities; (d) large tumours; (e) large hydatid cysts; (e) distinguished by lying at base of thoracic cavity, by obscuring diaphragm line, by a more or less level upper border, and by being shifted when the patient's position is changed. The other conditions may not be separable by an X-ray examination, although their boundaries may be mapped out.

In (a) effusion, diaphragm becomes invisible, as in (b) consolidation of lower lobe. With (a) the outline of the shadow may be easily shifted, and with patient on examining table with the head low, diaphragm comes into view. If entire lung consolidated, or if effusion encapsulated or reaches to the apex, one may need to make an exploratory puncture to distinguish between the conditions.

Williams (109). Appearances on Fluorescent screen. On October 1st, 1896, Williams published an article in which these words occurred. "In pleuritic effusion the outline of the diaphragm on the fluoro-
scope is less defined, or obliterated altogether, according to the amount of fluid present, as also are some of the ribs in the upper portion of the affected side; the lung is also denser, being compressed by the fluid if there is much effusion. I observed in one case that the line separating the fluid surrounding the lower part of the lung, from the compressed upper portion, ran from about the junction of the 6th rib with the sternum towards the outer end of the clavicle."

This line is not sharply defined, but is often more definite when the patient is sitting than when lying down. Displacement of the heart is striking; it is more if the fluid (same amount) be on the left than on the right.

The triangle below and behind the heart is wholly or largely obliterated according to the amount of fluid present.

When fluid partly fills the pleural sac, but does not extend to upper part of chest, the apex of lung on this side, is probably somewhat darker than on the normal side, owing to lung being compressed somewhat.

"Appearances in Empyema would be similar to those seen in some cases of pleuritic effusion." This was illustrated by experiment in 1896. He placed under the fluorescent screen a vulcanite cup full of pus, and beside it another cup full of serous fluid and found no difference between their respective shadows.
The screen never fails to recognise an abnormal condition of chest if a pleurisy with effusion or empyema be present.

METHODS OF EXAMINATION.

In pleurisy with effusion, outline of dark area, as well as other outlines of thorax, generally change when patient changes his position. Therefore examine patient when he is sitting up and when lying on his back. If patient in a sitting position and amount of effusion is moderate, the line is more nearly vertical than when chest nearly full of fluid.

Patient should also be examined when lying on his right and on his left side, and the position of heart obliteration of lines of diaphragm or movement of diaphragm or any part of it that can be seen, be noted. The screen is better than photograph for pleurisy.

The trustworthiness of percussion in determining the presence of fluid by means of displaced heart: Displacement of heart caused by fluid in chest, may be marked and yet not detected by percussion—especially if to right. X-rays show heart displacement best.

Encysted pleurisy. Physical signs may be difficult to interpret, and sometimes X-rays more clearly indicate real condition than does any other method.

Inter-lobar empyema or pleurisy: "Fluid may not only be encysted in pleura against the thoracic wall
but may be enclosed in pleural membrane between lobes of lung — such a collection would cast a shadow if the lung surrounding it were at all clear." Physical examination will not give us direct information.

**Diaphragmatic Pleurisy.** He has never examined a case of this by the rays, "but they would probably be of use."

**In Pleurisy with Effusion and Emphysema.** In pleurisy with effusion and emphysema, physical examination may not recognize the latter, but X-ray examination does.

**Pleuritic Effusion and Pneumonia.** In one case of the above, the physical signs in the left lower chest, considered by light of knowledge, that patient had had a pleuritic effusion, indicated that although from fluid had recently been drawn off the pleural cavity, but there was still some remaining; the second X-ray examination showed no fluid there. The physical signs probably due to density, persisting from pneumonic process. Right apex had been dull to percussion with prolonged expiration; first X-ray examination had shown right apex to be shadowed and excursion of right diaphragm to be shortened. A second X-ray examination showed apex much improved and therefore process probably not tubercular. No tubercle bacilli. The case had been one of pleurisy and pneumonia on left side and pneumonia on right side. Here the rays explained the condition and indicated improvement in a way physical signs did not.
PLEURISY WITH EFFUSION AND PULMONARY TUBERCULOSIS.

If screen be used at intervals in a patient suffering from pleural effusion, sometimes as fluid is absorbed the chest becomes clearer in its lower portion, but remains darker above, and it is sometimes noted between that an increasing light area may be seen between upper and lower parts of chest as fluid subsides. Here tubercle should be looked for. Signs of tubercle at apex of one lung become more and more obvious as liquid disappears on that side—fluid has at first obscured them. Or the other apex may be seen to be dark and so an early tuberculosis on other side recognised.

Sometimes we find in cases of pleuritic effusion indication of tuberculosis in lung not previously suspected.
HYDROTHORAX

Williams' (110) Appearances seen on fluorescent screen. Lower portions of both sides of chest are darker than normally and outlines of diaphragm cannot be seen. If the hydrothorax be more extensive the dark area extends higher up.

EMPYEMA with PERMANENT OPENING (112)

Appearances on the screen vary with the amount of lung involved - amount of diseased tissue in chest denser than lung - extent of cavity - pleuritic adhesions, etc. The diaphragm is more or less depressed, but not to the same extent as in pneumothorax.

After a permanent opening has been made, X-rays may be useful in letting one see the size of sinus. Thus, by injecting iodoform in suspension or bismuth subnitrate or a solution of potassium iodide, or even sterilized water, which all cast a shadow on screen, one can see the extent of sinus. X-rays also are useful in showing expansion of lung as condition improves, and the presence of absence of tubercle.

PNEUMOTHORAX, PYO-PNEUMOTHORAX and HYDRO-PNEUMOTHORAX (112)

Messieurs Oudin, Barthélémy and Béclère, at the Hospitals Medical Society, Paris, 1897 showed a photograph of pyo-pneumothorax with the level of fluid, the shrunken lung and an apical adhesion. The other lung, which appeared sound to auscultation, was
also said to be affected, showing opaque patches.

Bouchard and Claude (113), Paris, 1898, at the Tuberculosis Congress, stated that pneumothorax was characterized by an abnormal transparency of one side of the chest, allowing the light to pass through without any interference, except over a small area of the affected side corresponding to the retracted lung. The heart and vessels may be displaced — the curve of the diaphragm is lower than in health. In hydro-pneumothorax and pyo-pneumothorax the appearances vary according to the position of the patient; if he be lying down the whole of the affected side is dark; if he be standing up the upper side of the part is more transparent than in the normal state, while the lower part is opaque.

Walsh (114) quotes Dr R. Kienbock at Vienna Medical Club, April 20th, 1898. The patient, aged 24, from the clinic of Prof. Schroeter — had suffered for five months from pyo-pneumothorax.

Details of case: (I give these fairly fully, because the case is one of the earliest and most classic.)

Screen: Erect posture. Right chest showed a long, faint light zone, darker at its upper part.

Left heart showed three zones; an upper fairly light one corresponding to upper third of chest; a middle very light one, and a lowest very dark one, with an upper horizontal level of two fingers' breadth above the level of scapula — showing on dark
area ribs as still darker lines. The dark area merged below with lighter shadow of abdomen. Heart shadow displaced to right.

Various movements seen: On right side liver descended during inspiration - while on left the dark zone ascended for three quarters of the width of an intercostal space. Ribs rose on both sides in inspiration. Heart shadow enlarged and seen pulsating well. Horizontal level of fluid was continually in movement; (a) with respiration; (b) in undulations synchronous with the contractions of heart; (c) in irregular waves passing over the surface and disturbing the rhythm of (b). On patient holding his breath, level of fluid rose with each cardiac contraction.

Slight movements of thoracic floor affected surface level. The level kept horizontal when patient bent to right or left. Percussion of the thorax was attended by marked undulations of fluid, and on patient being shaken these rose to two inches - as liquid in a vessel when the latter is agitated.

If the patient lay on his left side, fluid was undermost, extending from apex to diaphragm and showing no pulsatory or respiratory movements. Median part of left diaphragm now visible, depressed, not distinctly moving. Heart shadow subsided slightly to the left.

Inferences: Right lung diseased nearly throughout; left seat of pyo-pneumothorax.
The comparative opacity of right lung due to compression, infiltration, thickening of pleura. Dark apex due to tubercle.

The left apex adherent and contracted; below was a zone of air. "Lowest and darkest part of apex was located but the lung also was more thickened where fluid was present." Left chest corresponded to fluid (probably serous and purulent). Heart enlarged, shifted to the right side.

Screen showed fluid to have been higher than percussion indicated - but this is a matter of frequent observation, author stated.

Explanations: of ascending inspiratory and expiratory descending surface level of fluid.

Author said perhaps due to inspiratory dilatation of right pleural cavity raising pressure on abdomen, and this in its turn tending to raise paralytic left half of diaphragm.

Pulsating movements of surface level due to heart. "There is a wave moving from the heart to the left during its systolic contraction (empyema pulsans)." This not perceptible outside - possibly because air pressure in pleural cavity not high enough - or chest wall perhaps too thick or pleural costalis too thick.

Third movement depended on outside influences - the shaking of patient, etc. "We are thus enabled not only to hear, but also to see, the succussion hypocritus."

Williams (115) 1899, said in pneumothorax waves
could be seen following the heart's movements, and also the splashing produced by succussion.

E. W. Martin (116), M.B. Edinburgh, described a case of pneumothorax. He stated the points brought out were: (1) clear demonstration of position of displaced viscera, where lung not firmly bound down by adhesions, and where a positive pressure within pleural cavity; (2) the flattening and downward displacement of diaphragm hardly to be made out by physical signs; (3) the collapsed lung and its position; (4) the complete displacement of heart from left side; (5) broadening of intercostal spaces on the side of pneumothorax. He had since shown five similar cases in the Museum, British Congress of Tuberculosis; and believed other cases to be on record, notably a case by Béclère.

Walsh (117) "In pneumothorax the diaphragm may be very low down on the affected side, and motionless except at its median end, where it sometimes moves with the sound side."

Crane in Walsh (118) A pneumothorax denoted by a bright reflex peripherally located and usually larger than in case of cavity. If it exists without presence of pulmonary shadow, diagnosis is clear because cavities always associated with some consolidation. If consolidation with pneumothorax, outline of lung will be seen.

A local pneumothorax from bronchial communication with the pleural sac and from circumscribing
adhesions, not distinguishable, and especially if occurring over front or back area. Its position determined by whether seen best from front or back, as the closer any object lies to the screen, the clearer is the image.

"A small pneumothorax, with a layer of air surrounding the lung, will give a general light reflex. Hydro-pneumothorax and pyo-pneumothorax would give the same as pneumothorax, except for dead shadows of effusion at base. By changing the position of patient, the relative positions of shadow and light reflexes would be changed.

Williams (119) Appearances seen on screen in pneumothorax. Affected side of chest unusually clear, the light area larger than normal; lung retracted; diaphragm is pushed low down in chest and shows little or no movement; organs displaced to opposite side. Amount of displacement depends on whether air in pneumothorax region is or is not under greater atmospheric pressure. If opening be valvular and air pumped in, displacement of organs may be very great.

X-rays may show improvement that takes place if and as air be absorbed.

By X-rays Williams has come to understand some of pneumothorax conditions more clearly than he ever appreciated them before.
In relation to traumatic pneumothorax, I think I may mention two radiographs shown to me a short time ago by Sir Hugh Beevor, of a patient at King's College Hospital. The radiographs were taken within short intervals of each other. The first indicated that re-expansion of the collapsed lung had begun, while the second indicated that the process was nearly complete.
PNEUMOHYDROTHORAX, PNEUMOPYOTHORAX

Appearance on fluorescent screen. In the sitting position, tube behind patient about level of 4th rib. Screen on front chest.

Affected area divided into two parts; an upper part unusually light, and a lower very dark. The general appearance may be likened to a tumbler partially filled with ink. When patient moves backwards or forwards, level of fluid changes. If patient is gently shaken, surface of fluid is disturbed and splashing clearly seen.

When fluid is at a certain level, especially if on left side, the pulsations of heart disturb the surface and cause visible waves. In upper part of chest and towards median line, slight shadow of retracted lung often seen. If lung were tuberculous, it would be darker than if healthy, and not so much retracted as if healthy. Fluid may be seen to rise with inspiration, because of pushing up diaphragm on diseased side when this muscle descends on well side; and to fall on expiration.

It is said fluid may rise with each systole when breath held - Williams has not seen this.

The expansion of lung, consequent upon subsidence of fluid, and absorption of air, may be watched on the screen if perforation closes.

In conclusion, in these conditions or diseases, the X-rays give less equivocal and more complete evidence than can be obtained by the physical signs.
The following case from Williams' book, p. 642, as Appendix, I quote in toto, suggesting a classic background against which to place some of the statements of my own experiences of pneumothorax as recorded among my cases.

"The following case shows that all the usual physical signs of pneumo-hydrothorax may not be present in some cases. . . . . . . . . . A.B., 50 years of age; pulmonary tubercle; diagnosis: pneumothorax pleurisy with effusion; 2 litres of fluid withdrawn from the chest. A few days later, he was examined with some other patients who had pleurisy with effusions, in order to compare the fluoroscopic signs seen in his chest with those observed in the chest of these latter patients. To my surprise, I found that X-rays showed that A.B. had a pneumo-hydrothorax, but careful physical examination made on the same and on the following days failed to give succussion or the coin sound. The front of the chest, however, below the level of the nipple, when the patient was in a sitting position, was flat to percussion, but the same area gave good resonance when the patient was in a prone position.

Bergonie and Carrière (120) in a paper on Pleural effusion, (See Ref. 105. ? date) "M. Mignon says that in hydro-pneumothorax, 'the movements of a patient cause an agitation of the dark surface of the liquid'. We have never been able to get this 'wave light' movement in any cases we have examined."

Comment: One can only suppose that MM. Begonie
and Carrière had never seen a case of the kind referred to. I suppose a pneumothorax limited to the apical region or so of lung and accompanied by a pleural effusion at corresponding base may have confused them. But I think it quite safe to infer that had they examined a generalised pyo- or hydro-pneumothorax they would not have put on record the above sentence. Personally, I have never seen anything more pleasing or pretty or striking in the way of medical signs than the movements of fluid in such a case and under such circumstances.
Bouchard (121) December, 1896, writing in Comptes Dec. 28, quotes a case of a child in whom a tumour to the left of the spine was due to adenoma of bronchial glands. Bérangonié confirmed (Gazette des Hôpitaux, 7, 1. 97) this.

Béclère, Oudin and Barthélemy (122) at the Paris Hospitals Medical Society, 1897, showed a case of bronchial and tracheal glands (radiograph of thorax) in which X-rays made it evident that besides the retro-sternal mass, which is alone capable of diagnosis by ordinary means, there were deep in the substance of the lungs around the roots, numerous other masses, on one side extending along the ramifications of the bronchi.

Walsham (123) in an address to Rontgen Society, Feb. 1st, 1900, said that although Prof. Bouchard said large bronchial glands were discoverable by rays, he himself had not succeeded in seeing them by the rays, for he had especially examined a case with all the classical signs and symptoms of enlarged bronchial glands with Eustace Smith's sign well marked; except for some slight broadening at the base of heart, chest appeared normal. Dr Walsham added that since the above was written, Dr Habershon had shown Walsham a typical example,
leaving no doubt, that X-rays would diagnose the condition.

Beale and Walsham (124) referred to Professor Bouchard and Claude's saying that enlarged bronchial glands, especially in children, are easily distinguished.

Houllin (125), in address to Roentgen Society, July 4th, 1899, said mediastinal glands can be photographed.

Walsham (125a) showed skiagrams of enlarged bronchial glands at British Medical Association Meeting, August 1899.

Dr T. Glover Lyon (125b) showed a case in which screen indicated indefinite shadows of enlarged bronchial to either side of heart shadow, and so confirmed a doubtful diagnosis.

Beale and Walsham (126) At the Medical Society of London, Jan. 14, 1901, said enlarged and caseous glands cast recognisable shadows.

Béclère (127) shows bronchial glands as some broadening of the shadow at base of heart.

Walsham (128) Feb. 2, 1901, showed some valuable photographs of Mediastinal tubercular glands.

Walsham (129) in an adult and Payne in a child, show plates of enlarged tuberculous glands. This Dr Walsham referred to in Present-day Skiagraphy at St Bartholomew's.

Williams (129a) In some cases of pulmonary tuberculosis, shadows of enlarged bronchial glands can be recognised.
Enlarged bronchial glands and disease extending into lungs. An X-ray examination may be of value in such a case in early stage, when no other methods will serve. Successive examinations will show whether or not disease be progressing. One case indicates that disease originating in bronchial glands may be shown to have ascended into the lung, and that this may be more easily shown by X-rays than by other methods.
NEW GROWTHS

Dr H. Campbell Thomson (130), in September, 1897, quoted a case of new growth displacing heart and origin of aorta.

Leo (131) Berlin, Klin. Woch. 18. 4. 98, described a case. A boy, aged 10, leg amputated for sarcoma. Six or seven days later, dry cough; sixteen days after operation, pain in left side of back. No physical signs. Six weeks later dyspnoea. Percussion note dull about angle of left scapula, and this was spreading. Percussion note impaired below right clavicle, with bronchial breathing.

Post Mortem: five tumours found in periphery of left lung beneath pleura. In right lung a mass as big as a fist, and also smaller nodules of bony and soft tissue. Photograph taken two days before death showed distinct shadow between ribs abutting on cardiac shadow, and with irregular limits. This on the left side. On right side there was a deep oval patch about the size of a fist, much larger than the physical signs suggested. Post mortem showed osteo sarcoma.

As to diagnosis, the photograph was of more use than the physical signs, although the diagnosis was already certain. No doubt X-rays may diagnose a tumour when percussion shows no abnormality.

Moullin (132), 1899, said intrathoracic new growth can be photographed.
Dr. J. Magee, Finny and Watson (133) maintained new growths could be diagnosed, and in some cases limits of a new growth could be shown by X-rays.

Case. Clinical diagnosis inclined to sarcoma. Skiagraph showed whole side more or less opaque— which might be due to pleural effusion alone. Closer inspection of skiagraph showed an ill-defined mass corresponding with deeper shadow in lower half of screen. Subsequently fluid was drawn off—and later on X-rays showed tumour definitely outlined.

Beale and Walsham (134) at Medical Society of London, 14.1.01, said the most important use of X-rays in chest disease is in the detection of new growths and aneurisms.

Williams (135) said new growth is often difficult to determine presence of by physical signs. An X-ray examination would enable one to detect growth earlier and to determine its position and size.

Moollin (136) A new growth in lung usually casts a marked shadow and in later stages may fill up most of one side of chest, and so render the side completely dark on screen. If new growth recognised early, shadow may be slight. In some cases X-ray examination soon makes presence of a new growth evident, although unsuspected by physical examination. Where it involves a large part or the whole of one lung, screen appearances might at first sight call to mind pleurisy with large effusion or unresolved pneumonia. Sometimes a new growth may simulate an aneurism.
Therefore if interpretation of screen appearances be not quite plain, patient should be examined with rays going through the body from different directions, and sometimes an X-ray photograph should be taken. Physical signs and history must be carefully considered. Williams has no doubt that as we learn to make and interpret X-ray examinations, the latter when the question is one of new growth, will aid us to make a more definite and earlier diagnosis than has hitherto been possible. If ordinary methods have been used, and the case does not seem to be obscure (although symptoms not wholly characteristic of new growth) or if diagnosis picture is incomplete, an X-ray examination should be made for confirmation or refutation of diagnosis.

One case sent to Williams with reference to early pulmonary tuberculosis, was carefully examined with screen and tube in different places, and careful tracings indicated a new growth - examinations, made from different sides, confirming each other, and giving indications of size, position and movement of the dark mass. The well-defined, rounded outline of mass suggested an aneurism, but an aneurism of such extent would have been accompanied by heart changes, which were not present.

Another case had been diagnosed as pleuritic effusion. Here X-ray examination showed whole of right chest dark throughout, as well as much of upper por-
tion of left chest, the only outlines visible being those of left diaphragm and a part of the left and lower border of heart. X-ray examination at first suggested pleuritic effusion, but a more careful study of screen picture suggested the possibility of another solution. Darkened right side suggested pleuritic effusion, and shaded left apex pulmonary tubercle. But in so large an effusion one would have expected a greater displacement of heart to the left, and also the left diaphragm to have been seen lower in chest than in health because pushed down by organs displaced to left by effusion — whereas left diaphragm was normal. At this time there was no fluid present. Six months before there had been some bloody fluid. The case was twice operated on.

X-Ray appearances of an extensive new growth and interstitial fibrous pneumonia compared. In one case of the latter left chest was dark throughout, but rather lighter below than above. Outline of left diaphragm not seen. Left border of heart barely seen.

In a case of malignant disease of abdomen, a suggestion of possible extension to lungs was nega-
tived by rays.
SOME GENERAL OBSERVATIONS

Crane in: Walsh (137) a faint reflex without the presence of pulmonary shadows, which is probably due to a dilated tube in bronchiectasis.

Dilated bronchus with consolidation could not be distinguished from a small cavity, unless by a longitudinal form.

Bauchard and Claude (138) Paris, 1898, Nontuberculous pneumatic foci cause a slight opacity, but according to Maragliano this becomes less marked on deep inspiration. On the other hand, foci of pulmonary sclerosis, like patches of tubercular infiltrations, do not become clearer on deep inspiration.

HYDATIDS OF LUNG

Walsh (139) Pulmonary echinococcus has been noted.

Tuffier (139a) in 1901, said in hydatid cyst, skiligraphy will probably fail to reveal the lesion.

Williams (140) Levy Dorn and Zadek (Berlin klin. Woch., 15. 5. 99) discussed the case of hydatids in a robust man who had been a butcher. In 1897 the man had dyspnoea, haemoptysis, expectoration of pus sometimes blood-streaked, no tubercle bacilli. In 1898 there were echinococci in expectoration.

Percussion and auscultation was not decisive. X-ray examination showed on right side a shadow about 5 c.m. long and 4 broad, with a light interior and a dark edge, connected to the diaphragm by a short streak
apparently drawing diaphragm up and making it unable to act as well in full inspiration as left diaphragm. 

In left lung there was an oval black shadow about the size of a plum. Both shadows were central. The conclusion was two separate areas of echinococci, one in right and one in left lung. Their central position explained the negative result of percussion. As the middle portion of area in right lung was light, probably the echinococci had been absorbed on that side and left the cavity filled with air, but echinococci were still present in left lung as indicated by dark area.
Waldo (141) mentions a case of cirrhosis of the right lung with displacement of the heart, described by Waldo, of Bristol. In a boy of 10, with good family history, heart's apex beat outside the right nipple - the whole of right lung impaired to percussion - no T.B. found in repeated examinations. The Röntgen rays showed great density of the affected lung and absence of the heart in left thorax.

SURGERY OF THE LUNG

Tuffier (142) in an article relating to cavities, etc., says he believed that in many cases where diagnosis doubtful, or where auscultation signs do not give reliable results and fail to localise with precision the pulmonary cavity, the rays will show the condition on the screen. Interlobular collections inaccessible to the usual methods, may thus be diagnosed. In a case of gangrenous abscess of the superior lobe of the right lung, in which, as usually occurs in cases of this kind, the stethoscopic signs are negative, Tuffier by the aid of radiography, discovered and opened abscess. It is said instances might be multiplied. A Röntgen examination will in most cases of multiple cavities reveal them all, and so prevent the surgeon from acting under the impression there is only one. Radioscopy is not an infallible means of diagnosis. In cases where presence of cavities rendered certain by auscultation, X-rays may
give a negative result. This is not surprising, specially if lesion be situated in lower part of lungs, near abdominal organs which are too thick for rays to readily traverse them. Radioscopy picture does not represent exact size of cavity, but only the extent of surrounding zone of sclerosed tissue. Tuffier has much faith in the prospects of radioscopy in the surgery of the lungs, and thinks that with improved apparatus minute differences in thickness of tissues would be distinguishable, and so the seat, limits, and probably the nature of pulmonary lesions be determined.

Tuffier (143) in August, 1901. Diagnosis and localisation of pulmonary lesions is often very difficult and skiagraphy should be used in every case. When skiagraphy confirms percussion and auscultation, one must act on its indication as it is then only an additional security. When its results are not in accord with those of pleximeter, it is held that the surgeon should be guided by the skiagraph and attack the obscure point indicated by it. If X-rays give negative results, specially if in left side of chest, they should be ignored and sole trust placed on percussion and auscultation. It is probable that cardiac shadow may obscure pulmonary lesion. In the most successful cases of skiagraphy of chest, it would fail to indicate nature of lesion, or even to show whether disease were single or multiple.
Walsh (144) "The localisation of diseased areas in the lung is now brought within the reach of the surgeon, who hitherto has been hampered in his attempts at lung surgery by the often misleading nature of physical signs. Supposing a shadow to be fairly defined, its exact position could, of course, be localised by ordinary means. The altered density of tissues may show in varying degrees from a slight haziness to a dark shadow; when extremely dark it is usually due to pleuritic thickening and adhesion. Williams (145). The more exact location of an abscess in the lung, or of a circumscribed gangrenous area, will no doubt aid the surgeon in operating."
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HEART, etc.

After quoting some statements as to the normal appearances presented on X-ray examination, by the pericardium, heart and great vessels, I propose to, as far as possible in historical sequence, refer to a number of opinions, some of very little, others of more considerable, value, expressed on the use of X-rays in cardiac and allied diseases. Thoracic aneurism is referred to under a separate heading.

Walsh "With the fluoroscope on the front of the chest, the position and outline of the heart is materially altered by deep inspiration. The normal state of affairs is thus well described by Dr F. H. Williams (Montreal Meeting, British Medical Association, B.M.J. 16. 4. 98) 'In health the outlines seen on the left of the sternum are as follows: — A part of the aorta in some patients may be observed in the first intercostal space; in the second intercostal space a portion of the pulmonary artery; the left border of the ventricle is seen in full inspiration when the apex and a portion of the lower border are also visible; the maximum pulsation is at the point corresponding to the cavity of the ventricle, about where its outline crosses the fourth rib; during full inspiration the heart moves downwards towards the sternum. To the right of the sternum the outline of the large vessels is seen, and, less distinctly, the right auricle between the second and fourth ribs."
From the front, then, the heart shadow fuses on the left with that of the sternum, beyond which the right auricle projects from the third to the fifth ribs; on the right the auricular and ventricular lines run with a bold indented curve from the second to the sixth ribs. This latter line is raised and pushed upwards in expiration. On the other hand, it is elongated and carried downwards and inwards towards the sternum in forced expiration, when a light fine falciform line or a broad band defines the apex and more or less of the lower border. Ordinarily the lower portion of the heart shadow merges into that of the liver.

The shadow of the heart is lighter at the pulsating margin. Between it and the liver, on taking a deep breath, a light interval appears. From the front of the chest the whole cardiac outline can be seen; but much less from the back, as the view is obstructed by the spine. From the back a definite shadow with well marked external border can be seen on the left, and a smaller and less intense shadow corresponding to the right auricle on the right of the spine. Outside the body, the valves of a heart emptied of blood can usually be well seen. Sometimes the valves, particularly on the right side, can be seen in situ in the living subject. "

Crane

Walsh (2) To the lower left side (of thorax) the shadow of heart stands out in bold relief, the apex lying at middle of left diaphragm, and the
base at the middle point of the thorax. (Comment: I suppose one must try to imagine what the middle point of the thorax would be.) To the right a narrow strip of the right auricle and ventricle can be seen. The contraction of left ventricle with the peculiar retracing movement of the apex may be well observed. Pulsations of right auricle and of either ventricle can also be distinguished. If the tube be at the level of the diaphragm, the clear pericardial space between apex and diaphragm is seen during deep inspiration. The aortic arch and pulmonary vessels occupy the space between the base of the heart and the sternal ends of the clavicles. The heart is best studied from the front and the great vessels from the back of chest.

Dr. Mackintyre (3) in 1896 saw the cardiac area, and also photographed a heart in not more than eight minutes' interrupted exposures.

The Lancet Office (4) in 1896. A case of arterio-sclerosis was examined. Intensely dark stripes were visible in region of coronary arteries indicating calcification in the horizontal as well as in the perpendicular position. Just above the heart, a very dark and broad moving shadow was visible, twice as broad as normal shadow of aorta. In two cases of mitral insufficiency, the heart being enlarged to
percussion, enlarged shadows of heart were seen. On, however, of these cases, with high tension pulse, showed much hypertrophy of left ventricle and enlarged aortic shadow. The other showed no such hypertrophy nor enlargement of aortic shadow, nor, clinically, was there increase of arterial tension. The first case was one of arterial sclerosis - the second one of morbus cordis from rheumatism. (Comment: The Lancet Note strikes me as somewhat confused)

H. Campbell Thomson (4a) in a letter in 1896, referred to the difficulties of photographing the heart, and said he considered them too great to allow the process to be of much value. He, however, stated that the screen overcame many difficulties, and a tracing, as he had shown before, could be taken without much difficulty. He thought the use of X-rays in examination of the heart would, taken in conjunction with routine methods, probably be of value. He had never seen any diminution of size of the heart under the influence of the rays as mentioned by Dr Bezley-Thorn.

Dr Mackintyre (5) in Nature in 1896, referred to having demonstrated changes in heart, as to position and shape, by X-rays or the new photography.

Sydney Rowland (6) in 1896, stated that much had been recently said re thorax and X-rays in relation to diagnosis of heart mischief, that it was true that a skiagraph of heart could be obtained, but only as to its outline, and percussion was just as good.

Sydney Rowland (6) in his Report to British Medical Journal on the application of the new photography to medicine and surgery (1896) included a
letter from Dr Bezeley Thorn, who considered that unless the process should undergo remarkable improvement one must not hope for too much in regard to observations on the heart. Whether the rays approached heart from front or back, the spinal cord made an obstacle concealing some of the parts of greatest interest and importance. One must also consider the different density of different tissues. The ventricles offered a sufficiently resisting mass but the auricles, especially the left, were easily penetrated so as to leave no impress on the plate. This would perhaps be overcome by experience, but the difficulty arising from the movements of the heart could be overcome by instantaneous photography alone, "as they impart to the marginal image a nebulous character incompatible with accurate observation." He also mentioned shrinking of the heart after 30 minutes' exposure. "Radiography is likely to yield results of academic rather than of clinical value."

Dr Ewart (?) in 1896, said that for some years he had practised posterior percussion of the heart, and that he now found akiography closely, but not absolutely, agreed with it.

Walsh (?) refers to statements by Mr Bezeley Thorn in the British Medical Journal, October 24th, 1896, Vol. 2, p. 1238. The latter noticed heart shrink visibly after 30 minutes' exposure to X-rays. In one case it shrunk two inches in the long axis, and one and a half inches in the short diameter.
He thought the appearance might be fallacious, and might be due to alteration in the current or to increased exposure being attended by increased penetrability, so that the appearance of a light zone towards the end of exposure might mean that the muscle was more fully penetrated, or else might indicate change of electric conditions. In either case, the dark core would probably represent blood or muscular tissue or both. If actual contraction were proved the fact might be useful. It might be due to direct contraction of the heart muscle—"while traumatic injury to the deep organs from the Rontgen exposure might be connoted."

The Lancet (9) stated that dilatation of right heart could be recognised.

Von Dr Med Georg Rosenfeld (1897) (10) estimated the size of heart by metallic buttons placed on chest—hypertrophy of left ventricle and dilatation of right heart could be seen at once.

During inspiration heart does not descend the central tendon of the diaphragm.

Walsh (11) says that as the result of experiment "Püch demonstrated in January, 1897, to the Vienna Gesellschaft, that it is possible in the empty heart to make out the valves and trabeculae as clear spaces against a darker cardiac background. When, however, the heart is full of water or of blood no such differentiation can be made."
Walsh (12) Dr Disam, in Dominion Medical Monthly for February, 1897, introduced an ingenious method of recognising alterations in the cardiac outline. First of all he marked out on the chest what should be the normal shape of the heart, and mapped out the area thus obtained with a copper wire, which he fastened to the chest with ordinary plaster. He then examined with the fluoroscope: 'at first the greatest strength from the apparatus is turned on. The observer then looks through the fluoroscope, and gets the chief landmarks of the chest, such as the scapula, ribs, spine, and convexity of liver - the wire being at the same time in view. The current is then reduced until the heart becomes visible. The fluoroscope is applied to the spot, marked at the left of the spine, corresponding to the fourth intercostal space in front of the chest.'

Dr G. M. Low, (13) at the Nottingham Medical Chirurgical Society, stated that he found X-rays of use in diagnosing enlargement of heart.

Bouchard (14) demonstrated by radioscopic expansion of right auricle during inspiration. The case was that of a girl with slight right pulmonary tuberculosis. A convex projection was thrown on screen at definite intervals to the right of the vertical column shadow and in the place corresponding to shadow of heart on left side. The shadow in question came to the right when the liver sank and returned when it rose.
By turning the patient somewhat, so that the left shoulder was in the rear of a line through transverse axis of pelvis, and the mass of auricles and also their movements were better seen. Increase in size of the auricular mass during sinking of liver, namely inspiration, was well made out. In two other tuberculopus cases Bouchard failed to see these phenomena. He also examined two women with asthma and was able in one to demonstrate an increase in size of auricle which brings about a slight diminution in the intra-thoracic pressure during inspiration, and so at once causes an influx both of blood and air.

Bouchard (15) at a meeting of the Academy of Sciences, said the existence of a marked dilatation of the auricles (when the intra-thoracic blood pressure is raised during inspiration) could be asserted, he also said he had discovered the existence of a clear horizontal space in forced inspiration between the shadow of the heart and that of the diaphragm, while during normal inspiration no space was visible. The phenomenon was remarkable, considering the diaphragm and pericardium are attached to each other, and was thus explained by Bouchard: - During the forced descent of diaphragm with a large inspiration, the inferior surface of heart is in contact with the diaphragm to a very limited extent. The pericardium tucks itself into the space existing between itself and the heart, forming in front and behind a gutter into which in turn the pulmonary tissue is pushed, thus forming a
layer of tissue much more penetrable to X-rays than the tissues making up the heart and diaphragm.

Walsham (16) in 1893 said he thought the rays would not be of much use in heart disease.

Hoffman (17) in 1899, referred to cardiac arrhythmia (In Deutsche Med.Woch. April 13th). Cardiac movements can be seen well in lower third of left border of heart. Arrhythmia well seen. Most frequent forms of irregularity are pulsus bigeminus and pulsus alternans. Clinically it may be difficult to recognise if alternate and unequal beats do not reach the radial, as sometimes the heart's apex beat is not to be seen or felt, and sometimes auscultation may fail to help one.

Case. Man, aged 26. heart's apex beat not seen or felt, pulse 70. After 14 days' illness, pulse 40. Even with phonendoscope the beat represented by very feeble sound only, and with no corresponding pulse at the wrist. X-rays showed very weak contraction, and the movements at the left border of the heart could be easily seen. Sphygmographic tracing gave no indication of the dropped beat. The case might be called brady-cardia. A few days later the pulse was 80.

Williams (18) stated that pericardial effusions, dilatation, hypertrophy and atrophy of the heart accompanying some forms of anaemia, are easily seen, as also is the enormous enlargement of left ventricle in aortic insufficiency.
Moullin (19) in Presidential Address to Rontgen Society of July 4th, 1899, said the changes in the position of the heart and in the size and shape of its chambers, whether brought about by disease or by strain thrown upon the walls, by difficulties in connection with distant vessels, could be distinctly seen and watched from day to day, especially easily in those cases in which, owing to the presence of emphysema and absence of cardiac dulness, the ordinary tests failed to give any information.

Schuster (20) referred in 1899, to his having employed X-rays extensively in his practice at Naunheim, and stated that there were various inferences to be drawn from the character of the heart's shadow and also from its relation to shadows of the vertebral column, sternum, diaphragm and ribs. The rays show heart not to be resting on diaphragm, but to be supported by the large vessels. Normally a free space exists between diaphragm and heart during inspiration. Benedikt first noticed this, and noticed that in enlarged hearts this space is obliterated, and also that when adhesions occur between the pericardium and diaphragm, the former cannot move independently of the heart. Sometimes the exact position of the heart is important, namely in transposition of the viscera and in displacement by fluid or growth, as also is the point whether the enlargement is vertical or horizontal chiefly. The extent of shadows gives
the proportionate size of heart, but not always the exact cardiac dimensions - "the heart is not as large as its shadow." It was further found that the further the plate was removed from the tube, the more nearly did the shadow coincide with the actual size of the heart. It is only by comparing, with the help of certain fixed points, the relationship between the various shadows caused by the heart and the structures in the immediate neighbourhood, that the real size of the heart can be ascertained. Such a fixed point is the nipple made prominent by attaching a penny to the skin. The spinal column and sternum give the most prominent shadows. Normally the right side of heart extends one third from mid-sternum, while the left side extends two thirds from mid-sternum. The increase in size of the heart cannot be measured in centimetres, but can be seen in photograph. The cardiac movements can be observed and so it is often possible to determine the strength of cardiac muscle. One can also make out large blood vessel abnormalities, as persistent ductus arteriosus or even the sclerotic changes in coronary arteries (which Schreiner apparently included among the large number of comat).---

Bergonie and Carriere (20a) pointed out that the heart was lowered 2 or 3 c.m. in inspiration (Paper on pleural effusions referred to earlier).

Walsham, (20b) in Address to Rontgen Rays Society, of February 1st, 1900, said he could never
satisfy himself that the clear space between heart and diaphragm had any existence.

Walsham and Beale (21) in 1901, said that in heart disease the rays seem of less value than in pulmonary disease, but admitted more observation was needed.

They also referred to certain faint streaks near the left side of the heart, and on both sides of the mediastinal shadow, and said they were due to junction of the pericardial and visceral pleura (Jan. 14, 1901, Medical Society of London).

Williams (22) In X-Ray examination it is possible to determine the borders of the heart more accurately than it has been possible hitherto.

Mignon (23) Heart shadow, apart from pathological displacements, is not always the same. Its position differs with the patient's recumbent or standing posture. Others say that no two heart shadows are alike.

Mignon says volume of heart cannot be estimated by screen examination only. Shadows (which some call light shadows by preference) are seen corresponding to the borders of pericardium.

Beclere (24) shows figures of pericardial effusion.

Walsh (25) Grunmach by the fluoroscope traced the action of digitalis on the heart in aortic and mitral insufficiency and other conditions resulting in cardiac dilatation and hypertrophy. He also suggested
that the action upon the heart of various medicinal and toxic drugs might be studied by X-rays.

The Schott plan of treatment in heart disease can be followed by rays. Dr Dawson Turner radioographed injected vessels of human heart. Professor Benedikt, of Vienna studied heart and noted that in cardiac systole there was a shortening between the base and apex, and concluded there is only a systolic lateral apex impulse. During systole the heart is not quite emptied of blood which casts a shadow. The bloodless heart is relatively transparent but even then layers of blood cast a shadow.

"Hypertrophies of the heart are readily examined on the screen. In those of the left ventricle the apex elongates, and the clear space usually seen between the heart and the liver on deep inspiration is either diminished or disappears altogether. The screen phenomena of right sided hypertrophy are thus described by Regnier: 'In hypertrophy the right ventricle of the heart drawn down at the base, tends towards a horizontal position. When the right ventricle undergoes excessive enlargement, there may be twisting around the longitudinal axis of the heart, and the right ventricle is pulled to the front. There may be also a twisting of the heart around the vertical axis of the body, the base being directed backwards, and the apex to the front. This twisting is
visible when one examines the patient from the left side: the cardiac cone is then sharply shown in its whole length.' (Radioscopie et Radiographie cliniques Dr. Regnier) Regnier saw under Prof. Potain, a case in which acute dilatation of the heart was registered on several Rontgen photographs, "which, in spite of their want of sharpness, nevertheless enabled one to follow the gradual disappearance of the dilatations and to preserve a graphic record of the occurrence."

Crane in Walsh. The heart can be outlined by X-rays with a precision unequalled by any other method. Hypertrophy, dilatation or aneurism of either auricle or ventricle may be perceived and measured. In marked distension of right ventricle, apex may be tilted upwards so that a space is left between the tip of the heart and diaphragm. In dilatation of left ventricle, heart's apex beat becomes nearly indistinguishable. Rarely a calcified valve may be seen.

A vigorous cardiac reflex indicates a good tone of the heart muscle and is worthy of careful study. In examining the heart, its visibility, position, size, form and movements should be carefully kept in mind.

Pericarditis with effusion shows well. The space between the heart and diaphragm is obliterated, even by a very small effusion. A large effusion will show a faint outline of heart within a large ring.
A distended pericardium gives a ringed appearance. An aspirating needle is clearly visible behind the screen, and may be accurately guided into the distended pericardial sac.

I include at this place Crane's third Chart in Walsh, P. 286.
CHART III

Visibility

- Increased
  - By deep inspiration
  - By emphysema
  - By cardiac hypertrophy
  - By cardiac dilatation

- Decreased
  - By deep expiration
  - " adjacent pulmonary shadows
  - " oedema of emphysema of lungs
  - " generalised thickening of pleura
  - " Empyema or effusion
  - " Very thick chest walls

Displacement

- To Left
  - Emphysema or effusion R. side
  - Tumour or aneurism R. side
  - Cirrhosis of L. lung

- To Right
  - Emphysema or effusion L. side
  - Tumour or aneurism L. side
  - Cirrhosis of R. lung

- Downward
  - Hypertrophy
  - Aortic aneurism

- Transposition - Congenital

Size

- Increased
  - Hypertrophy
  - Dilatation
  - Pericardial effusion (apparent)
  - Cardiac aneurism

- Decreased
  - Senile atrophy
  - Congenital lack of development

Form

- Irregular
  - Aneurism of auricle or ventricle
  - Dilatation of single auricle or ventricle

- Rounded
  - Senile atrophy
  - General dilatation
  - Pericardial effusion

Pulsation of Auricles

- Increased
  - Auricular dilatation
  - Aneurism

- Decreased
  - Old age
  - Debility

Pulsation of Ventriles

- Increased
  - Apex beat
  - Certain diseases & drugs

- Decreased
  - Dilatation
  - Pericardial effusion

Heart reflex

- Increased
  - Hypertrophy
  - (and Dilatation of R. ventricle)

- Decreased
  - Senile atrophy
  - (lack of development)

Heart reflex elicited by rubbing skin over heart by a blunt instrument.
Walsham (26). Present day Skiography at St Bartholomew's. In enlarged heart of chronic Bright's the apex beat displaced out and down, and also sometimes commencing dilatation can be well seen.

In mitral stenosis the heart takes a peculiar shape which may be differentiated by the screen. It is 'purse-shaped', this being produced by hypertrophy and dilatation of the right side of the heart over and above that of the left.

As to whether it will be ever possible to show valvular disease, it is extremely doubtful. All Walsham's attempts have failed so far. Outside the body the calcareous valve shows distinctly enough. The systole and diastole of the heart is clearly seen, and in some cases, specially in thin persons, the systole and diastole of the auricles can be made out.

Walsham has attempted in many persons with reduplicated second sounds, to demonstrate any difference in the systole of the two ventricles, but up to the present has not been able to differentiate the systole of one from that of the other. (1901)

Williams (27) To determine the borders of the heart, the lungs and pleuræ must be clear. Thus:

If the lower left lung be dense, the left border of the heart cannot be distinguished. In a considerable left pleural effusion, it is impossible to determine the left border of the heart.

The heart may be examined if the patient is standing, sitting or lying down.
If lying position be used the patient should be flat on his back exactly in the middle of the canvas stretcher used by Williams; the position of the vacuum tube being determined by plumb lines; and the target placed under the stretcher about 30 inches from the screen. A level may be placed across the sternum to make sure that one side is not higher than the other. The screen is on the front of the thorax.

**Appearances seen on the screen.** The heart hangs in the thorax resting in inspiration on the diaphragm, so that its long axis is at an angle with the median line of the body. (Comment: Query, is the sagittal plane meant?) On a deep breath being taken, the outline of the heart can be seen most fully (as Williams pointed out in 1896), the heart moving down and in, the whole of the left border being clearly seen and the right border also becoming visible to the right of sternum. That is, the inclination of the long axis of the heart becomes more horizontal as the diaphragm rises in inspiration, and more vertical as the diaphragm descends in deep inspiration, this latter change occurring most during the later part of the diaphragm’s descent, when its pull on the pericardium is stronger and the lungs distend. At this latter part of inspiration the transverse line from the heart is somewhat lessened, and its pulsation is of smaller amplitude.

In quiet respiration in some people both borders of the heart can be well seen and the organ be measured.
Where the borders cannot be well seen at this time the left border can first be traced, and after a little further inspiration, but before full inspiration is reached, the right border.

References to an X-ray photograph (taken during full inspiration) by Williams. (It should be noted that for X-ray photography the heart pulsations diminish the sharpness of this organ)

On each side of the heart's shadow may be seen the shadow of the pulmonary vessels with a general direction of downwards and outwards. In the negative, on the right side, above the level of the heart, could be distinguished the outline of the outer side of the superior vena cava, and within it that of the ascending aorta - the descending aorta also well seen. In the photograph nearly the whole of the outer curve of the ascending transverse and descending arches of aorta could be followed (1899).

Levy-Dorn, in 1899, showed two pictures of the heart, one in deep inspiration, the other in forced expiration, indicating that the diameter of the heart is greater in expiration.

The pulsations of the heart seem less marked in full inspiration than in expiration, or quiet inspiration.

The pulsations of the left border of the heart are seen best in full inspiration - the screen thus shows that the outline is changed chiefly over the cavity of the left ventricle towards the base of the
heart, and that the apex is but little shortened. Pulsations of the right ventricle may be followed when its border is well defined in full inspiration, and sometimes in the inspiration of quiet breathing. After a full breath has been held, the pulsations of the ventricle are not only more rapid, but more ample during succeeding expiration. The right auricle casts a faint shadow and with a good apparatus its pulsations may be followed in a thin healthy person, but not so easily as if emphysema be present or the auricle distended by disease.

Heart's apex beat. The impulse felt on the chest wall is not always the beat of heart's apex. By X-rays the anatomical apex beat is sometimes seen lower down than where the impulse is felt.

Where the heart is displaced to the right, the impulse felt to right of the sternum and attributed to the apex is, in some instances, a blow from the right ventricle. One would have thought that the term apex beat as applied to the pulsation in question would, to most people, not be supposed to indicate clinically what Williams seems to mean by it.  

Appearances on screen to right of sternum. These are apt to vary and to be puzzling. The shadow of the blood vessels may be seen in expiration, but the right border of the right ventricle shadow is not always seen.
Williams has studied the position of the blood vessels and the borders of the heart at autopsies, and measured the position of the organ after death, but the number of his cases was too small for positive conclusions. The measurements he obtained compared with appearances he has seen on the screen show the position of the right border of the heart with reference to the sternum to vary in different people, and under different pathological conditions following disease in the heart itself or neighbouring organs.

In a case with a normal chest, he found the heart, after death, was a little higher in the thorax than in life.

Care should be taken to study the screen view and to take measurements at autopsies after the sternum has been removed, and both before and after the pericardium has been opened. The distance from the median line to the border of the heart can be readily found by measuring the distance from a string stretched midway from the point between the clavicles to the pubes. The heart is ordinarily nearer the front than the back, and so the foregoing is the best method of examining the heart. The heart may be examined from the back and from the side and from different directions.

"If the patient be on his right side, his arms well forward - screen applied to left side - vacuum tube so applied that the light is opposite the middle of the right side and the lower border of heart, a
bright area, usually triangular in shape, is seen. (First, so far as Williams is aware, described by himself in 'X-rays in Medicine', Trans. of the Med. Soc. of the State of New York, January, 1898) The triangle is made up of three lines, the base being the outline of the diaphragm—the upper and anterior side, the posterior border of the heart—and the posterior side the outlines of the spine or of tissues immediately in front of it. This triangle is usually closed at the anterior angle. "The outline of the anterior border of the heart may also be followed in some patients, as well as much of the lower and posterior border."

When the patient is examined with the light going through from side to side, a space broad above and narrower below is seen between the anterior and upper portion of the heart and chest wall—it widens and lengthens in full inspiration because the heart moves downwards and the upper portion slightly backwards, as more lung intervenes between the upper part of the heart and chest wall than between the lower lower part of heart and chest wall.

The distance of the heart from the chest wall would prevent an accurate determination of the upper borders of heart, specially in full inspiration.

The width of the dark area at the back of the sternum and above the heart varies with patient's position; it is a little wider when the patient is lying down than when he is sitting, and in expiration
than in deep inspiration. In the same manner and for the same cause, the width of the heart varies.

The heart and blood vessels are farther from the screen when the patient is lying down than when he is sitting up, and so the dark area referred to and the heart cast a broader shadow on the screen when the patient is in the former than when in the latter position. This difference in width, however, may be neglected for clinical purposes if the source of light is at the proper distance from the patient.

Williams states (I suppose he means to imply that he is basing his statement on X-ray work) that for accuracy the right and left borders of the heart should be measured by distance from the median line.

Abnormal Heart. The abnormal heart sometimes gives a more complete outline on screen than the normal one gives. A much distended right auricle is seen if the lungs are clear but often when the right auricle is much distended, circulation in the lungs is such that the contrast between the lungs and the right auricle is not sufficient for their distinction one from the other. In emphysema a distended right auricle may probably be well seen. He thinks the left auricle might be seen under unusual conditions if very much distended. In examining the heart, one should note whether either ventricle is enlarged, whether the right auricle is dilated and whether the heart changes its position in full in-
expiration, and what the changes are. In estimating the enlargement of the heart, one should consider the transverse diameter, and how much relations between the lower border of the heart and diaphragm differ from those in health. In health there is usually a free space between the heart and diaphragm during deep inspiration, the heart being then supported by the vessels and not resting on the diaphragm.

The lateral borders of the dark area above the heart are cast by the blood vessels and soft tissues lying between the spinal column and the sternum. Here changes in outline may be due to early aneurism or to new growths, but often to a deviation towards one side or the other, because of displacement by fluid in opposite dark side of thorax; or if the heart be drawn towards the darker side its displacement may be due to contraction of pleura or lung on that side.

Williams states he devised an instrument to listen to the cardiac sounds while the cardiac movements are followed on the screen; but that a better form of this instrument has been devised by Dr Rollins, and is called a Seeshear. It consists of a fluorescent screen placed above a vulcanite pad of equal size, and separated from it by about one centimetre. A stethoscope is connected with an air space between the plates, so that the chest can be looked at by screen, and cardiac or other sounds listened to at the same time.
METHOD OF EXAMINATION

Light must be of suitable intensity. If it be too bright or too faint borders are ill defined. One must be specially careful in the young as if the light be too bright the heart will cast no shadow.

The position of the patient must be carefully noted in case of future examinations. The patient must be examined lying down or sitting up - sometimes dyspnoea necessitates the latter position.

Care is needed in measuring the width, first in regard to the position of the tube and secondly as to the manner of recording the outline.

The tube must be from 70 to 75 c.m. from the heart to avoid exaggeration of the shadow on the screen. "If the heart be much enlarged, tube should be directly under the left border when that has been determined, and moved to a position immediately under the right border when that is to be obtained." This is unnecessary in the normal heart (Comment: To state that the heart is normal rather suggests begging the question) for the slight exaggeration caused can be neutralised by drawing the outline of the heart's border on the inner side of the shadow instead of on the outer side.

The position of the screen. If the patient be stout or a woman with well-developed mammary glands, so that the screen is some distance from the heart, the size of the organ, specially on its left border, will be exaggerated, that is, the shadow will fall...
too far to the left. Therefore, here the tube may be placed directly under the border to be determined, and this point may be determined by means of indirect plumb lines.

Tracings on the skin or tracing cloth are accurate if the left border extend too far to let the median line of the sternum and the mark indicating the left border be on the same plane. If the border on the measure go round the body, it will make the left border by measurement fall at the greater distance from the median line of the sternum. Here one must measure horizontally out from the mid-sternal line to a line dropped perpendicular on the tracing of left border of heart. If a thin sheet of glass or a transparent film of celluloid be used, the error is avoided.

On the whole, outlines drawn on the skin and copied carefully upon tracing cloth give the best results.

There are two sorts of error to be avoided in measuring the width of the heart, the first being a faulty manner of recording the outline on tracing cloth, the second being due to the position of the diaphragm. (Comment: I suppose what is referred to position in variation of the diaphragm's different phases of the respiratory cycle).

By percussion, too, one must measure the distance from the median line in a plane parallel with the front of the chest, otherwise the source of error
is greater than the corresponding error obtained by X-rays.

Photograph of the heart taken in full inspiration leaves no room for doubt as to X-ray trustworthiness in determining borders of heart, if the photograph be taken under suitable conditions and proper precautions.

Comparative value of radiograph and screen examination of Heart. The radiograph is less good because the pulsation blurs the outline somewhat, and because the changes in position in respiration cannot be studied. The delay for developing plate is also a drawback.

In a considerable number of cases Williams has first determined the borders of heart by percussion and marked them on skin in blue pencil, and then determined them by X-ray examination and marked them with black crayon. On comparison he often found marked discrepancy in one or more borders of heart, and was struck by the more complete cardiac outlines obtained by X-rays.

He has secured from time to time the opinion of other physicians re percussion size of heart, and as yet he has found no one whose percussion, like his own in the same cases, did not give the size of heart incorrectly when tested by X-rays.

In the few cases in which Williams was by autopsy able to compare the size and position of heart, as shown by X-rays, and the post-mortem condition, they agreed, except that post-mortem heart was somewhat
When the heart is normal in size, its border, so far as it is obtainable by percussion, can usually be obtained if the patient be not too stour and if no pulmonary emphysema be present; when the heart is abnormally small or large this condition may be missed by percussion. Thus, by percussion the upper part of the left border of the heart sometimes appears nearer the sternum than the rays show it to be. The X-rays "also show in some cases of a heart enlarged on the left side, that when this organ approaches nearer the side of the thorax than in health, percussion may give dulness closer to the axillary line than normal, because there is too little lung tissue between the left side of thorax and the heart to give the usual resonance to percussion, and therefore the width of the left heart would be over-estimated by percussion." (Comment: The use of the word normal in such a relation seems somewhat inappropriate, but perhaps I misunderstand the author's meaning).

The right border is often difficult to locate by percussion because it lies away from the chest wall; the varying thickness of this wall, too, would affect the percussion results. "In a word, percussion, as a rule indicated what lies near the inner side of the chest wall (but not much beyond, as shown by the failure to determine the cardiac border in pulmonary emphysema); but when a heart is much enlarged to the left, it may lead the practitioner to a wrong interpretation of the conditions present."
A small heart is recognisable by X-rays, as also is the presence of abnormal condition in congenital malformations.

**Displaced Heart.** The heart may be pushed up by the diaphragm when the latter is forced up by gas or fluid in the abdominal cavity, and its axis thus become more horizontal. By physical examination the change may be mistaken for enlargement in the heart to the left, but it would be rightly interpreted by X-rays.

The effect on heart of unequal excursions of diaphragm is to be noted. When the movement of the diaphragm is much greater on the left than on the right side, a change in the position of heart during deep inspiration may be greater towards the right then it would be if both sides of the diaphragm descended normally. An unusual lateral movement of the heart may be due to excursion on one side of the diaphragm being greater than that of the other.

In early pulmonary tuberculosis of one side the heart may at full inspiration be drawn or pushed towards affected side.

In pneumonia the heart may be displaced to one side as well as probably be enlarged.

In aneurism and new growth in thorax or new growth in abdomen, heart may be pushed out of place.

Sometimes the heart is drawn rather than pushed out of place. Its position may be changed by diminu-
tion in volume of one lung as in early pulmonary tuberculosis, or by contraction of one lung and pleura or by pleuritic adhesions.

It is during full inspiration the heart is lower in chest and its axis more nearly vertical than in expiration, but sometimes though excursion of diaphragm be normal the heart in full inspiration is tilted in some peculiar manner, or fails to move owing to the presence of adhesions. Adhesions near upper left border of heart may so hold it that its apex moves upwards and to the left during inspiration, instead of downward and to the right. If adhesions be present, about right lower border, the heart may be suddenly jerked to the right towards the end of inspiration.

The heart may be drawn backward and to the right when the right lung and pleura are affected.

Displacement of heart simulating enlargement by percussion. X-ray examinations show axis of heart to be more inclined in some places than in others, and therefore that the width of this organ, taken in a horizontal line might give too great measurement. A heart whose position has been changed may sometimes be mistaken for an enlarged heart, thus, when the diaphragm is a little higher than normally, the axis of heart may be more horizontal and so the left border be turned more toward the left, and the organ seem enlarged on the left side. This displacement
of heart may be misinterpreted by percussion and a diagnosis of enlargement made when none exists.

In chlorosis percussion may show cardiac enlargement to right and left; and after the patient has improved percussion may show heart to be more nearly normal in size. This apparent decrease in size can be shown by screen to be due to descent of the diaphragm, and consequent change in direction of the long axis of the heart.

In anaemia with constipation the diaphragm will be higher than normally, thus tipping the heart and making it appear to have greater width. (Comment: The conditions referred to in the last two paragraphs under different terms must surely be pretty well identical.)

In four out of seven cases of anaemia Williams found the hearts smaller than normal.

The pulsations of the heart may be followed in cases of irregular action, as in myo-carditis, and may be seen not to correspond with the pulsations of the wrist, some of the ventricular contractions being abortive.

In marked insufficiency of mitral or aortic valves, or of both, excursion of the left border of heart, between systole and diastole is much greater than normal. The two and fro excursion is greater and
length of the heart's border seen moving is much greater.

Slight dilatations of the aorta may be seen in aortic insufficiency, and pulsations of the artery may be observed.

X-ray examinations sometimes show movement of the heart between systole and diastole to be much diminished during a deep forced inspiration, - this may be due to lessened regurgitation of blood, or may show heart to be dilated rather than hypertrophied. He has considered by physical examination that some hearts dilated, and by X-rays has found them smaller in size during forced inspiration than by quiet breathing.

PERICARDIAL EFFUSION.

When the cardiac area is enlarged, one should note carefully whether or not pulsations of left border can be carefully followed; if so, the heart is enlarged, if not, one should think of pericardial effusion, in which the dark shadowed area is rounded and unlike the shadow of the normal heart. Large pericardial effusions increase the shadow of the heart, obliterating the outlines of left border of heart, and also the triangle already referred to. The patient should be examined in different positions. The shadow of the effusion traced on chest wall is a good guide for tapping the pericardium if operation be needed. In small effusions examine the patient in different
positions.

Sitting position - tube behind patient - with screen on front of chest - deep inspiration. The border of left diaphragm is not followed so far towards the median line. If a patient were inclined to one side or the other, the cardiac outline might be modified. Sitting position - light going through from side to side - deep inspiration. The lower and posterior border of the heart should be determined as far as possible. If outline of triangular area formed by this portion of heart be not much enlarged, there is probably not much, if any, pericardial effusion. Recumbent position - deep inspiration - Examine the patient on his back and also on his right and left sides and with the light going through horizontally, the tube being on a level with the heart, to see whether there be any modification of the heart's outline.

Hoffmann (Verhandlungen des Congresses für innere Medicin, 1898) found in four cases of paroxysmal tachycardia (otherwise normal) the heart surprisingly movable.

He also found the heart moved to the left surprisingly little in children; in ten persons in first and second decades, it did not move more than 1.2 c.m. - in adults the movement was from 2 - 7 c.m.
Auscultation and X-ray examination combined may enable one to determine with unusual exactness the site of a murmur, if auscultation be effected after outline of heart has been traced on chest. The combined process may also enable one to recognize that the disappearance of a murmur, due to enlargement of the auriculo-ventricular ring, is coincident with diminution in the size of the heart. Thirdly it may let one recognize that murmurs present when the heart is pushed out of place, disappear when pressure is relieved.

Fluoroscopic examinations aid auscultation in determining the position of heart with reference to anterior thoracic wall in inspiration and expiration. Thus, when the lower border of heart is farther from the chest wall than usual, we find murmurs heard less distinctly than we would expect, below the line where heart and chest wall separate. By fluoroscopically determining the exact position of the heart in the thorax, the reason why heart sounds are transmitted more distinctly in one place than in another becomes clear, namely, we find that in one case the heart is near the chest wall, and the other far away.

Fluoroscopic examinations in cardiac disease show some of the outlines of ventricles, auricles, pulmonary artery, vena cava, vary from the normal as would be expected.

Zinn (Deutsche med. Wochenschrift No. 8 Supplement, pp. 41, 42. 1898,) describes diagnosis of
persistence of ductus arteriosus Botelli, and says the chief interest lies in the fact that the widening of the pulmonary arteries established by percussion could be seen on the screen and radiograph.

The progress of improvement in heart may be watched by X-ray examination during treatment. Improvement is indicated on the screen in two ways. (1) The size of enlarged heart lessens, (2) the lungs gain in transparency as oedema or congestion is lessened. Hoffmann found in some cases of mitral insufficiency that the width of the heart was 18 or even 20 c.m.; in one case it went from 18 to 16 c.m. and later returned to 17.2. He also found in normal men of 20 to 40, the width of the heart varied from 14 to 15 c.m., but in older men, the average width was usually greater.

The rays, by showing the lower portion of the lung to be dark, may indicate the further use of digitalis, where otherwise this may seem unnecessary.

Murmurs due to inefficiency of the muscular wall may disappear as the heart lessens after rest, etc., and by X-rays one may watch this process. A Warning of the patient's serious condition given by X-ray examination.

Case. A woman of 55 came to Hospital as a case of myocarditis. She was X-rayed. Pulmonary areas were so dark as to let outlines of heart be seen only very dimly, and the diaphragm outlines be seen only on right side and in full inspiration. The heart
was much enlarged to the right. Warning given caused the patient to be put on the Danger list. She died suddenly six days after. (Comment: One cannot help wondering whether equally valuable information could not have been obtained by clinical means, subjecting (possibly) the patient to less physical disturbance. There seems to me a great lack of details.)

In cardiac as well as in renal diseases, want of clearness, specially in lower portion of lung, will indicate early need of suitable treatment in the way of remedies to supplement inefficient action of the heart.

X-rays may show how much increased density of the lungs there may be owing to passive congestion or oedema, without well marked auscultation and percussion signs.

In certain conditions of diseases of the valves of the heart, the pulmonary circulation may be so much obstructed as to darken lungs.

Passive congestion has sometimes been shown to be absent in cases of cardiac disease, where clinically it has been suspected.

In one case X-rays showed enlarged heart and the patient utterly unfit for the severe life he was proposing to engage in. (No reference to physical signs)

In reference to over-taxing heart and the advisability of an annual examination, Williams says such examination would be even more useful now, "for by
means of X-ray examinations we are able to give earlier
warnings of some diseases of the chest than it has
hitherto been possible to give.
On this subject, again, I have collected a series of statements and opinions from the literature, and these, as far as possible, I give in historical sequence, apart from all reference to their relative values.

Campbell Thomson (28) in 1896, stated that by screen, many difficulties such as exist in aneurism of the heart and the first part of the aorta could be cleared up.

Again (29), later in the same year he referred to cases.

**Case.** A man of 40, had pain in the left side and occasionally in the back, which Drs. Coupland and Wheeler said was probably due to deep-seated aneurism. Physical signs were some impairment of resonance in inter-scapular region, with a blowing systolic all over the same region, its point of maximum intensity being to the right of vertebral column. Another physician thought the evidence insufficient to say so much. X-rays found the heart slightly hypertrophied and just above the junction of the left border with the sternum, a faint indefinite shadow, this from the front. The view from the back was better. The shadow of the heart appeared as usual, but just above it was a very definite shadow seen on both sides of the spinal column, and about on a level with the fourth dorsal vertebra - on the right side its border was convex and pulsating, and in intensity it was
a little lighter than the heart's shadow - on the left side the shadow was faint and its margins not so definitely made out. The X-ray appearances combined with the physical signs, made the diagnosis certain. Still more, a diastolic murmur appeared later.

Later on he examined two other cases of aneurism with equally satisfactory results. (30)

In the same number of the Lancet, it is stated that atheroma and aneurisms of the aorta can be recognised.

Walsh (31) quotes Bouchard (Comptes rendus 28, 12, 1896) who said aneurism of the aortic arch, with a clear view as to position, outline and size, could be well seen.

Walsh (32) quotes Wasserman at Vienna Medical Club, January, 1897. Wasserman showed an aneurism (diagnosed by rays) "in the left mediastinum, where the fluoroscope demonstrated a dark space - the margin of which moved with a distinct impulse" and so distinguished between aneurism and solid tumour.

Bouchard (33), January, 1897, had diagnosed aneurism by the rays.

Campbell Thomson (34) at the Clinical Society of London, in February, 1897, showed radiographs of aneurism before and after some particular treatment by Dr Bezley Thorn - when compared they showed no difference in the size of the aneurism.

Drs. Dalgarno and Galloway (35), in May, 1897, recorded a case of suspected aneurism confirmed by
the rays and included a skiagram picture.

Campbell Thomson (36) in congratulating the last observers on their successful skiagraph, referred to the value of the screen, and said a photograph of aneurism might be spoiled by slight movement. He found the rays of great value in aneurism, as they made some doubtful cases clear and confirmed some others.

Aron (37) (Deutsche Med. Woch. May 27, 1897) discussed early diagnosis of aneurism by rays.

Case I. A woman of 40, with paralysis of left vocal cord, but with no definite chest evidence of thoracic aneurism or growth. The rays showed aneurism; the observation was more important because the paralysis had come on after influenza.

Case II. A man of 32, who five years before had been insufficiently treated for syphilis. Two years before he had had a fibroma of the interarytenoid removed. At the time of examination he had paralysis of left cord, but no other sign of symptoms of aneurism. X-rays showed a fortnight later a pulsating protuberance, from the aorta in the neighbourhood of the second rib. The diagnosis of aneurism was confirmed by subsequent examination. Aron considered the results important from a treatment point of view. Thus, the second case improved under mercurial inunction and potassium iodide.
Becleere, Oudin and Barthélemy (38) by radiography diagnosed aneurism which had not been diagnosed by the usual means.

The same observers (39) showed in one case (Hospitals Medical Society, Paris) thoracic aorta at its junction of the arch to be somewhat dilated and bulging towards the left of the vertebral column to the level of the fifth dorsal vertebra, as they had seen before also by radioscopy with hard and tortuous peripheral arteries. (Comment: This may not seem the proper place for such a reference, but I include it here because it seems more closely allied to aneurism than to any other subject, and because it does not seem of sufficient importance to stand by itself)

Campbell Thomson (40), in 1897, quotes some cases. In one case aneurism was suspected and confirmed. In another aneurism was suspected by rays - but some of the clinical facts taken together suggested mediastinal abscess. Subsequent events pointed to aneurism. In the third case aneurism was suspected and confirmed.

The same observer says a positive result is more valuable than a negative one, as it may always be that an aneurism is too small to be seen, or so situated as not to show; but where thoracic symptoms and physical signs prove nothing. It is in many cases a useful corroboration to know that Rontgen Rays prove nothing also, and that a result has in several cases
further strengthened the diagnosis. (Comment: The
diagnosis being apparently one of absence of local or-
ganic disease).

Rosenfeld (41) said the great vessels were usu-
ally difficult to see because of the shadow cast by
the sternum, but that aneurism and dilatation of the
aorta came into view as soon as they extended beyond
the margin of the bone.

Williams (42), in 1899, said that aneurism was
sometimes unsuspected and the symptoms erroneously
explained, and that the X-rays had sometimes corrected
such mistakes.

Case I. Stricture of the gullet had been assumed
and treated, to the imminent danger of the patient,
by the passage of bougies. In another case, an
operation had been done for supposed intercostal
neuralgia. In a third, the proposed use of digi-
talis was abandoned on the detection of a commencing
aneurism.

Schuster (43) in 1899, stated that that the
diagnosis of commencing aneurism and dilatation had
been facilitated by the use of X-rays. It was pos-
sible to estimate the size and site of a dilatation.
Slight dilatation occurring in the arch of the aorta
is not uncommon and is often seen in cases of aortic
insufficiency. In this condition the heart's action
is increased, the blood propelled with increased force
into the aorta, and this fact, combined with loss of
elasticity in the wall of the artery, causes local
weakness and bulging. The pulsations of the aorta
are much more marked in these cases than in true aneurisms.

Moullin (44), in an address to Rontgen Society in 1899, said aneurisms had been successfully demonstrated.

Walsham (45) in 1900, stated that many aneurisms can, of course, be diagnosed without any help from skiagraphy, but that there are others, and these are not a few, in which the physical signs leave us in doubt between an aneurism of the aorta and a mediastinal new growth, or the aneurism may be unsuspected. In such cases as these, X-ray screen should be used, because the pulsation of aneurismal sac can only be discovered in this way in an aneurism very deep in the thorax. He thought the following cases worthy of record:

**Case I.** A man of 33. Five or six weeks before examination, he had had cramp like pain in the region of the heart, lasting a few minutes and recurring frequently for two or three days. Heart's apex beat was in the left nipple line fifth space. In the third and fourth left spaces about 3½ inches from the mid-sternal line there was a diffuse area of expansile pulsation with systolic murmur. The aortic and pulmonary sounds were clear. There was a systolic murmur at apex with weak breath sounds and deficient expansion of left chest. Pupils were equal and vocal cords moved well. The screen showed
a projecting shadow to the left of the base of the heart corresponding exactly to the pulsation, and well-marked pulsation was visible. Twelve months later the screen showed the shadow to be more than twice its original size.

Case II. A man of 42, for 18 months had had dyspnoea and pain down the right arm, the veins on the right side of the neck swollen. Superficial veins on the right side of the neck and over epigastric region were very tortuous. There was percussion dulness at the right side of the chest in front, and less marked dulness behind. Heart's apex beat was in the sixth space outside the left nipple line. Systolic murmur at apex; pulse weak and soft, especially in right radial. Screen showed a large tumour occupying very nearly the whole of the right chest, the shadow being so enormous that it seemed hardly possible that it could be aneurismal. Four and a half months later, a second skiagram showed much contraction and alteration of shape. No doubt the tumour was aneurismal.

Case III. An aneurism of descending thoracic aorta discovered by X-rays. The case had been diagnosed as one of intercostal neuralgia.

Walsham (46) in an Address to the Rontgen Ray Society, 1900, said one is often left in doubt between aneurism and new growth. Here the Rontgen rays, specially the screen, are useful. The screen is the
only means of seeing an aneurism very deep in the thorax. But even here we may be in doubt because pulsation, as seen with screen, may be a communicated one lying in or near to the aortic arch. The speaker quoted two cases, one of aneurism of the ascending arch and one of the transverse arch, which were verified on post mortem. He also referred to a case of aneurism or dilatation of transverse arch discovered by rays - the patient having been admitted to St Bartholomew's as a case of bronchitis. In, however, one case of aneurism the skiagraph suggested pericardial effusion, but the patient proved post mortem to have a large aneurism of the transverse arch.

Mignon (46a) in 1901 said that he found the X-rays the only means of accurately diagnosing aneurism.

Beale and Walsham (47) at the Medical Society of London, in January 1901, stated that the most important use of X-rays in chest disease was in the detection of aneurisms and morbid growths. There were many examples indicating that the evidence of X-rays was far more precise and definite than that obtained by ordinary methods. The condition of aneurisms, as to whether full of dark clot or translucent fluid blood, with the extent and position of their maximum pulsation, could be determined with a fair degree of accuracy.

Williams (48) considered the X-ray examination of special service in two ways with reference to
they
aneurisms - firstly indicated the presence of an
aneurism without well-marked physical signs; secon-
dly they also negatived the supposed presence of
an aneurism.

Drs Magee, Finny and Watson (48a) in a paper be-
fore the Royal Academy of Medicine, Ireland, main-
tained that the X-rays diagnosed some cases of aneurism
and new growth. They also affirmed that the rays
sometimes are useful in determining the limits of a
new growth or aneurism. In one case an aneurism had
been diagnosed clinically, but its extent was much
better indicated by the rays and skiagraph. They
also quoted a case of a fairly large aneurism of
descending aorta diagnosed by rays.

Lyon (49) at the Hunterian Society in April,
1891, showed a case of aneurism of the first part of
aorta not detectable on physical examination.

Walsham (50): in a paper in the Edinburgh Medical
Journal, showed the great value of akiagraphy in the
diagnosis of thoracic aneurism. The time of exposure
depends a good deal on the patient. Fat and muscular
people need a longer exposure than thin ones; adults
and males than children and females. For thin pa-
tients one minute 50 seconds was sufficient - for
very muscular men 3 or 4 minutes may be required.
A knowledge of the normal shadows of heart and
aorta is needed before skiagram can be interpreted;
normally the shadows of heart and aorta are well seen
and the aorta is traceable nearly up to the manubrium and body of the manubrium (Comment: is the junction meant) Tumours originating in the anterior mediastinum can occasionally be seen by the lateral oblique method of Mignon. Any bulging of the vertical vertebral spinal shadow would indicate an aneurism springing from the thoracic aorta, or an oesophageal tumour, the rarity of the latter, however, making an aneurism probable.

**Case I.** A man aged 45, who had been treated by three physicians for intercostal neuralgia. The upper dorsal vertebrae were tender on percussion. There were no dulness, tracheal tugging, inequality of pupils or cough, and there was only slight dyspnoea. Radioscopy showed a large aneurism of the thoracic aorta.

**Case II.** A woman, aged 51, admitted to Hospital in 1897, with signs of aortic regurgitation, was discharged much improved. She returned in 1900 in much the same condition, but with pain in the back, from which she had previously suffered, much worse. Radioscopy showed aneurism of the descending aorta.

**Case III.** A woman, aged 58, sent to Hospital with diagnosis of laryngeal phthisis. Laryngoscopic examination showed paralysis of left vocal cord, but this was the only sign suggesting aneurism. Radioscopy showed a large aneurism of transverse arch of aorta.

**Case IV.** A man, aged 37, was admitted to Hospital and intra-thoracic tumour diagnosed. A
Skiagram showed a large aneurism of aorta.

Skiagraphy is also useful. Fluid blood is almost completely transparent to the rays. Clotted blood is comparatively opaque. The greater the opacity of aneurism, the more abundant therefore is the laminated clot containing it.

Walsham (51) in Present day Skiagraphy at St Bartholomew's, 1901, said radioscopy often showed a small oval bulging to left of aortic shadow. It is often found in strong athletic men; is much less common in women; is never very large; is often seen in normal chests in which no reason to suspect aneurism.

In aneurism the heart is apt to be transverse and this has more than once drawn Walsham's attention to probable aneurism.

Béclère (52) says he thinks too much stress has been laid on pressure in the diagnosis of aortic aneurism. Pressure signs may be well marked in what radiography shows to be a small aneurism, while there may be hardly any pressure signs where radiography shows a large aneurism to be present. He thinks the "pressure signs" depend more on the inflammatory irritation of the surrounding parts than on the size of the aneurismal sac.

Dr Low (53) at Nottingham Medico-Chirurgical Society, stated that he found X-rays of use in diagnosing aneurism.

Mr Shenton (53a) of Guy's, in a paper entitled
A System of Radiography, and read before the Rontgen Ray Society, said "We have to thank Dr Hugh Walsham for enabling us to say, almost with certainty, whether an aneurism be present or not."

Walsham (54) on the diagnosis of thoracic aneurism by X-rays before the Rontgen Society said that a stereoscopic examination should always be used in suspected aneurism, and also that he considered the rays useful in diagnosing cardiac aneurism.

Walsh (55) "Relative opacity of blood is an important quality, so far as concerns the Rontgen diagnosis of alterations in the form of the heart and blood vessels". In one case an abdomen was exposed for two hours to the rays. There was "no record of bones left, but the abdominal aorta threw a strong shadow.

"Some forms of rapidly expansile aneurisms are recognisable on the screen, whereas they cannot be photographed; nor can the latter result be hoped for until the instantaneous photography of the thorax be an accomplished fact."

Walsh quotes a case under Doctor Coupland of diagnosis of doubtful deep aneurism of the chest. Fluoroscope converted a doubtful into a certain diagnosis. "From the front slight hypertrophy was noted, and just above the junction of the left cardiac border of the sternum a faint indefinite shadow. From the back, a well developed shadow was seen on both sides of the spinal column, at about the level of the
fourth dorsal vertebra. On the right border this outline was convex and pulsating; the intensity of the shadow on that side was almost the same as that of the heart, while on the left it was lighter and less definite."

"The pulsating margin of the non-cardiac shadow in the thorax, other than fluid, of course, points to aneurism."

"Bulgings are not uncommonly found in the aorta, and movements may be communicated to tumours or enlarged glands."

"Aneurisms may at times be detected by the rays in the thorax when their presence could not be demonstrated by percussion and auscultation."

Walsh mentions several cases of unsuspected aneurism being revealed by the screen. In one case he took a Röntgen photograph from an elderly asthmatic of heavy build. A good sized aneurism was seen in the thorax, where owing to the large and emphysematous lung, it could not be diagnosed by physical signs. "Indeed, an experienced physician subsequently denied in Court that an aneurism existed."

"A dilated aorta can be seen from the back on the left side of the vertebral column. Bouchard says that when aortic sufficiency is present, pulsating aortic shadows are visible on both sides of the spine—that is, in the ascending and descending portions of the aorta:"

Walsh says atheromatous patches have been de-
monstrated in the aorta. They are usually better seen by screen than by photograph.

Crane in Walsh said that aneurism of the thoracic aorta affords brilliant examples of the value of the X-rays. Aneurism is distinguished from mediastinal tumours by pulsation - if this be expansile the diagnosis is certain. But pulsations may be transmitted to tumours which lie against the heart and aorta. The certainty with which long needles may be past into an aneurism, while in view beneath the screen, may aid in treatment. A calcification of aortic wall may sometimes be delineated on the plate.

Walsh quotes, by way of caution, a case described by Kirchgaessn in Munich Med. Woch. In a woman of 65, the screen revealed a dark shadow of expansile pulsation just above the heart shadow. Aneurism of the aorta diagnosed. Post mortem showed aorta firmly adherent to oesophagus - owing to a carcinomatous arising from cardiac end of stomach. There was no aneurism - screen shadow was probably due to the distension of oesophagus with fluid.

Williams (56) A small aneurism of descending arch of aorta casts a shadow to the left of the sternum above the heart, and is in the posterior rather than in the anterior part of chest. An aneurism of the ascending aorta usually will cast a shadow to the right of the sternum, nearer the anterior than the posterior chest wall.
A large aneurism casts a shadow on both sides of the sternum; the heart is often more or less displaced or enlarged.

By ordinary methods it is often difficult and sometimes impossible to diagnose aneurisms. Aneurism is often overlooked in the early stages. Or, if recognised, its extent is not appreciated.

The presence of an aneurism is often suspected when there is no aneurism present.

The patient should be examined from the front and back and sides. Photograph may be of use, but the screen shows pulsations.

If walls of aneurism are thick and the sac filled with a dense clot, there may be no pulsation. Williams supposes it is possible for a dense body near a normal aorta to have a movement imparted to it by the aortic pulsations.

Method of examination by X-rays. Spinal column should be examined; any displacement of vertebrae that might push the aorta to one side will give rise to the false impression that aneurism was present. In some healthy people aorta is more prominent than in others. There are some people with no trace of aneurism or dilatation, but in whom the outline and even the pulsation of the descending aorta can be followed.

If there be any departure from the normal outlines in this part of the thorax, one should determine whether this be nearer the front or the back
of the chest, by making two examinations of the patient, one with the screen in the front, the other with the screen at the back of the chest; or the screen may be in a constant position and examination conducted with the tube in two different positions, about 60 cm. apart. Outlines should be traced on the skin or celluloid and an X-ray photograph also be taken.

In distinguishing between new growths in the thorax and aneurisms, it is important to carefully determine between the lateral and antero-posterior outlines. If there be a small shadow on the screen in the neighbourhood of descending arch of aorta on left of sternum, one must determine whether it be cast by something in the front or the back of the chest. As a rule aneurism of the ascending part of the aorta will be found nearer the front of the chest than the back; early aneurisms of descending aorta nearer posterior than anterior part of the chest. Pulsation of the outline means that aneurism is probably present, though possibly movement might be given to new growth situated over the aorta.

"Whether or not this variation of the normal is due to a new growth or to an aneurism, cannot always, of course, be determined by the X-rays alone. They furnish only one way, though a very valuable way, of studying this region." One should use all available means; in some cases of aneurism it is difficult to recognize the cause of abnormal outlines on the screen.
In general, it may be said aneurisms of thoracic aorta may be recognised by X-rays before any physical signs appear. X-rays are of much use in excluding aneurism. Sometimes in patients with such symptoms or signs as dyspnoea, paralysis of left vocal cord, pain in the chest and percussion dulness over an area suitable for site of an aneurism - the use of the X-rays is valuable. In one case in whom Dr Leland found paralysis of left vocal cord, Williams' X-ray examination showed no aneurism - later the vocal cord paralysis had gone. We may be sure no aneurism if X-rays give normal outlines in thoracic cavity, and careful examination of the patient in various positions, including the triangular space below and behind the heart, has been made.

Aneurisms may give signs suggestive of pulmonary tubercle, neuralgia or oesophageal stricture. Williams quotes 41 cases of whom 37 were examined because aneurism was suspected, and 4 in order to determine the size of the heart. 16 gave normal outlines, in region where aneurism had been suspected; 6 had more or less dilatation of some part of aortic arch; and 19 had typical aneurism - 17 of which having their site in the aortic arch, one of them had also an aneurism of innominate artery. Of the other two aneurisms one was an aneurism of innominate and also subclavian, (? which subclavian) and the other aneurism of subclavian.

In one case where the family history suggested
the likelihood of pulmonary tuberculosis and where some of the physical signs, as Williams details them, appear to suggest the presence of aneurism as not unlikely but by no means certain, while others distinctly suggest pulmonary tubercle, there was found an aneurismal sac of such a size as to indicate the likelihood of early rupture, which occurred some weeks after. (Comment: There is no reference to pulses or pupils)

In one case the size of aneurism and of heart as determined by X-ray examination, was confirmed at autopsy. The shadow of aneurism was a little larger than the aneurism itself seen after death, but during life the sac may have been distended, and therefore larger than at autopsy.

In several cases of aneurism, Williams has been able by autopsy to verify correctness of left border of heart, as determined by X-rays, and to show that percussion result was incorrect.

The difficulties presenting themselves to the diagnosis of thoracic aneurisms, where X-rays have not been used or have been wrongly interpreted, are well seen in this case from American Journal of the Medical Sciences, in 1900. The woman came to Hospital in June, 1898, for treatment for "aneurism". There was a tumour extending through the upper portion of sternum, soft, elastic, with slightly expansile pulsation, every heart beat causing apex of tumour
to rock slightly from side to side. Below the tumour at the level of the third and fourth costal cartilages was a second pulsating mass larger, flatter and less inflamed than the other, in the median line and covering an area as large as the palm of a hand.

(Comment: The paradox of a mass covering an area as large as the palm of a hand and being situated in the median line, is perhaps worthy of note). The upper tumour broke on the third day, and owing to the discharge of bloody puriform material, its mass was reduced by one third at least. The lower swelling was opened and similar stuff evacuated. The patient improved and went to a convalescent home, and returned as an out-patient some weeks later. Three physicians who had seen the patient agreed that no aneurism was present. In an X-ray photograph no indication of an aneurism was observed. On the night of September 15th, after she had gone to bed feeling as usual, she got up. There was the sound of a gush and a cry, and the husband found patient dead in a pool of blood arising from her chest. The radiograph, when looked at more intelligently, showed tumour in the region of aortic arch. Williams also states that had screen been used, the present of a good apparatus being taken for granted, the aneurism could not have been overlooked.

In no case, so far as he can ascertain, has any patient, in whom Williams found no aneurism by X-rays, proved to have one.
All cases in which Williams had definitely diagnosed aneurism by X-rays and in which subsequent history has been obtainable, have either died of rupture of aneurism, or, if death has occurred from other disease and a post mortem been made, an aneurism has been found corresponding in size and position to that Williams found by X-rays. One case offered a partial exception. Death was due to a mass of glands below the sternum, which caused, in life, on X-ray examination the casting of a shadow with outlines very like those of some aneurisms. Patient was seen only once - examination was not so complete as Williams wished and he found it difficult to decide between new growth and aneurism, but inclined to aneurism.

X-ray examinations should be made both by screen and photograph. The normal outlines of the upper part of the chest give the best assurance that no aneurism is present. An outline suggestive of aneurism may be due to other causes, namely to new growth. But confusion of this kind is not common, and by careful examination one can usually decide whether or not it is an aneurism that casts the shadow.

X-rays let one determine the extent of an aneurism better than the usual method of examination does, and to detect an aneurism earlier, generally before any physical signs have appeared. Successive X-ray examinations let us know whether or not aneurism is increasing.

Treatment can be planned more intelligently be-
cause knowledge of the extent and position of aneurism result of is more accurate, and (as to other treatment) any change is more easily measured. Sometimes, as, for instance, if an aneurism directly under the sternum, the physical signs as well as the X-ray signs could be observed earlier.

The operation should not be performed on an aneurism near the thoracic aorta until the latter artery has been examined by X-rays, for if an aortic aneurism exist an operation would not be advisable.

In some instances a new growth under upper sternum simulates a thoracic aneurism. It is therefore important to examine a shadow both in inspiration and expiration, and specially its outline. If no pulsation of outline be seen, aneurism may or may not be present. If there be pulsation and outline increases in size, an aneurism is probably present. If there be pulsation producing displacement, but not enlarging the outline, new growth is more probable
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Notes and Radiographs of a series of Cases at the City of London Hospital for Diseases of the Chest, in dealing with these cases. My original plan was to record a full statement of their histories - condition on admission - with detailed notes as to diagnosis, prognosis, treatment and progress - that is, to treat of them in the routine clinical manner. With the fulfilment of this object in view, I made, and have now by me, extensive and voluminous notes. As some of the cases are, as I think, of more than quite ordinary interest, my original plan was perhaps so far justifiable. On the other hand, I am obliged to admit to myself that to pursue this, my original plan, would be to insert an absolutely unwarrantable amount of matter irrelevant to the subject of my Thesis.

I therefore intend to follow the plan of the literature and do little more than give essential details. Of course this plan will in some of the cases, notably in those of aneurism or new growth, necessitate my entering into fairly minute details, so as to indicate how much and what kind of clinical evidence there was towards making a diagnosis supported or otherwise by the X-ray conclusions.

In, however, a fair proportion of the cases, I intend, as far as their clinical aspect is concerned, to give little more than charts of the physical signs and contrast the charts with the X-ray view, or with
the radiograph. The charts of the X-ray view are necessarily very diagrammatic.

In some of the cases the X-rays proved of much value as a diagnostic agent. In others they proved little more than a means of verifying the obvious conclusions to be drawn from physical examination. But in none of the cases was the use of the rays unattended by a feeling of added interest. Seeing, so to speak, the image of a disease is a satisfaction as gratifying to me as that of hearing the music of amnestic breathing, or of the Bell-sound.

As regards the radiographs, (which, owing to their being larger than the regulation size for the paper on which the subject matter of the Thesis is written, I include in a separate volume) I send them in life size and unreduced, as in reduced prints very important details are apt to be lost.

As regards apparatus, I had at my disposal none of the more complex apparatus referred to in the earlier part of this Thesis, and had to content myself with apparatus consisting of the coil (giving a 10" spark) worked with 2 accumulators of 8 volts each & 21 ampere hours' capacity, tube and screen. The fluoroscope I found and to be avoided cumbersome and unsatisfactory, unless the examination were being made in a ward which it was impossible to darken sufficiently. During my last two or three examinations, I was able to use the Mackenzie Davidson brake instead of the ordinary spring. The light thus obtained was certainly brighter and more satisfactory for screen work, but I cannot say I
found any improvement as far as radiography was concerned. In all but two instances, the plates used were Cadet-lightning.

The exposure time in taking the radiograph was generally from 3 even to 3½ minutes. This proved, as mentioned in some of the individual cases, somewhat long sometimes. As, however, some of my earlier attempts were quite spoilt through an inadequate exposure, I subsequently resorted to a longer exposure than here mentioned.

The distance of the tube from the plate was generally from 2 to 3 feet, possibly in one or two cases this was too near, and may have given slightly exaggerated shadows once or twice. But I do not think there was much error in this connection.

Most of my radiographs were taken with the patient in the sitting posture. The plan I found best to adopt with the apparatus at my disposal was to place the tube so that the rays fell horizontally about the median line of the chest, front or back, and (within such limits as are referred to in last in such a position paragraph) as gave the clearest and best view on screen examination. This being obtained, the current was turned off, the light in the room turned up, the patient asked to sit as still as possible, and then the plate in its envelopes brought into the room and slipped beneath the screen and pressed firmly against the front or back of the patient's chest, and the current turned on.
Radioscopy proved, on the whole, more satisfactory than radiography.

The fact that radioscopy allows one to move the screen, and so at one examination to study different aspects of the chest, and also to watch the diaphragmatic and cardiac movements, will readily suggest the superiority of radioscopy. The screen view, too, is often clearer.

Occasionally, however, the radiograph seems to emphasize a point more strongly than radioscopy.

I have to thank Sir Hugh Beevor, Bart., M.D., and Doctors Walsham, Hadley, Williamson, Vincent Harris and Chaplin. for permission to use cases.

I have also to gratefully acknowledge many kind hints as to the interpretation of screen pictures and as to the mechanism of radiography, etc.

Again, I should like to emphasize that the diagrams of the charts of screen views are absolutely diagrammatic, and simply intended to compare with the charts of physical signs, or sometimes to emphasize a point not well brought out in the radiograph.
CASE I

Pyo-pneumothorax: Radiographs 1, 2, 3 and 4.

William H., aged 22.

In this case the Rontgen Rays proved of use as a diagnostic agent. Several of us saw and examined the case, but all failed to diagnose it. Naturally, some of us thought of pneumo-thorax, but failure to elicit the Bell sound caused us to abandon that explanation. On the whole, we were inclined to regard the case as one of fibroid contraction of the right lung and advanced emphysema of the left lung; although the brief history, the absence of retraction of the right side of the chest, the impairment at the left base, the very oscillating temperature touching the level of about 103 at night, could hardly be considered to be satisfactorily explained thereby.

The patient had been ill with cough and wasting for some nine months. Six months before he came to the hospital, as I ascertained subsequently by further pressing the patient for fuller details, he had had a sudden attack of giddiness and dyspnoea unattended by any pain in the side; and two months later he had had what was called left sided pneumonia. His expectoration was very profuse and contained numerous tubercle bacilli; the temperature was as referred to above.
Chief Physical Signs: - The patient was noticed to lie persistently on his left side. The chest was not badly formed, and there was some hollowing under the right clavicle, but no definite retraction anywhere except some indrawing of the lower spaces on both sides in inspiration. Although the left side appeared to bulge somewhat towards the base, mensuration made the two sides practically equal. The right chest was moving better than the left.

Fronts. Right - V.F. increased, P.N. much impaired down to about the fourth space where dullness began, and P.N. impaired in axilla. B.S. harsh vesicular, expiration prolonged, with some crepitations and increase of vocal resonance.

Left side: - V.F. absent; P.N. hyper-resonant, not tympanic. B.S. absent; V.R. absent.

Backs. V.F. increased; P.N. impaired and much so at the apex, but little at the base. Breathing at apex bronchial, with whispering pectoriloquy, with some crepitations - below vesicular and loud with a few scattered crepitations.

Left side: V.F. absent; P.N. impaired but not strikingly so, and at this time not specially dull or resistant at the base. Breath sounds absent, about the fourth rib a spot of vocal resonance almost aegophonic - below that absent.
There was not a vestige of pulsation to the left of sternum. Epigastric pulsation was well marked and there was a limited area of pulsation in the fourth right space, a little internal to the right mammary line. Area of cardiac dulness not to be made out, that is, there was no dulness in the usual place but simply hyper-resonance. Cardiac sounds were not heard to the left of the sternum, except by the immediate method of auscultation. Cardiac sounds fairly well heard to the right of sternum - pure. They were also well heard in epigastrum.

No displacement of the liver or spleen could be made out.

There were marked throat symptoms and ulceration about the base of the epiglottis on right side.

There was a little albumen in the urine.

The patient went on much the same and no special change was noted in physical signs, except that there was marked dulness and resistance at the left base for a limited area, but so much was the percussion note impaired on most of the right side, that until X-ray examination was made the dulness at left base was given insufficient prominence to. It was limited to the base and above that area, even after X-ray examination had disclosed the state of affairs, one was struck at the relative resonance over much of the left back when compared with the right. The posterior dulness nearly 2" lower than upper level of shadow of fluid. (Please see p. 104)
we decided, though it meant the disadvantage of using the apparatus in a ward that could not be properly darkened, to examine the patient by the rays in the ward.

On looking through the fluoroscope placed upon the front, I saw up to the level of the third rib what I at once recognised as the upper horizontal edge absolutely obscuring rib and spaces of thick fluid in the left chest. The diaphragm on that side could not be seen. Above the horizontal level, the left ribs and spaces stood out with intense distinctness. On the patient's being moved to either side, the upper limit of the fluid was seen to keep horizontal. The fluid oscillated with the patient's voluntary movements, and less also with his respiratory movements. On his being shaken, the fluid was seen to move about just as any fluid in a glass will move on the latter's being shaken - while from the surface of the fluid black spray was tossed into the region of the pneumo-thorax. The right side of the chest was seen to be mostly occupied by opaque areas of the size of a threepenny piece or so, dotted about among relatively "luminous" areas of similar size, the coalescence of some of the dark areas making the dark aspect of the view the obvious one. This, the first radiograph, does not bring out except as a large blank area. The second radiograph, which, unfortunately, owing to the patient's weak condition, was not taken quite square on the plate, faintly repre-
sents the mottled aspect. The very dark parts correspond to the areas of lung more intensely infiltrated with tubercle, while the lighter areas are relatively free from tubercle.

The view from the back was much the same, except that the fluid stood at the level of the sixth rib, and at the right side towards the diaphragm the lung was somewhat clearer. The diaphragm, however, could not be well seen.

Charts. Chief Physical Signs and X-Ray View.
The patient stood the examination rather badly. The search for further physical signs was somewhat curtailed. Somewhat small areas of the Bell sound could be elicited. Hypocratic succussion splash could not be elicited. About this time so small was the area of the Bell sound that one observer, not present at the time of the X-ray examination, appeared somewhat sceptical as to its presence. There was, however, no doubt as to its presence, though over rather limited areas.

The patient, a few days afterwards, made much wider areas of the Bell sound could be made out, but these showed from time to time considerable variations in extent. Hypocratic succussion was well brought out on one or two occasions, but on others was difficult to elicit. Probably the patient's feebleness sometimes prejudiced results, by altering the diaphragm.

Movable dulness could be well made out. On the
patient's sitting up there was dulness up to the third left costal cartilage, but on his lying back dulness was not elicited until the fifth costal cartilage was reached. In the original physical examinations patient had been examined when lying back. There was no amphoric breathing.

The patient went on much the same and some weeks afterwards, he consented, at the suggestion of the visiting physician, to have an incision made under local anaesthesia. I incised along the lower border of the ninth rib, and removed about 66 oz. of sero-purulent fluid. Removal of part of the rib was out of the question. Four days afterwards, the patient was well enough to be briefly examined. Heart's apex beat was in the same position; amphoric breathing heard in left front; percussion note fairly resonant at the left base. Left apex behind, faint breath sounds and some crepitations, and some percussion impairment. At first intense amphoric breathing was heard over the lower half of the left back, but this large area of Bell sound over left front and I. base disappeared in a few seconds. No metallic vocal resonance and no metallic tinklings heard. Prolonged examination impossible. Eight days later, heart's area of maximum pulsation was midway between right marmary line and right sternum. P.N. at left base more resonant.

Some days later the right side was briefly examined. Over the right front there was a considerable area of bronchial breathing, it being in places almost cavernous in character. There were also numerous
crepitations.

In passing, I may say that since operation patient's cough had been better, and that on one occasion he was seen to lie on his right side.

The patient gradually grew weaker and the physical signs, so far as they could be examined for, continued much the same. Unfortunately, the patient's condition rendered further X-ray examination out of the question. Eventually he died.

After death the X-ray apparatus was conveyed to the post mortem room, where I took two radiographs. It was not possible to study the fluoroscopic screen view in detail, but the radiographs give such clear results that the omission hardly signifies. The plate in its envelopes was slipped first of all under the back of the thorax, (the cadaver lying on its back) and exposed for something over three minutes, the tube being some three feet away from the plate and the rays falling vertically on the body. The proceeding was then repeated with the body lying supine.

The view from the front shows on the right side of apex a most extensive cavity, practically involving the whole of upper lobe - this contrasted with the earlier views is very striking, there being in earlier radiographs no suggestion of cavity formation. The right half of the diaphragm in its inner part just comes into the picture, and between this and the cavity the lung is seen to be infiltrated with tubercle, and the heart is vaguely seen.
On the left side the heart vertically placed and considerably to the right side of its ordinary position, is well seen, as is also the collapsed lung with the spur-shaped process noted by Dr Walsham as generally visible in cases of pneumo-thorax examined by the rays. The intensely clear part of thorax, devoid of lung tissue, stands out obviously. The view as seen from the back is similar, except that the heart is not seen and that the view is quite above the diaphragm level.

Post-Mortem: - On the right side, at the posterior and outer part of the apex, two layers of and visceral parietal pleura were adherent and together quite a quarter of an inch thick. Elsewhere the two surfaces covered by a pus-forming layer, and there were 2½ dz. of pus in the cavity. The right lung showed the entire upper lobe and part of the middle lobe to be occupied by a cavity, very rapidly spreading. The rest of the lung was closely studded with tubercle, except quite at the base where it was relatively free.

In the left visceral pleura at the anterior surface of the lung, there was an opening from a quarter of an inch wide and one eighth of an inch long. Its margins were smooth, regular and thickened. It communicated with a small old cavity with fibrous walls in the lower part of the upper lobe, and with a bronchus, and not with the main fairly large cavity. The opening was not valvular. The left lung, markedly collapsed and studded with tubercles, was pushed up-
wards, and contained a cavity (not recent) the size of a small orange. The heart was much enlarged, specially on the right side from dilatation, and was considerably displaced to the right.
CASE II

Pneumothorax becoming Pyo-pneumothorax. Radiographs 5 and 6.

Charles W., aged 33. Cough and expectoration for 12 months; recently had left sided pneumonia and pleurisy, namely, a sudden sharp stab on the left side, followed by dyspnoea, sweating and much cough. Since the above attack, five weeks ago, has never been out of hospital. He lies on his left side. Fingers not clubbed and nails not curved. 

Physical signs. Chest is a very fair shape, but of somewhat limited dimensions. Left side moving much less well than the right.

Mensuration. On deep inspiration left side measures 16 inches, right 17½ inches. V.F. present only on the right side. On right side P.N. sub-tympanitic from apex to upper border of third rib. In parasternal line very dull from third rib down to 2 inches below the costal margin. A little outside right mammary line, P.N. is impaired from about third to sixth rib, absolute dulness not beginning until sixth rib reached. P.N. much impaired in axilla from level of fourth rib downwards until absolute dulness begins at sixth rib. Breath sounds over the region extending from clavicle to fourth rib in front, and roughly corresponding to the larger part of the upper lobe, are harsh and vesicular, with prolonged expiration, with fine crepitations on inspiration and expiration. In axilla inspiration is loud, somewhat blowing and there are many crepitations.
but less so than might have been expected

On left side breath sounds are absent. P.N. resonant

Above the level of the left nipple (situated in the fourth space) the bell sound not well elicited; below that level it is very well elicited.

Backs: The left side moves and expands less well than the right. V.F. increased over the right lung; absent on the left side. P.N. is dull at right base, somewhat impaired at apex. On left side P.N. is dull in region of root, with a doubtful zone of impairment at the base unaltered by changes in patient's position. Elsewhere P.N. tending towards tympanitic. At right apex behind there was prolonged expiration and harsh breathing, with crepitations and increased vocal resonance. Below the breath sounds are harsh, with crepitations. On left back, breath sounds absent unless very faintly heard in the region of root. Bell sound well heard over whole of left side; no metallic tinkling; no hypocratic succussion.

Apex beat indefinite, faint pulsation in fourth right space, no evidence of A.C.D. to the left of sternum. In third right space, near sternum, cardiac sounds distinct, and a slight systolic murmur present.

Liver felt a little below the costal margin; there was no albumen. Temperature was raised at first but gradually fell to sub-normal, with only about 1 degree difference between morning and evening readings. At this time the screen view was as follows: - from the front, the left side was extremely
clear, except for a slight shadow about the inner edge of the second to fourth cartilage, not pulsating, and perhaps corresponding to root and collapsed left lung. The left diaphragm was slightly low and was stationary. On the right side, there was a dark apex shadow, with below an area of less intense shadow, and an area of intense shadow corresponding to the heart and liver. The diaphragm was moving satisfactorily. From the back most of the left side was very clear, the diaphragm was rather low and moving very slightly, if at all, and the shadow of the collapsed lung was well seen. On right side the apex was a good deal in shadow; over the rest of the lung there was a somewhat diffuse shadow; a large area of pulsating heart shadow was well seen, and the diaphragm stood out fairly well.

Diagnosis: The case was evidently one of extensive tubercular disease of the right lung, with pneumo-thorax of the left lung and tubercular infiltration of the collapsed left lung. Unfortunately at this time I was not taking radiographs, and so, at this stage, can only include diagrammatic charts of screen views to contrast with charts of physical signs.
Movement better on left side
VF present
PN both in lungs
PN "in lung" dull

Movement worse on right side
VF present
PN present
Bell sound; joint crackled
Bell "not" better
No H.R.
No C.S.

L. shoulder lower than R.
Movement worse on right side
VF absent
PN symmetrical
Skull and ribs normal
B.S. absent
Bell sound; well crackled

Movement 1/2 present better than on L. side
PN "in lung"
B.S. hard, Sep. 6th.
PN "in lung" dull

Diaphragm
Stationary L. diaphragm
Collapsed L. lung shadow
Diaphragm lowered 1/2 slightly

Heart.well seen
Heart.well seen displaced to right
The patient went on much the same. A fortnight after the above examination the patient was again examined by the X-rays, almost a week after a note of physical signs had been taken, which had then shown no material change. The screen showed fluid up to the level of the sixth rib from behind. As described in the case of W.M.N., this was seen oscillating with the patient's movements. On the patient being shaken the surface layers of fluid rose in commotion. No special inspiratory rise of fluid was noted, nor other special undulations. Exploration showed sero-purulent fluid to be present. On the patient's being leant from side to side, the horizontal level of fluid was well maintained. Exploration showed the presence of sero-purulent fluid.

Mensuration 1 inch below the level of the nipple made the sides equal. There was well-marked dulness at the base; the area of the bell sound was lessened, and hypocritic succession was well marked.

Fortunately I was enabled to obtain radiographs (from the back) one taken with the patient sitting up, and the other when he was leaning over. Unfortunately, however, before there was opportunity to obtain information as to various other details, the patient apparently resenting the proceedings, discovered serious illness among his friends, and bolted.
CASE 111.

Pneumothorax

George J., aged 38. Cough and dyspnoea for 12 months; sometimes left sided pain like "daggers". Slight enlargement of ends of fingers.

Physical signs: Chest showed no particular malformation; left side immobile; right side moving deficiently. At level of nipples right side measured 16\% inches, left side 16 \% inches in quiet respiration. Just below angles of scapulae left side measured 16\% inches, right side 16. Over both fronts V.F. present and P.N. hyper-resonant. From apex to third rib right B.S. were bronchial with some sharp clicks; below level of third rib there was harsh vesicular breathing. On left side there was a considerable from area of amphoric breathing extending about the lower border of the second rib to the upper border of the fifth rib, with amphoric resonance and bell sound to be elicited. About the same region there were occasional metallic clicks. Below the breathing was harsh vesicular, with expiration prolonged and some crepitations. Over the right back, at the apex there was slight impairment of percussion, while below the percussion note was hyper-resonant. The breath sounds were loud, harsh vesicular, expiration prolonged with some crepitations. On the left side percussion note was hyper resonant, except quite at the base where it was perhaps slightly high pitched. B.S. were feeble towards the apex and louder below.
vesicular in character. Crepitations at left base; bell sound well elicited at apex. Heart's apex beat was about one finger's breadth beyond the I.M.I. Area of cardiac dulness extended from the third rib to one finger's breadth beyond the I.M.I. and not to the right of the sternum. The sounds were pure. The liver was made out about an inch below the costal margin. No albumen.

Diagnosis: With the signs as above, case was obviously one of double phthisis, with, in addition, a considerable area of pneumothorax towards the left apex. One of my colleagues had missed the pneumothorax. But the amphoric breathing which attracted my attention to the pneumo-thorax, had probably been absent when my colleague examined the case, or been very much limited (as it was some four weeks after admission) namely to a small part of the second inter-space. The screen from the front showed spidery shadows towards the right apex, with a dark shadow, perhaps due to the bronchial gland, in one place, while between the apex and the liver the lung was fairly clear and perhaps emphysematous. The diaphragm showed increased excursion. On the left side the lung was not very clear and was perhaps somewhat obscured by pleural thickening. About the level of the fourth rib could be seen a horizontal line. As to whether it kept its level on the patient's being moved from side to side, one could not well make out as the line was difficult to see., Below was seen
the dim shadow of the heart, and beyond it fairly but
diffuse and in places fairly intense shadows, evidently
not due to fluid. Just above the diaphragm was a con-
siderable fairly clear area. The diaphragm was almost
immobile, but was not clearly shadowed. From the
back most of the right lung was in fairly deep
shadow. The upper part of the left lung was clear,
but owing perhaps to the presence of adhesions, not
absolutely clear. Below the level of the pneumo-
 thorax there was a horizontal, fairly intense narrow
shadow. Between this and the diaphragm (which could
be dimly seen and was practically immobile) was some
at diffuse but not very intense shading, and the outer
side of this there was a distinctly clear part of
lung. Although none of the signs nor the X-ray ex-
amination suggested the presence of fluid as at all
likely, I should like to have explored the left base;
but the case not being mine, I could not do so, es-
pecially as it was being rigidly treated by rest.
The radiograph, like the screen view, was disap-
pointing. I was interested to note that Dr Walsham,
who did not know of the case, recognised what the ra-
diograph represented. It was taken from the back.
Marrow & Perilymph
VF present
PN hyper. Osseous
VR++
B. S. Lord
Breached from
KK 6 8 1/2

Liver sound

PN hyper. Osseous

B. S. tender

PN hyper. Osseous
quite at tone

Sputum positive
back sternal. Brochial
Feltly clear. &amp; Pneumonic.

Diaphragm no longer
+ Exhension

Clear

? Adhesion

Clear

Diaphragm dark seen
+ moving well
In regard to both this case and that of Thomas P. No. IV, I have been perhaps rather absolute as to the nature of the opinion I expressed in reference to their chief feature of interest, namely the areas of amphoric resonance. I suppose it is undoubted that a very large cavity may give the Bell sound, just as one may sometimes elicit it over the stomach. In the case of Samuel W., my attempts to hear the Bell or anvil sound failed. I have tried for it in a good many cases of large cavities, but have not obtained it. Some months ago Dr Hadley told me of two cases of cavity over which he had heard the bell sound, and I suppose there are a good many such cases on record. Perhaps the relatively small amount of any heart displacement favours cavity rather than pneumothorax, but I suppose in localised pneumothorax one would not expect much cardiac displacement.

Nor does it seem that in such a case the X-rays, apart from noting well any visceral displacement there may be, can clear up any doubt there may be.
CASE IV.

Thomas P., aged 35. 

Radiograph 8.

Had had cough for two years, also sometimes been dyspnoeic; also had left sided pleurisy two years ago, waking up very short of breath, with intense pain in left side. No sudden attack of pain in the right side. The temperature was raised at night - down in the morning.

Physical signs: Chest showed great depression below both clavicles; both sides moved and expanded very badly - the left rather better than the right. At apex R.V.F. was better marked than L.V.F. where it was almost absent and much less than that at left base. P.M. impaired over the right front, down as far as the fourth rib, where absolute dulness began. Over the left front P.M. was somewhat impaired, but less than on corresponding side. The right P.M. showed no hyper-resonance, tympanitic or other special characters other than impairment. There was some impairment of right apex behind, and this increased as percussion travelled down and towards the right base there was much impairment and resistance. The left percussion note was slightly impaired at apex behind, resonant below.

There was amphoric breathing from clavicle to the fourth rib on right side - below that level, especially in axilla, loud cavernous breathing, with corresponding whispering pectoriloquy. Where the resonance breathing was amphoric, the breathing was also amphoric
and a cough produced some metallic tinklings over the same area, which also showed many metallic rales: over the left front the breathing was harsh vesicular with expiration prolonged, with some creps and bronchophony. Behind, on the right side, breathing was loud and cavernous at the apex. There were some creps present, with whispering pectoriloquy at the apex, but no amphoric characteristics. At the left base the breath sounds were very feeble, being very faintly cavernous. On the left side the breathing was loud, harsh and vesicular, with expiration prolonged and with bronchophony at apex. No crepitations. Auscultation and percussion gave the bell sound very well over the area extending from the clavicle to the fourth rib, but nowhere else.

Heart apex beat could not be defined. The A.C.D. extended from the fourth left space to one finger's internal breadth to the left mammary line. Right border could not be defined. Sounds were pure. No accentuation or reduplication.

Diagnosis: clearly pointed to a limited pneumothorax. The signs also rather suggested possible fluid at base in right pleural cavity, that is, a small right pleural effusion. But the case not being mine, I had no opportunity of using the hypodermic needle.

Screen view. The right front was seen as an intensely clear area corresponding to the region of amphoric signs. Below that region the right chest was
much in shadow, and the right diaphragm poorly seen. The right heart was just seen; the left side of chest was poorly seen, being the seat of spidery shadows. The heart was fairly well seen and so was the diaphragm, which was moving badly. From behind the view was similar; at the right apex there was an intensely clear area, and below that area a fairly intense shadow extending to the diaphragm, which was badly, if at all, seen. I question whether the shadow was quite well enough marked either as to intensity or to definite upper margin to indicate the presence of much fluid. On the left side the very apex was fairly clear; below there was a considerable area of spidery shadows and the left diaphragm was moving badly.

The radiograph taken from the front is disappointing. Corresponding to the right side of the chest, that is, on the left half of the picture, the shape, so to speak, of the pneumothorax comes out fairly well, but the complete absence of ribs is puzzling. The left side of chest though a very slight shade less clear than the right side, is still far too clear and ought to be much darker. The absence of ribs on the two sides suggests that the plate, which was rather an old one, and the only one available at the time, must have been defective. I enclose the radiograph only because the shape and limits of pneumothorax are faintly indicated, and because the patient did not seem quite strong enough
for a repetition of the proceedings. But for these facts, I should have disregarded it.
CASE V.

Aneurism of the Aortic Arch. Radiographs 9 & 10.

Joseph S., aged 56. This case entered hospital as one of phthisis.

His work was heavy; he had been a fairly heavy drinker; had never had syphilis; his wife had had no miscarriages; and the children no snuffles.

He had had pain for three or four years behind the lower sternum; it was at the level of the fifth rib and a deep breath "catches" him. The pain was slightly worse after food, sometimes it made him cough; it was sharp. There was also slight pain behind the right chest. He had cough and dyspnoea; he had formerly had expectoration, which was yellow, and used to be slightly streaked with blood.

Physical signs. The heart's apex beat was felt about one finger's breadth beyond the left mammary line, in fifth left space. No other pulsation could be made out, except in suprasternal notch, and doubtful pulsation in second left intercostal space. Area of cardiac dulness: upper border was not satisfactorily made out. The left border was one half finger's breadth beyond the left mammary line. The right border not to the right of the sternum. On auscultation there was doubtful reduplication of the first mitral, and the second aortic sound was markedly accentuated. No bruits. Pulse: the two pulses were sometimes described as unequal, but the difference
never seemed to me very obvious. The pulse rate was 80. It was regular, equal of fairly big amplitude; rise rather rapid; fall not very rapid; no obvious secondary waves. Walls somewhat thickened.

The distal vessels were seen pulsating; no capillary pulsation.

There was frequent cough, very profuse mucopurulent expectoration containing no tubercle bacilli. The cough was not brassy, but was short and frequent and suggestive of nerve irritation. Standing by the patient one could frequently hear the Leopard growl.

There was no special prominence of retraction anywhere in the chest. The left side moved slightly measured less than the right; right chest measured half an inch more than the left, and right vocal fremitus slightly greater than left vocal fremitus. There was slight impairment of percussion note over the left clavicle, otherwise percussion note resonant. The breath sounds were harsh in places, notably on the right side, and particularly at the right apex behind. Over the left back the breath sounds were rather feeble. Vocal re-
sonance was greater on the right side than on the left (probably physiological) Upper border of liver at the level of sixth rib. Liver and spleen not enlarged.

Vocal cords: The drawing forward of the tongue necessary for the examination of the larynx, was attended by a suffocative tendency on the part of the patient. Pupils equal, and reacted well. There was very doubtful tracheal tugging. The knee jerks were slightly exaggerated, but equal.

Diagnosis: Here was a case sent to hospital as one of phthisis, and such lung signs as there were made such a diagnosis quite possible. The character of the cough, the pain, the possible tracheal tugging, the accentuated aortic second, the suprasternal notch pulsation (the slightly displaced heart's apex beat being not inconsistent with the view of aneurism) and still more the leopard growl and the history of alcohol and hard work, all, up to a certain point, suggested aneurism of the aorta. There, still, it did not seem to me enough clinical evidence to make one at all sure, and certainly not evidence of so large an aneurismal swelling as X-ray examination at once made manifest.

Screen showed from the front clear lungs and both sides of diaphragm moving well. Transverse position of the heart well seen. Heart's shadow came just to the right of sternum. Aortic shadow was much enlarged on and its pulsations were well seen both sides of sternum. From the back, much the same points were brought out, but the enlarged aortic bulge to the right was better indicated.
radiographs are somewhat blurred, but the picture taken from the back indicates one point much better than was brought out by the screen - namely, that the intensity of the shadow of the enlarged right aortic bulge was much less marked, its outline less defined, these points probably indicating a thin part of sac wall.

No expectations anywhere.

Any want I clear apart from Heartante shadow probably due to thick chest wall
Please note the large size of left aortic shadow in the view from the front, and of the right aortic shadow in the view from the back. I should say from the appearances of the X-ray view that the transverse part of the arch would be the chief seat of the aneurism, but that, to a less extent, the ascending and descending parts of arch were affected.
CASE VI

Radiographs 11 & 12:

William F., aged 50.  Aneurism of Aorta

In the last week of November, 1900, just about two years before these notes were taken, the patient's illness began in a professional trauma. He was violently banged by a swinging sack of wheat against the rail of an adjacent ship, and felt "something go" over his left ribs. He was able to work for a few days, but then had to stop owing to increasing dyspnoea. He also spat some congealed blood. Since accident patient has had much progressive pain. This was originally much over the cervical column; later on was in the region of the loins and latterly has chiefly run through from praecordia to back; there has also been some epigastric aching; also subject to attacks suggestive of angina beginning about the middle of the back, and sometimes running down the arms (and not limited to one particular aspect of arms) and accompanied by dyspnoea and the feeling of impending death; also a fairly constant pain across the front of chest, chiefly behind the lower part of the body of the sternum. Much palpitation, sometimes giddiness, no dysphagia. Patient came from a very long lived family. There was no history of syphilis, but one of his wives had had several miscarriages. There was history of alcohol. Occupation involved patient in much heavy lifting.

Dilated venules and capillaries over malars, etc.
Nails very slightly curved longitudinally, showing no capillary pulsation. Some visible pulsation of vessels. No oedema of legs. Breathing easily and comfortably. Temperature not raised.

Physical signs: - Slight prominence of second right costal cartilage. Doubtful supra-sternal notch pulsation. Well marked epigastric pulsation. Doubtful pulsation at second right intercostal space just to the right of sternum. No other pulsation. No enlarged veins over praecordia, etc. Owing to pulmonary emphysema heart's apex beat and area of cardiac dulness not to be made out. Heart sounds best heard (specially as regards the ordinary position of mitral area and its neighbourhood) when patient sitting up; heard about L.M.L. fifth space as well as at any other spot thereabouts. A double murmur heard all systolic and over the praecordia - fairly loud diastolic murmurs; systolic conducted as far as angle of left scapula; vessels both murmurs well heard in the of neck; systolic also heard over radials.

Slight P.M. impairment over second right costal cartilage and space, but the note over right infra-clavicular region was a very little higher pitched than that over left infra-clavicular region. Pulse: Right slightly less well felt than left; the two pulses synchronous. 72, regular, equal in force and time, volume fairly large, force poor, tension low, rise somewhat rapid, maintenance poor, fall fairly rapid. No dichrotism. A mild type of
Corrigan's pulse. Wall somewhat thickened.

Chest well formed; no special prominence (except as noted above) or retraction. V.F. present over both fronts and in axillae—of ordinary intensity and about equal on the two sides. Sides move equally. P.n. hyper-resonant over both fronts and axillae, but right note rather higher pitched than left. B.S. vesicular and feeble, especially on left side. Right V.R. greater than left V.R.

Backs. V.F. present all over and equal on the two sides. Vesicular breathing on the two sides, feeble on the right, very feeble on the left. R.V.R. greater than L.V.R. No patch of dulness and no pul-
Mensuration left side 19 inches, right 18½.
(although not a left handed man, patient states he used to be able to lift heavy weights better with the left hand.)


Eyes: - left pupil reacts well; right immobile from an old trauma. Fundi: No venous or arterial pulsation. Knee jerks: left is exaggerated and more easily obtained than right. No motor or sensory disturbance; no tracheal tugging; no albumen.

The clinical diagnosis of this case was by no means certain. Personally, owing to the widely diffused and frequent pain and the sudden onset, the history of alcohol being consistent with this view, as was also that of hard work, I inclined to aneurism - others thought there was no aneurism. And here again the use of X-rays left, I think, little doubt as to the primary trouble being aneurismal. It is interesting to note that the aneurismal swelling is much more marked on the left side, although the higher pitched P.N. and the doubtful second intercostal pulsation were on the right. The left back breath sounds being more feeble than those of the right (owing to pressure) of course the presence of emphysema embarrassed physical diagnosis. Screen from the front showed both sides of chest to be fairly, but not
probably because chest wall thick.
very clear. Right diaphragm was well seen, the left
was badly seen. The heart tended towards the
transverse position. The aortic shadow was well
seen on both sides; its pulsations were well marked;
and the left showed distinct aneurismal dilatation.
From the back the view was similar, except that the
transverse position of heart was better seen and that
the increased aortic shadow stood out better. Both
the radiographs were taken from the back. They are
somewhat blurred as to details, but the aneurismal di-
latation stands out well.

Chart of physical signs and screen view.

The descending part of the arch would probably
be the seat of the aneurism.
CASE VII

New Growth

James M., aged 39. Had had swelling on right side of neck, front of neck and face for about five months, recent dyspnoea and pain in the right supraclavicular region shooting up the neck, occurring Voice high-pitched and weak chiefly after meals. A forced cough was very high pitched, and not unlike the neigh of a horse. Very little expectoration. There had been a little dark thick stuff, like congealed blood. No pain in chest. Sometimes giddiness after stooping. Sometimes dysphagia more marked when taking solids than liquids. Sometimes pain behind the manubrium sterni. Gradual loss of flesh. His work was heavy and meant his wielding a ponderous hammer. Never much alcohol. Had had sore throats and falling out of hair in former years. His wife had two healthy children and had had no miscarriages.

Patient lay comfortably on his back or sat up without any discomfort. Right upper eyelid suggested ptosis, but the appearance was probably due to oedema. No enlarged glands. No clubbing of fingers or curving of nails. Respiration 24, Temperature 98.4. Second left costal cartilage was prominent and over chest and front of abdomen there was a striking number of enlarged veins, as seen in accompanying diagram.
H.A.B. well felt for about three and a half fingers' breadths beyond L.M.L. in fifth left space. No supra-ternal, epigastric or other pulsation. A.C.D. extended from third rib for four fingers' breadths beyond L.M.L. The right border not to be outside the defined. Also slight P.N. impairment in middle of sternum, between clavicle and third rib, specially over second rib and space. On right side extensive dulness, as described later. Heart sounds in all areas pure, no special accentuation at the base.

Pulse: Left much more easily felt than right; regular, equal, 96, volume fairly large; tension low. Up stroke rapid, ill-sustained; fall fairly rapid. Slight *diacrotism*. Wall somewhat thickened. I include pulse tracings, which, though rather poor, emphasise the greater amplitude of the left pulse.

Chest well formed. Right side moving very badly and inadequately. Left side moving and expanding very fairly.

Percussion: Just above level of nipples right: side measured 18½ inches; left 17½. R.V.F. absent; L.V.F. present, but no doubt owing to peculiar character of the voice, not well marked. Percussion: left side resonant, except as motioned above, and slightly impaired at left apex behind.

Right side. Front: Much impaired to fifth space, where absolute dulness began. Some impairment at right apex behind. Dulness from third rib to base.

Left side: Breathing harsh, vesicular all over.
Expiration prolonged. Breathing approaching bronchial left apex behind. On right side breathing bronchial in front - very faint in axilla - bronchial right apex behind - below that B.S. behind very faint, where specially at base. Quality doubtful, but rather like very distant cavernous breathing. V.R. present on left side and bronchophony at left apex behind. Very poor on right side; no adventitious sounds.

No pulsation over the back. The liver felt a little below right intercostal margin. Spleen not palpable. No albumen. Right pupil pin-pointed and inactive. No tracheal tugging.

Larynx: Right cord paralysed. In phonation the cords meet, but the left is over-acting and crosses the middle line. In respiration the left cord alone acts. (Kindly see diagram on page 135).

The patient was examined with screen. From the front, left side was clear. Left diaphragm was seen acting well. The heart shadow extended considerably and was rather transverse outwards. Left aortic shadow was seen pulsating well and was somewhat displaced. The right side had its upper part fairly clear, but below was much in shadow and the right diaphragm was not seen. The right aortic shadow was somewhat higher than usual and was perhaps slightly enlarged, but was difficult to see well (in this relation I ought to emphasise the comparatively wide range as to size of normal aortic shadows - this is referred to in greater detail in quotations from the literature.) From the back
the left side was clear, the heart rather out and transverse, left aortic shadow fairly well seen. The right side was clear at the apex; diaphragm was not to be seen. Between apex and base there was a fairly dense and diffuse shadow, with at one place, as represented in diagram, a very dense semi-circular shadow, which was possibly pulsating.
Ten days later, patient's face and neck were more swollen. There was much duskiness over the chest fading on pressure; but there was more dilatation of the veins and some definite oedema of chest wall. Physical signs, too, had become more intense, as represented in accompanying charts. The screen views, too, had changed much, as represented in accompanying charts.

Physical signs, too, had become more intense, as represented in accompanying charts. The screen views, too, had changed much, as represented in accompanying charts.
Diagnosis: The widespread signs, particularly the large area of dulness, pointed to new growth rather than to aneurism. On the other hand, the pupil signs and (although the right cord was affected) the throat involvement, and the pulse inequality, are probably commoner in aneurism. The impairment to the left of manubrium perhaps favoured aneurism. Absence of cardiac or auscultatory phenomena was earlier against aneurism. The screen examination, suggested possible aneurism - the dense, somewhat semi-circular ray resistant mass seeming to be very possibly a saccular aneurismatic dilatation - but was probably a very dense and rapidly increasing part of tumour. The aortic shadow as seen from the front appeared somewhat extensive - but probably not beyond the physiological range.

The change of physical signs as well as of the screen view, was quite remarkable for ten days' time. Some two or three days later, three pints of serous fluid (not blood stained) was moved from the left chest. I should have stated that Dr Walsham was present at the second screen examination. He said he thought the chest was one of the densest he had ever examined, and that at first he could see practically nothing, and that he considered there was no doubt as to the presence of a new growth. He was also surprised that the radiograph (that I include) taken only ten days before should give as much detail as it did.
I tried, after the removal of fluid, to again examine the patient by the X-rays, but the apparatus was not working, the accumulators having run down. Subsequently, after I had left the hospital, and by the courtesy of the Resident Medical Officer, I was able to examine the patient with the screen, and found the chest less in shadow than at the second examination. At that time, too, the signs were less intense. I should have liked to have explored for fluid, but the patient not having seemed much benefited by the removal of fluid, exploration was not considered advisable. The radiograph taken at the time of the first examination was from the front.
CASE VIII

New Growth

Hew Growth

Radiograph 14.

Elizabeth T., aged 50. For three years pain in left side of chest - used also to be pain in left arm. Much cough - cough is high-pitched, somewhat resembling a cry - dyspnoea on lying down. Palpitation. Fairly profuse expectoration in discreet lumps suggesting nummular sputum, but containing no T.B. The patient had had two miscarriages, and had to do much hard manual labour. She had rheumatic fever years ago. No history of alcohol. Scars on back and legs suggesting old specific disease. Patient showed many dilated venules and capillaries on the cheeks, also dilated veins on left upper chest and on left upper arm. Physical signs: No sternal notch pulsation. Well marked and forcible epigastric pulsation. Heart's apex beat not definitely defined - there was some indefinite pulsation in the fifth left space a little internal to the left mammary line. The A.C.D. upper border merged with dulness of mass to be described - there was dulness well out into left axilla, but probably not due to left heart. The right border was not beyond the right margin of the sternum. There was a systolic murmur heard in the ordinary positions of mitral and tricuspid areas and up towards the aortic and pulmonary areas. In the latter areas (and over the mass about to be described) first and second sounds were fairly well heard, slightly impure but not masked by definite bruits.
Pulses: The right pulse was well felt - 90 - regular - equal in force and time - volume moderately large - force poor and tension low, - Wall not much thickened, - left pulse was never present.

From the upper border of the second costal cartilage of rib down to the upper border of the fourth costal cartilage, and extending transversely outwards to near the anterior axillary margin, there was a mass with well marked pulsation over it - pulsation being not expansile but transmitted. The mass was dull to percussion. It should also be noted that the heart sounds were best heard to the right of the normal mitral area, that is a little to the left of the sternum.

The left side of the chest was moving badly, the right very fairly. V.F. absent over left front - present over the right front. Over right front and in right axilla P.N. resonant. On left side, P.N. absolutely dull over the mass as described - above the mass, P.N. impaired to the apex, and also impaired in axilla. B.S. vesicular on the right side - absent on the left. Over the backs V.F. was present at the apices, absent below. P.N. much impaired all over left back., - resonant over right back. Vesicular breathing over right back - no breath sounds over left back. From about the fifth rib downwards, there was on both sides well marked whispering pectoriloquy more intense on the left side, but definitely present on the right side. Above the level of the
fifth rib V.R. was present, but there was nothing to note about it. There was no contraction or bulging of the left side, and no difference in resonance. Left base was explored, but no fluid obtained.

Deep dulness of the liver began at the lower border of the fifth space, and the liver was felt about two fingers' breadths below the right costal margin.

The spleen was felt about two fingers' breadths below the left costal margin. Percussion method was not applicable because of the general left sided impairment.

Vocal cords: On phonation, the left cord was observed to move rather poorly—suggesting paresis rather than paralysis. Pupils were equal and reacted well to light. There was no tracheal tugging; there was no dysphagia; temperature was somewhat raised; there was a faint cloud of albumen in the urine.

The patient went on fairly well, seeming better for the rest in bed. She was given potassium iodide and arsenic, but these drugs were not pushed as patient was not tolerant of them.

The signs continued the same, except for a curious variation over the left back. Sometimes there was present a large area of faintly tubular breathing at the left base behind, with a few fine crepitations. On other occasions no tubular breathing was to be heard, when breath sounds would be feeble
or not heard at all. There was also sometimes to be heard, at a spot a little internal to the angle of the left scapula, and at about the end of expiration, a curious two and fro rub - "pericardial" in tone, but difficult to describe.

The patient was rigidly kept in bed, but at the end of six weeks was discharged.

A few days before she went out, when the breath sounds at the left base were very feebly heard and the to and fro rub, described above, was present, the patient was examined by X-rays. From the front the screen showed the left side of chest to be very resistant to the rays. There was no sign of anything suggesting the definite pulsating margin of an enlarged aortic shadow. On the right side a larger than normal right heart shadow was seen, the diaphragm was moving well and the lung was clear. From behind the view was similar, except that towards the base of the left chest the shadow was slightly less intense and that on the right side the heart was better than seen from the front. The radiograph was taken from the back and conforms to the above description.

**Diagnosis:** In this case, in spite of the strong suggestion of the patient's having had syphilis, of the history of hard work, of the obliteration of the left pulse and the weakness of the left cord (I understand in regard to the latter two points, that some observers say they often obtain in new growth) and have the long history, which one would hardly expected in
an intra-thoracic new growth - the clinical diagnosis I should say pointed to new growth rather than to aneurism. The absence of anything in the way of marked contraction of the left chest would probably contra-indicate the presence of anything in the way of syphilitic fibroid contraction, nor would one expect the other signs to be so intense in that case.

The screen picture, like the radiograph, was somewhat disappointing. The striking point was the great blank shadow on the left side. X-rays strongly favoured new growth.

Charts of physical signs and screen view.

--- --- PN: absolutely dull + VR: constant
--- --- VF, VR, BS = s absent in UR + BS.

VF absent
PN dull
BS absent

Where horizontal lines Equal Whispers
Peeler's Log.
The patient died a few months after she left Hospital, but I heard no details, except that there was no post mortem examination.
CASE IX

Double Basal Disease

Nancy C., aged 31. Had had wasting and weakness for one year. For five months cough. One month and keep to previously influenza, which made her go to bed. At time of admission the cough was better. Expectoration used to be green; later on it became white and frothy; it was never rusty or red. The patient was thinner. Two weeks before admission she had had heavy sweats, but not otherwise; she had also had much dyspnoea and considerable pain in the chest, made worse by coughing. She slept on her back. No curving of nails or clubbing of fingers or toes. Temperature was raised at night, but gradually came quite down.

Physical signs: Poorly clothed chest, both sides moved badly. Over fronts V.F. and V.R. poor; no impairment of P.N. and B.S. vesicular and feeble, with no definite crepts or other adventitious sounds. Behind: Vocal fremitus was poor at apices. P.N. resonant, breathing vesicular; there were no crepitations; vocal resonance was poor. At bases, there was a strange concentration and bilateral arrangement of the signs. From about the sixth ribs P.N. was impaired - more so at the bases, especially at the right, where it was absolutely dull - with marked resistance, this being specially marked on the right side. The breathing was bronchial, V.R. aegophonic. There was also a curious intensity of the signs just
below and without each angle of scapula. There were many sharp crackles at each base. There was slight indrawing of the right base. Expectoration was numerous; no tubercle bacilli found. Heart's apex beat was felt and seen about half an inch internal to the left mammary line. A.C.D. extended from third rib for one finger's breath within the L.M.L. and not beyond the right sternum. Sounds were pure. Liver extended from left base to 6th costal margin. Bases were explored and from below the angle of the right scapula there was removed a tiny flake (proved, on microscopic examination, to be pus with some blood). Left side gave a like result. There was evidently no fluid. The flake obtained must have been from the lungs. There was no albumen at first, but there was some found on other occasions. The chlorides were normal.

The patient progressed fairly well. The physical signs at the bases continued much the same, except that the intense cavernous signs below and outside the angles of scapulae disappeared. The heart's apex beat, too, gradually came to be pulled out. There was much dulness with bronchial breathing at both bases, extending up and even to between the scapulae. There were spots of intense cavernous breathing, whispering pectoriloquy and in places aeogony. The heart's apex beat had come to be pulled out beyond the left mammary line. At this time the patient was examined by X-Rays. The screen showed both fronts
to be clear; the left heart to be pulled out to the left, the right diaphragm to be somewhat high and the left to be not well seen. The important view was from the back. At first sight on looking at this view, one's impression was that the picture presented a view of diaphragm on both sides, but the mass as described was seen not to move on respiration, or but very little. The heart was seen pulsating on the left side, but was rather involved with the shadow of left base. Where there is a circle in the diagram, the lung was unusually clear. Dr Walsham, who was kindly seeing the case for me, on seeing this said vomica signs ought to be found on that spot, and so examination proved. The radiograph taken from the back, does not present some of these points very clearly. Its great feature is that one sees, instead of ribs and spaces at the base (with, on the left side, the heart shadow and a little heart shadow on the right side) a part of the sensitive paper, corresponding to the part of film unaffected by rays unable to pierce the mass, presenting simply a blank shadow.

---

Physical sign from front:

Physical sign from back:

Diaphragm:

A. S. diaphragm

Heart:

A. B. heart
The patient gradually improved. Physical signs grew less, the subsequent screen views showed somewhat less marked shadows and no cavity signs. The patient went to a Convalescent Home. I heard that afterwards she returned to hospital with a little and doubtful cavernous breathing at the right base and with a few crepitations there, One cannot feel sure that the case was, but on the whole the indications seem to point to a double, very gradually resolving pneumonia.
The explanation that the auscultatory signs might be conducted from one base to the other was quite apart from percussion, which showed dulness at both bases, negatived by the X-ray picture of bilateral disease.
CASE X

Bronchiectasis. Radiographs 16 & 17.

Florrie G., aged 36. This case was one of old-standing cough with, in latter years, paroxysms of profuse and foul expectoration. At the time these notes were taken, patient's breath was foul; there were also attacks of profuse and offensive expectoration, generally coming up in large amounts with paroxysms of coughing occurring first thing in the morning. No joint or skin lesions, vary marked clubbing of the fingers and toes.

Physical signs of chest, etc. The left shoulder depressed, marked scoliosis of dorsal spine, convexity being to the right. Left side of chest deficient in expansion and movement, but showing no marked retraction. There was a swelling showing slight but not very evident pulsation, over the second costal cartilage, and better seen than felt. Left V.F. well marked, specially over the back; R.V.F. poorly marked. Crepitations at right front about second rib, vesicular breathing and no dulness. On the left side, P.N. impaired about second left costal cartilage, and dull over left back. Over left back there was tubular breathing at the apex, and vocal resonance much increased. There was also a considerable patch of cavernous breathing, with whispering pectoriloquy at the level of the fourth and fifth ribs, and a patch of cavernous breathing and pectoriloquy just below the angle of left scapula.
Scattered bubbling râles just along the inner border of scapula. Heart’s apex beat not well felt. A.C.D. extended from fourth rib to one finger’s breadth beyond the left mammary line and not to the right of the sternum. Sounds pure; no special accentuation or reduplication. Temperature not raised. The case was evidently one of bronchiectasis, as favoured by the very long history, the foul breath, paroxysms of offensive expectoration containing no tubercle bacilli, and separated by comparatively long intervals, the scoliosis, the scattered more or less cavernous signs, the very marked clubbing of fingers and toes. The screen from the front showed right side to be clear; and diaphragm moving well. On the left side there was a dark patch, as put in in diagram, there was also a very clear patch and general slight shading. The heart was well seen, and was not much out. Diaphragm not very well seen. The scoliosis was, no doubt owing to the sternum, and the site of the scoliosis, and the fact that scoliosis affects the processes rather than the body, being a rotation rather than a displacement, scoliosis was not to be seen from the front. From the back, the first and most striking point was the extreme scoliosis; less striking was the general shading over the left lung with a comparatively light area roughly corresponding to one of the cavernous areas referred to in notes. The right side was clear, except for a slight tract of shading as in diagram. The left diaphragm could
right half
not be seen; the left was moving well. Perhaps the
marked clearness of the right side indicated the
presence of "compensatory emphysema". The radio-
graph of the chest was taken from the back. Most of
the above points are fairly well brought out. In
reference to it, I must emphasise the fact that when
it was taken, the patient was sitting up with the
shoulders square, and that the appearance of extreme
scoliosis was not artificial, I also include a
radiograph of one hand and one foot. The clubbing
of the fingers and toes, unassociated with any os-
seous expansion or enlargement, is fairly well
seen.

Chart of physical signs and screen view.
CASE XI

Large Vomica

Samuel W., aged 11. This case was one of pulmonary tuberculosis, with very extensive vomica signs at the left apex, as well as wide-spread tubercule scattered through the left lung. The important points were brought out by the X-ray examination, and all are well seen in the first of the accompanying radiographs - the vomica affecting practically all the upper lobe of the left lung - the high diaphragm on the left side making the two halves of the diaphragm on the same level instead of the right half being, as normally is the case, higher than the left - the small and more or less vertical cardiac shadow - and the very clear right lung, due to the presence of a certain amount of emphysema, but still more to the very thin chest wall of the patient, the important point being, of course, the absence of any indication of tubercular infiltration of the right lung.

Two radiographs are enclosed because in the first, where the cavity is so well seen, there is above the right clavicle a white circular patch, due no doubt to the plate having been fogged at that area.

The second radiograph gives the cavity (which possibly at the time the radiograph was taken may have been partly filled) less well, but shows absence of the patch described above. In both the right sides, owing perhaps to the thin chest wall being hardly able to stand so long an exposure, are rather
blank—the rays having attempted to penetrate all the structures on the right side.

I append charts of chief physical signs and diagrammatic representations of screen view.

The radiographs were taken from the back with the patient in a sitting posture. I should like to call attention to the sharply defined limits of cavity in this case. Physical signs

Screen view

Very clear

R. Heart shadow

Diaphragm well seen

with movement

Faintly clear, pressure shadow

Diaphragm badly seen

V. clear + definite matted wall

Diaphragm high

+ showing for

Expiration

Clear

R. Heart + echo

Diaphragm moving

Faintly well
Pulmonary Tubercle.  

Elizabeth B., aged 39. The interest in this case lies in its slow progress, as evidenced by physical examination and skiagraphy. Patient had been 18 years ill with cough and pain in the chest. Five years ago there were at right front signs improbable indicating vomica formation. The right apex behind also showed impairment to percussion and the presence of crepitations, with bronchial breathing and whispering pectoriloquy. There was also some impairment of percussion at right base and crepitations with well marked vocal fremitus. When I examined the patient, expectoration had been more recently, and contained numerous tubercle bacilli. She was able to get about and do her work. No wasting, slight curving of nails. Temperature 97.6. Respiration 24 and easy.

Physical signs. Movement and expansion very poor and limited on both sides, and very deficient on the right side. Both fronts were prominent, but shoulders and posterior aspect of thorax not rounded. Under there was slight hollowing at right clavicle. V.F. well marked from right clavicle to second rib. Absent on the left side. Percussion note dull from right apex to lower border of second rib - then resonant to the fifth space, where impairment began (the screen showed upper border of liver under the diaphragm at about the sixth right space in I.M.L. in quiet respira-
tions. P.N. resonant on left side. B.S. were cavernous over the right front from apex to about the lower border of the second rib. Below that bronchial. Whispering pectoriloquy to second rib. A few crepitations over right front. In right axilla breathing masked by sharp crepitations. Left B.S. harsh vesicular and expiration prolonged.

Backs: W.F. absent except at right apex. P.N. impaired from apex to fourth rib, then resonant to the base. Left P.N. resonant. Right B.S. sounds cavernous to third rib, then vesicular downwards - rather feeble at base - many crepts from angle of right scapula downwards. On left side breathing harsh vesicular. Heart's apex beat not seen, not felt; no praecordial or other pulsation. A.C.D. extended from third space to three quarters of an inch within L.M.L. not made out beyond right margin of sternum.

(Please see X-ray diagram) No cardiac bruits, but first sound in mitral area (as placed by percussion at left border of heart and by auscultation) was very markedly reduplicated. Liver not palpable.

Screen from the front showed on the left side clear spaces and ribs, left diaphragm moving well; heart shadow small and vertical. On the right side there was a dense shadow extending from the clavicle to the upper border of third rib and with very definite borders. Right diaphragm was not moving very well; right heart shadow just seen. The remaining part of
lungs seemed to me to be clear, but not so brilliantly clear as the left lung. As regards the very dark patch towards the apex, I should, viewing it in the light of physical signs, have been inclined to regard it as the shadow of thickened pleura obscuring the bright reflex of the cavity. But as to how far the pleural thickening really cast a shadow seems somewhat uncertain, as I have tried to indicate by the literature. Again, clinically, the signs as to a cavity are, of course, somewhat misleading sometimes.

The wide spaces and the horizontality of the ribs are also worth noting. From the back, the view was similar. There was a well marked right apex shadow and definite shading below.

**Chart of Screen view**

![Chart of Screen view](image)

- Physical Signs
- Better movement
  - VF present
  - PN present
  - B.9. hardness. Sept
- PN impaired
  - B.9. 1st. posterior & anterior Peck
  - B.9. feet
  - Many coughs

L. Lung
Screen Views

V. Clear

Vertical heart well seen

R. diaphragm showing fair excursion

L. diaphragm showing good excursion

Clear lung

Vertical heart

Tentatively .

Some slight clearing

Tentily dense shadow
CASE XIII.

Pleural Effusion. Radiograph 21

Charles N., aged 40. This is the case of a man with a large serous pleural effusion. Physical signs: The right side of chest was moving very badly, and the left expanded and moved satisfactorily. No special bulging or retraction anywhere.

MEASUREMENT

Just above nipples

18 ½ in. 18

A little below angles of scapulae

18 ½ in. 17 ½

taken in quiet respiration

Other physical signs: Fronts: on right side vocal fremitus present from apex to third space; below that level absent. Skodaic resonance above second right space. From second right space to fourth rib, P.N. slightly impaired; below that level P.N. dull and resistant. B.S. above second rib loud with expiration prolonged; below second rib B.S. fainter and becoming very faint over the upper part of dulness. In right axilla P.N. very dull. Bronchophony about second space. No adventitious sounds.

Left side: V.F. and V.R. well marked. P.N. resonant. B.S. vesicular and loud.

Backs: right. V.F. present at apex; below third space absent. P.N.-skodaic resonance quite at apex below second rib slightly impaired; from fourth rib absolutely dull. B.S. very faint; absent in places; quality doubtful. Aeogophony about the angle of scapula
and extending upwards somewhat. Left side: V.F. well marked; P.N. resonant, B.S. loud, vesicular.
The area of cardiac dulness extended from the fourth to two and a half fingers' breadths beyond the left mammary line; right border probably merged with right sided dulness. There was no movable dulness.

The screen showed all the right front to be much in shade - the right border of the heart was seen to right of the sternum; the left border of the heart well beyond L.M.L. as in clinical notes. The diaphragm was dimly seen on the right side from the front, but better seen on the left side. From the back the greater part of the right side appeared in shadow; the shadow having a definite sickle-shaped upper margin at the level of the third rib, just below the definite margin was seen a very limited small clear space. It should be noted that the margin had its convexity upwards. The screen showed faintly the inner inch or so of the fourth and fifth ribs, but the radiograph shows more in the way of ribs. The right diaphragm not seen from behind, while the left diaphragm and the heart were dimly seen. In the light of subsequent events, it is very interesting to note that the fact of the left base was not very clear suggests the possible presence of a little fluid.
The want of clearness of the right apex should also be noted, as indicating the possible presence of tubercle.

Subsequently 64 oz. of serous fluid was removed.
When I wished to examine him again by the screen to get a contrast view, the patient was too ill to let me do so. Some days afterwards his left side had to be tapped for an extensive effusion, so that it is not unlikely that the dimness at the left base, as mentioned above, was due to the presence of the fluid.

Chart of chief physical signs with screen view.
CASE XIV

Slight pleural effusion

Thomas B., aged 35. Some weeks previous to the time when the present notes were made, this patient had had a fairly extensive pleural effusion in the right chest. At the time the radiograph was taken, the patient's chief physical signs were as follows: -

The right side of chest was moving very deficiently, especially at the apex. There was slight impairment right of percussion note, with feeble breath sounds and slightly jerky inspiration. On the right front V.F. was well marked, and V.R. was present. In right axilla percussion note was dull. On the right side behind there was bronchophony at the apex, while at the base from about the angle of scapula downwards, the P.I. was somewhat impaired, B.S. feeble. But the V.F. was well marked all over the right back and quite to the base. The left side, back and front showed very fair movement, with well marked V.F., resonant P.I., loud B.S., with some prolongation of expiration; the vocal resonance was present in front and well marked behind.

As in diagram H.A.B. was not seen or felt, A.C.D. not made out to right of sternum not defined; the cardiac sounds were best heard about the fifth space, and a little within the I.M.L. The liver could just be felt below right costal margin. The temperature for some weeks had been of a hectic type, but had gradually come down to about normal, and was remaining steady.
From these signs one could scarcely say whether there was still a little fluid present or not.

**X-Ray examination.** From the front, the right side appeared to be somewhat in shadow (Query: thickened pleura - or Query: tubercular consolidation).

The right diaphragm was moving less well than the left; the left lung was clear; the heart was seen well and was not at all displaced to the left; the diaphragm was moving well, and on a deep breath the space between the heart and diaphragm was well brought out.

Screen viewed from the back. From the right side there was seen a fairly dense shadow with more or less definite edge, as in diagram; there was much less clear lung on the right than on the left side; the right base was slightly in shadow, apart from the more defined shadow referred to above. The right diaphragm was somewhat dimly seen. On the left side the cardiac and diaphragmatic shadows were well seen, towards and there was just a slight shadow at the left base.

Dr. Walsham, happening to be in the Hospital at the time the examination was made, I asked him to examine the patient with the screen. On his doing so he thought there was probably a little fluid left at the right base. His opinion was verified by my removal of half a syringeeful of serous fluid, the needle being inserted about two inches below and a little within the angle of the right scapula.

The radiograph was taken from the back, the patient being in the sitting posture. Unfortunately,
probably through over-exposure, it shows considerably more of the ribs on the right side than the screen shows - a faint line in photograph indicating the inner edge of the shadow as seen by the screen. It also shows nothing suggesting the presence of any fluid at the right base. I, however, must confess that by the screen the presence of fluid was not very obvious, although there was present the appearance I described above. But I was struck with Dr Walsham's verified observation, as it seemed to suggest great possibilities for the X-rays as used by an accomplished expert.
Screen View

Shadows of:
- Thickened flanks
- Consolidated lung

Breadth moving
- Anteriorly
- Lateral

Clear

Heart pulsating well seen

Space between heart
- Breadth

Breath moving
- Anteriorly
- Lateral

Clear

Slight shadows

Breath moving
- Anteriorly
- Lateral

Clear

In the left
- Shadow
- Bounded edges of a
- Breadth
- Anteriorly
- Lateral
This Thesis, being already, as I fear, longer than may be considered desirable, it behoves me to be extremely brief in bringing it to a conclusion.

Firstly, then, there are in these pages various references to the need of special and skilled observation for X-ray work to be of any real value in medicine. Personally this aspect of the subject strikes me somewhat forcibly. Thus, so little do some people seem to see in their earlier examinations with the screen, that I recall once hearing a distinguished authority on cardiac disease say (after examining with the screen, a man with a view of ascertaining whether the patient had an aneurism or not), that he could see nothing at all. Nor was this surprising, as the observer went on to say that he had never examined with the screen before.

To begin with, it is very difficult "to see" one's way about the chest. I have constantly felt surprised to find the heart shadow, as examined for from the back, so low in the chest. Then again, the aortic shadows generally seen lower than one would expect from clinical and anatomical impressions. The difficulties of localising are, no doubt, much lessened by resort to some of the means referred to in the Introduction.

Undoubtedly much patient observation is needed.
The varying statements and conclusions on the same subject as reported on by different observers, suggest that the field for differences of opinion and for uncertainty is as great in this as in any other branch of medicine. Thus Williams and Gardiner seem to have come to quite different conclusions as to the normal excursion of the diaphragm. Again, with such authorities as Walsham, Williams, and Bergonie and Carrière expressing, as to the relative intensity of shadows cast by serum and by pus, opinions utterly at variance, not to mention the apparent uncertainty as to whether thickened pleura casts a shadow, or to what extent one may feel sure as to the presence or not of pleural adhesions, one at once recognizes the need, before one can speak authoritatively, of experience in this subject as in all branches of medicine.

Still more, owing to the eye-strain involved and the somewhat sombre surroundings, (for groping about in a dark room is not an enlivening occupation and contrasts somewhat unfavourably with the pleasure to be derived from meeting your patient eye to eye) one needs the patience of that greater character of history.

Granting all such drawbacks, I still feel from some of my own experiences and from the statements, personal or otherwise, of such authorities as Williams and Walsham, that in the X-rays we have a most valuable addition towards more accurate and certain diagnosis, and that in this relation, as in all other
aspects of medicine, one must take a broad outlook, and, as Tennyson says "Let knowledge grow from more to more."

While the great scope for X-rays in chest disease is, I should say, chiefly associated with the diagnosis of early pulmonary tuberculosis and of aortic aneurism, there are obviously many other diseases and cases on which the use of Rontgen Rays would throw light. The author will never forget his feeling of extreme humiliation, when, on taking a glance through the fluoroscope, he realised he had clinically missed a pneumothorax with one side of the chest half full of fluid. In connection with the diagnosis of early pulmonary tubercle by the aid of the screen or the fluoroscope, I have not had much experience, but from such cases as I have seen, I am certain of the difficulty of being sure whether or not a faint shadow is within the range of what is normal for the chest in question, and whether the diaphragm is making sufficient excursion or not, and realise that such difficulties are only to be overcome by patience and experience. In such cases casual opinions are worthless. With the treatment of pulmonary tubercle steadily becoming more hopeful, especially in cases diagnosed early, the importance of any means of very early diagnosis is obvious. Hence, of course, the extreme importance of the use of X-rays in this relation.

In aortic aneurism the difficulties are, no doubt, much less. But even here one must remember how wide
is the range of what is normal.

Sometimes, too, no doubt, the roentgen Rays would settle the question of whether pleural effusions were present, and so save the patient from the dread "operation" of exploration. But on the whole, I should think that at present in effusion (apart from the or subsidence question of its extent, or of whether associated with pulmonary tuberculosis) the interest is more academic than practical, unless indeed a limited pleurisy or interlobar empyema.

Also in sometimes proving a more accurate agent of localisation in various pulmonary lesions, or a better means of indicating the extent of a pericardial effusion, the rays may prove of great value to the individual surgeon; Also in innumerable instances of cardiac or pulmonary diseases easily, as a class, recognised and defined by clinical means, the use of X-rays is no doubt of value in indicating a point missed by clinical examination or not sufficiently attended to.

In all these aspects of disease, there seems a wide and extremely useful field for this new means of investigation. But when we come to acute disease, such as acute lobar-pneumonia, I think we ought to pause before advocating routine use of a method that surely must put the patient to some considerable inconvenience. When one thinks of how, in such cases, the patient has to be supported while one percusses rapidly over a limited area, or hurriedly listens somewhere else — it seems somewhat sweeping to discuss the question of in such disease studying by the
aid of the rays the progress of events, and even, in
a severe case to us, this means for trying to verify
or make a diagnosis. Undoubtedly, the patient is
fit to stand the proceedings, the method must be of
great use in central pneumonia. In unresolved
pneumonias running on for some weeks, the use of the
rays would probably be tolerated fairly well. Again,
in oedema of the bases, associated with failing heart,
or with kidney disease, it seems doubtful whether
the patient is fit to be subjected to this method of
examination. But one must remember that such ob-
servers as Williams seem to claim that passive conges-
tion of the bases indicated by the rays although not be
recognised clinically. Perhaps, too, as Williams makes
no reference to any physical exhaustion attendant on
this method, he may find that with the apparatus at his
disposal the patient gains rather than loses by the
proceedings, even though the disease be fairly acute.
In the field of thoracic therapeutics, Rontgen Rays
do not seem likely to take a very prominent place.

One point that strikes me as rather significant
is that while many of the observations (as to individ-
ual cases, etc.) of "minor lights" prove nothing
really in favour of the use of the rays in thoracic
disease, at the same time the few adverse criticisms
are not in the least convincing, and are feebleness
itself when compared with the authoritative statements
of Walsh, Walsham, Williams, Bergonié and Carrière, etc.

One meets physicians who state that they have not
time to trifle with the X-rays, and that they prefer to be as nearly as possible perfect clinicians. Quite so, but at present the tendency of X-rays in certain medical diseases seems to be to indicate that some of the physical aspects of disease do not favour the evolution of anything like perfect clinicians.

Finally, at the very least, it is due to the Rontgen Rays in relation to intra-thracic disease, to admit that they are a most worthy ally of inspection, palpation, percussion and auscultation.