motive changes in the tissues concerned (Croonian Lecture, *Brit. Med. Jour.*, Mar. 22, 1902).

Perhaps one reason for the addition of so many grams (about 15) of NaCl daily to our food is this, that the organism needs and utilises it as a means for the production of electrical work.

CONCLUSION.

One word in conclusion. There are those who look upon the ionisation theory as absolutely false, and who will have none of it.

I think, however, there is a deepening conviction among chemists and physicists that, whatever may be its difficulties, and whatever form it may ultimately assume, it is an extremely useful working hypothesis.

It has co-ordinated whole series of facts which were before dissociated, or obscurely recognised; it has shed the light of reason upon many practices in analytical chemistry which were previously altogether empirical, and it explains many reactions which are otherwise but dimly or imperfectly understood.

ART. XVII.—*On the Use of "X-rays" in Medical Diagnosis.*^a By WILLIAM S. HAUGHTON, M.D.; Surgeon to Stevens' Hospital; University Demonstrator in Röntgen Photography; Member, Röntgen Society of London. (Illustrated.)

DURING the past six years the X-ray examination of a considerable number of patients (some 1,900 odd) in hospital and private practice has brought home to me the conviction that while Surgery and Dentistry have claimed an ever-increasing amount of help from the Rays, Medicine, at any rate in this country, has not availed itself as fully as it might have done of this additional mode of diagnosis.

The reason for this may be twofold—a natural diffidence to adopt a new method of examination, whose utility was unproved, or neglect on the part of advocates of the process to call attention to its utility in medicine.

^a Read before the Section of Medicine in the Royal Academy of Medicine in Ireland, March 7, 1902. [For discussion on this Paper, see page 448.]

The first of these difficulties is now removed by the records of splendid and sterling work from French, German, and American centres;^a and with regard to the second, I may state that some three years ago I had the honour of calling attention to its possible value in the Pathological Section of the Academy, and in a Presidential Address before the Dublin University Biological Association.

It is my object briefly to call attention to those applications in medicine which have been proved successful, only detailing one or two illustrative cases amongst those which have come under my own notice.

In pulmonary tuberculosis I need hardly call attention to the great value of an early diagnosis, placing, as it does, the physician in a much better position to prescribe treatment, and greatly increasing the patient's chances of recovery.

In this disease, whose great prevalence and high mortality are universally recognised, "X-rays" have rendered splendid service, and will, I am confident, come into very general use when their true value is justly estimated.

Two constant physical signs are present in this affection when examined by the Röntgen method—namely, *opacity*, which depends on the *extent* and *density* of *consolidation* in the lung, and *restricted movement* of the diaphragm on the affected side, depending on the *loss of elasticity* in the lung tissue.

Before detailing cases let me describe my method of conducting this examination. I may say at the start that the fluorescent screen is infinitely preferable to any photographic method, for these reasons—the cardiac movements disturb the lung tissue for a considerable area around, and though very short exposures may avoid the faults due to respiratory movements, the disturbance due to the heart considerably lessens the value of the examina-

^a Many of the observations mentioned in this Paper as the result of my own "X-ray" experience have been made independently by other "X-ray" workers, an excellent account of which will be found in the "Röntgen Rays in Medical Work," by David Walsh, 3rd edition; "Practical 'X-ray' Work," by Addyman; and "The Roentgen Rays in Medicine and Surgery," by Williams.

tion. On the other hand, the method by screen examination occupies a much shorter time—a few seconds in some cases—and possesses the further advantage that with the eye one can actually *watch* the movements of the heart and diaphragm, as their contour and position change, and record them on a suitable surface, from which accurate measurements can be made.

I find most “X-ray” workers of experience agree with me in this opinion; and when *very delicate differences* in shadow have to be estimated, as happens in very early cases of lung trouble, one can so graduate the “X-ray” light, while watching it on the screen, as to indicate a very slight opacity, which cannot be done in the photographic method.

To examine a chest, one merely places the patient with his back to the Röntgen lamp, which is placed at a fixed, known distance from the screen, and in a fixed relation to the anatomical structures in the thorax.

I find two feet from the lamp to the screen a convenient working distance, at the level of the ensiform cartilage, for observing the movements of heart and diaphragm.

It must here be pointed out that if the comparison between two different patients is to be of any use, the successive examinations must be conducted on what is known in experimental science as exactly similar conditions. Hence the necessity for adopting some such constant method as I have described.

If the patient is more comfortable sitting down the examination can be made so, but diaphragmatic movements are thus impeded; while if the recumbent position is essential for the safety of the case, a canvas stretcher permits the examination in the horizontal position. Having placed patient in one of these positions, a large screen is placed over chest, the light turned on, and observations are made of the position of the heart, and excursions of the diaphragm in quiet breathing. Then its level in forced inspiration and expiration is observed; and finally a close scrutiny is made of the relative transparency of the two lungs, and any isolated shadows due to patches of con-

solidation are searched for. During the course of this examination it is very necessary to vary the amount and quality of "X-ray" light, as I find slight differences of shadow may be overlooked in a light which is too strong.

To record the results of this examination I use one of two graphic methods. First, looking at shadow of heart and diaphragm on screen, with a dermatographic pencil I trace the outline of each on the patient's skin, first in full inspiration, then in full expiration. Next, the position of any shadow due to consolidation is marked on skin. From these marks on skin a tracing is made on tracing paper (some of which were exhibited), noting position of supra-sternal notch, ensiform cartilage, and nipples, or any special rib.

The other method of recording is to use a large sheet of celluloid, placed either on patient's skin or in front of screen, and on this celluloid the shadows are traced precisely as in the first method. One advantage of the celluloid method is that a case can be examined and recorded without the removal of clothes—a point that is sometimes much appreciated by the patient.

DIAGRAM 1.—NORMAL ATHLETE'S CHEST.

The highest line marks level of diaphragm—in forced expiration. The lowest line—in forced inspiration. The two intermediate lines—in quiet breathing. The central mass is shadow of heart in full expiration and inspiration. The excursion of diaphragm in this case in extreme movements was $3\frac{1}{4}$ inches; in quiet breathing, $\frac{1}{2}$ inch.

"X-ray" examinations have proved most valuable in the following varieties of *Pulmonary Tuberculosis* :—

1. In the diagnosis of very early disease, when there are *no* physical signs, or where they are very doubtful. For instance, in a patient suffering from anæmia, digestive troubles, and a slight temperature; but with *no* cough or expectoration.

2. In a case with very slight physical signs.

3. In one with complications, such as bronchitis, pleurisy, emphysema, or pneumonia, masking the tuberculosis.

4. To confirm diagnosis.

5. To test lungs (*a*) where a known tubercular focus exists elsewhere; (*b*) or in cases with a bad family history, to allay fears on part of patient or relatives.

DIAGRAM 2.—PHTHISIS.

The *apex* of left lung throws a shadow (shaded area), due to "consolidation." Excursion of diaphragm (extremes of full inspiration and expiration) on diseased side was $1\frac{1}{2}$ inches, as against $2\frac{1}{2}$ inches on the normal side of chest. The only physical sign in this patient was hæmoptysis. A few days after "X-Ray" examination tubercle bacilli were found in sputum.

In a very early case of consumption the following signs are found present in an X-ray examination :—

1. Slight opacity of one apex, or of that part of lung where disease is commencing.

As I have pointed out elsewhere, to detect this slight opacity, due to consolidation, requires sometimes a very

considerable experience in X-ray screen examinations, and manipulative skill in adjusting the quality and quantity of X-ray light.

2. Restricted movement of diaphragm on the affected side, due to loss of elasticity in the lung tissue. This restriction of movement is most marked, as a rule, in the lower ranges.

3. In some cases, during deep inspiration, the heart is displaced towards affected side.

Later on in such a case, where the usual physical signs have become established, "X-rays" show an *increase* in the *opacity* and *size* of the shadow of the consolidated patch: and at same time the diaphragm's movements become more restricted on the affected side.

Very often in a case where one apex only is suspected, "X-rays" will demonstrate a patch of consolidation in the other apex.

We can easily see the important bearing of these observations on the treatment of a case of phthisis, especially when taken in conjunction with percussion and auscultation. The results of the usual methods of examination can be confirmed, and in some cases the presence of more extensive disease diagnosticated.

DIAGRAM 3.—ACUTE PNEUMONIA.

The right *lower lobe* is affected, and throws a **shadow** (shaded area), due to "consolidation." Note excursion of diaphragm restricted to $1\frac{1}{2}$ inches on affected side, as against $2\frac{1}{2}$ inches on sound side.

In the course of treatment the precise extent and progress of the disease may be watched by "X-ray" examinations repeated at regular intervals.

The process of resolution in a patch of consolidation is marked by a diminution in the opacity and size of its "X-ray" shadow. What has been said of the value of this examination in the treatment of a case is, of course, equally important in giving a prognosis.

When phthisis is complicated by bronchitis the former condition is recognised by the patches of opacity.

When pleurisy is present it can be distinguished by signs to be mentioned later on. This is true, also, of such complications as emphysema and pneumonia.

In the diagnosis of acute pneumonia little doubt exists as a rule; but where the disease commences in the central portion of a lobe, much doubt may exist for a time.

The Röntgen method in pneumonia yields following signs:—

1. Dense opacity of part or whole of lobe, according to degree of affection.
2. Restriction of diaphragm on affected side, or sides.
3. Displacement of heart away from affected side, accompanied by dilatation.

DIAGRAM 4.—LOBULAR PNEUMONIA.

Both sides of chest being affected equally, the excursions of diaphragm are equal, $1\frac{1}{2}$ inches; but note that this $1\frac{1}{2}$ inches is a "restricted" movement, as against the $2\frac{1}{2}$ inches *normal* range in full expiration to full inspiration.

In the after-treatment of a case of pneumonia, and more especially in forming a *prognosis* as to risks of secondary affections of the lung, I believe "X-rays" will be of the greatest service.

For a considerable time after the crisis in pneumonia—some weeks—the affected lobe is found to be somewhat opaque, and the diaphragm's movements much impeded by the want of elasticity in the lung. If these signs (when other physical signs are absent) persist for a considerable time, as they sometimes do, the after-treatment of such a case would be necessarily more cautious and prolonged.

The complication of pleurisy in pneumonia also leaves behind it signs of restricted movement.

DIAGRAM 5.—PLEURISY.

Right-sided effusion—tapped—80 ounces. Note that upper surface of diaphragm on affected side cannot be distinctly seen, owing to adhesions and thickened pleura, &c. The *upper line* points to "compressed" lung—(shaded area). The *middle line* points to a narrow area, where "X-Ray" shadow was intermediate between that of lung and liver. Percussion over this area gave absolute dulness. The *lower line* points to liver shadow. The movement of diaphragm on affected side was practically nil—probably owing to adhesions.

In pleurisy, when an effusion is present, the screen shows following signs:—

1. Contour of diaphragm is partly or wholly obscured—the pleuritic fluid being very opaque, compared with lungs.

2. The lung in affected side is more opaque uniformly, due to compression by the effusion.

3. The heart shadow is also, of course, displaced away from the fluid.

When the fluid is free in the pleural cavity, changes in the patient's position will cause a corresponding change in the appearance on the screen; while in an encysted pleurisy the shadow is stationary.

"X-rays" also show much more displacement of the heart than can be elicited by percussion, in a certain number of cases.

Interlobar effusion can also be readily distinguished.

In emphysema of the lungs the screen shows a much brighter and more transparent condition, due to dilatation of air vesicles, and greater quantity of contained air.

This is, of course, present on both sides.

In pneumo-thorax, both with or without hydro-, pyo-, or hæmo-thorax, the pleural space filled with air is remarkably transparent, when contrasted with opposite side of chest.

Tumours of intra-thoracic origin, malignant growths in lung, pleura, or mediastinal glands, also bronchial tubercular glands, and some cases of œsophageal cancer, all yield distinctive "X-ray" signs.

DIAGRAM 6.—ANEURYSM OF AORTIC ARCH.

Contrast this diagram 6 with the normal heart, No. 7. The line through left shoulder indicates the shadow of the aneurysm; which had undergone consolidation under treatment. Note also the shadow of the *broad, flabby, dilated* heart.

Aneurysm of Aorta.—This condition is very readily diagnosed by X-rays, and especially in early stages seems of larger area than percussion can indicate.

DIAGRAM 7.—NORMAL HEART.

This shows the contour shadow of the normal heart in *full expiration* and *full inspiration*. In the latter position the area of *cardiac dullness* as obtained by *percussion* is marked in dotted lines; and the impulse beat, both to sight and touch, is indicated by the "star."

Normal Heart.—Its size, shape, and character of pulsation (*i.e.*, its size and position in systole and diastole) can be watched and measured on the screen.

In many forms of cardiac disease most valuable information is obtained by observing changes in the size, shape, position, and pulsation of the heart. For instance, dilatation of an auricle can be distinguished from that of a ventricle.

It is superfluous to indicate the value of these observations during the treatment of cardiac disease.

In the abdomen we can now measure accurately the size, position, and shape of a distended stomach by giving a large dose of subnitrate of bismuth, and observing the shadow cast by the stomach fifteen or twenty minutes after.

I should also mention that dilatation of the œsophagus, due to stricture, can at certain levels be diagnosed by the same means.

In summing up the uses of "X-rays" in medical dia-

gnosis I would most vigorously insist that this graphic method for observing and recording the thoracic or abdominal organs by the eye should be used only as an aid to and in conjunction with the tactile and auditory senses of percussion and auscultation.

[Before and after the meeting Dr. Haughton demonstrated this method of screen examination with his apparatus on a number of patients suffering from phthisis (early and late), malignant tumour of œsophagus,^a and pleurisy, who were very kindly placed at his disposal for this purpose by Dr. Travers Smith and Dr. Percy Kirkpatrick.]

THE WAR IN SOUTH AFRICA.

A BOOK has just been published, entitled *Mentioned in Despatches* (Army and Navy Gazette, 3 York-street, Covent Garden, W.C., 1s. 2d. post free), which gives the whole of the mentions, honours, and special promotions in the Navy and Army, in connection with the South African campaign, which have been gazetted up to May 6th, 1902. We extract from the volume a summary of the honours bestowed upon the medical branch. The nursing sisters and other ladies have had forty-eight Royal Red Crosses. The share of the Navy is very small, being only two D.S.O.s. To the Army, and we include those consulting and civil surgeons who volunteered for service, and also Colonials, there have been awarded five V.C.s, one K.C.B., twenty C.B.s, two K.C.M.G.s, forty-seven C.M.G.s, and thirty-seven D.S.O.s. Non-commissioned officers and men have thirty-eight Distinguished Conduct Medals, and a sergeant-major has been awarded a bar for the medal he already possessed. The volume contains nothing new—all the information has been given in the pages of the *London Gazette* during the last two and a half years—but everything is presented in a concise form convenient for reference, and we are sure it will be welcomed by all who have friends or relatives mentioned or promoted for their gallantry and devotion to duty.

^a Since this Paper was read this case (malignant tumour of œsophagus) has died, and I am informed by Dr. Travers Smith that the *post-mortem* examination confirmed the "X-ray" appearances in every way.