

demonstrated that we furnish the highest grade of medical service, we need not fear that socialism and state medicine will come whether individuals, local charitable organizations, the towns and cities, the counties, or the state, give financial relief to the very poor.

I for one, am certain that earnest and free discussion of this matter among the members of the medical profession will set us on the right path of progress, and that along the lines of obstetrics at least, the danger of state medicine will amount to no more than it has in the lines of tuberculosis and mental diseases.

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### Original Articles.

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#### SOME CRITERIA OF X-RAY DIAGNOSIS.\*

BY FREDERICK W. O'BRIEN, A.B., M.D., BOSTON,

*Assistant Professor of Roentgenology, Tufts Medical School.*

ROENTGEN first observed the phenomenon of x-radiation twenty-five years ago. Like most things that are new and unexplored, x-rays were a fertile field for the charlatan in the early days and are today virgin soil for the snap diagnostician.

There is much to be said for the view held by certain eminent men throughout the country as to the unreliability of roentgen diagnosis. This distrust among members of the medical profession is partly the result, I believe, of the commercial development of a certain type of x-ray apparatus, very efficient in the proper hands, partly the result of a general lack of appreciation of the importance of certain criteria in x-ray diagnosis as demonstrated by jejune interpretation, faulty method of employing x-rays, failure of consultant and roentgenologist to cooperate, and a quite universal misapprehension of the limitations of x-ray in relation to final diagnosis.

It seems a paradox to say that the development of x-ray apparatus as we know it to-day has made for inefficiency when one reflects that the inefficient apparatus of days gone by was made the excuse for poor technical work and interpretation. But it has come about in this way.

Coolidge first described his hot cathode tube in 1911 and since that time has produced many modifications of it, including the self-rectifying radiator type, tubes which allow ready and exact regulation. Then came the evolution of the step-up transformer with auto control permitting exact regulation of voltage and milliamperage, current and pressure, so that we now have in tube and transformers, instruments of rela-

tive precision, out of which has been developed a technic for making x-ray negatives by rule of thumb that can be repeated *ad libitum* and learned by anyone, with abandon.

Contemporary with this progress was the perfection of double intensifying screens, photographic aids which materially cut down the time of the exposure of x-ray plates or double-coated films, so that we have had the commercial exploitation of the small transformer, a tremendous gift to mankind and useful beyond words, but mark me, pregnant with danger, not necessarily to life, although this cannot be disregarded, but particularly I had in mind the danger to our diagnostic standards.

This development in apparatus may be compared with that in surgical instruments. The old hand versus the electric trephine, the latter efficient to a degree but manifestly more potent for danger in the hands of the unskilled surgeon. It is my farthest thought to minimize the value of modern x ray apparatus any more than I would the electrically driven trephine, although I declare that neither one or the other can be used with success by following the printed instruction sheet that accompanies it.

The truth is the commercialization of the small x-ray transformer with double intensifying screens has not made for scientific education, but conceit.

As hinted above, the making of good x-ray negatives today is readily learned by formula. It may be done by a layman. In busy clinics, this procedure must prevail, but it should always be done under the direction of a competent physician specializing in roentgenology. My own experience has been that very well trained lay technicians never accomplish what a roentgenologist can, because they lack medical intuition. Their work is routine and not creative. If we are to have technicians, let them remain such, and roentgenology will be the better for it.

Roentgen interpretation in the field of medicine is the translation into the terms of pathology or normalcy of the visibilized shadows of the human body registered by x-rays on a fluorescent screen or suitable substance coated with a photographic emulsion. It is a study of color tones. It first presupposes that one is familiar with the character of shadows as they are cast upon fluorescent screens and upon the photographic plate, the color values being reversed in each case; secondly, that one is familiar with the x-ray appearances of shadows cast by the normal anatomy of the body as well as the anomalous and the pathological.

It would seem then that the lay technician is at once ruled out as one qualified to interpret x-ray shadows. Yet we have the spectacle of recognized hospitals employing laymen for interpretation as well as technical work.

Is a physician, then, better able to interpret roentgen findings than the lay technician? As

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a generalization, yes. In many instances, no. He has had a medical training and possesses what I have termed medical intuition, but unless he has made a special study of roentgenology, his x-ray diagnosis must be of limited value. The roentgenologist alone is the proper person to interpret x-ray findings. He should be a well trained physician specializing in diagnosis by means of the x-rays. His general training in medicine should be liberal and his training in roentgen diagnosis thorough, which connotes a period of earnest, intensive study of something more than three months. Obviously we are not going to have this type of man enter and remain in the specialty of roentgenology if the practice of some of our hospitals is continued of asking highly trained men to take full time positions at less than the wages of a journeyman employed there, nor if the profession in general shall continue to support commercial laboratories which are precisely what their name signifies, their "medical directors," so-called, being part of the plan to capitalize the sick. Their x-ray work, generally speaking is inferior for it follows that a conscientious physician would not lend himself to selling his medical birthright. I mention trade laboratories only to dismiss them with the comment that their diagnoses are in worth only commensurate with the method used to obtain the consultations.

Of all criteria of x-ray diagnosis, the method of employing the rays stands out preëminent. There are two great x-ray diagnostic methods, fluoroscopic and photographic. The distinction between the functions of the fluoroscopic screen image and the x-ray negative has been so often, so fully and so definitely exposed that it seems impertinent to call attention to it again. Yet demonstrable truths that are not recognized or are forgotten need reiteration.

The terms "fluoroscope" and "roentgenoscope" are used to describe apparatus by which an object may be exposed to x-rays and the effect of the radiation on the object visibilized upon a screen, so-called, usually a piece of cardboard coated with a proper fluorescent substance. It is a method of examination which must be employed in a room free from ordinary light. It is a rapid method of examination accomplished with little effort on the part of the operator, and because of this very freedom and ease, a source of error. In studying the image on the fluorescent screen there are several optical factors that must be considered, *viz.*, a screen that is fluorescing, viscera in motion and the accommodating ocular muscles of the examiner; factors which cannot be discarded when one is considering minute pathological changes. It truly is a method where he who runs may read, and surely the error in reading while running is greater than while in repose. The roentgenoscopic method is of value only in the examination of thin or medium

sized subjects, for rapid orientation and differential diagnosis of gross changes. It does not give one a personal record for historical data or reference.

The chance for personal error seems greater because of the ease with which the method can be employed, because of the necessity of working rapidly to limit the exposure of patient and operator to the rays, and because of the optical difficulties. There are certain types of cases wherein it should never be used, no matter what the size of the patient or the experience of the examiner. For instance, the direct examination of the gall-bladder region for stones, as we know it today, is distinctly not a fluoroscopic method.

The advantage of plate study is that it gives us a record which can be studied at leisure and correlated with clinical data. It has not the same relation to a patient's stature as has the screen method. It is somewhat more costly, time consuming and a matter of detail.

However, it must be distinctly understood that x-ray diagnosis is a unit. Both the photographic method and roentgenoscope must be used and in many cases, indeed, is essential to correct deduction. I point out particularly the limitations of the roentgenoscopic method for reasons which will appear hereafter. The exclusive and abnormal development of one x-ray method of examination would be as destructive of a rounded final diagnosis as would be the specialized training of an athlete which neglected certain classes of muscles.

Regardless of the method employed or the one employing it, the intelligent coöperation of the consultant is a great desideratum in x-ray diagnosis. Our medical knowledge has become so vast within the past decade that accurate diagnosis is today a group affair. The roentgenologist attempts to demonstrate directly when possible, the pathology. This he may do and yet be unable to recognize its precise nature without interchange of opinion with clinician, surgeon or specialist.

The preparation of the patient bears a very intimate relationship to failure or success in x-ray examinations and it is only by the coöperation of the consultant that this can often be accomplished. For instance, in gall-bladder work it is of the greatest importance that the patient be examined when fasting to rule out food particles and to be free from ingested medicinal metallic salts which cast confusing shadows on x-ray examination. Yet constantly these factors in success are neglected. In the examination of the stomach it is again of the highest importance that the patient report for examination fasting. Gastric carcinoma has been reported more than once because of defects in the gastric silhouette due to food, so that when the roentgenologist asks that patients present themselves fasting he has a reason for it.

For several years past at the medical school, where I have the privilege of teaching, I have made it a practice to ask in the final examination, in some form or other, this question, "Why should the habit of asking for one plate of this or that part be discouraged?"

The consultant requests it under the mistaken notion that it will be a matter of saving to the patient. The installation and overhead of a modern x-ray consultant's office is the largest of any of the specialties, to my knowledge, yet I like to feel that the material used and operating expense should play a minor rôle, while the skill and knowledge necessary to obtain the desired diagnosis should determine the major part of the fee. The important thing to keep in mind is that what we want to know is what is wrong with a patient, and it is far better to ask the roentgenologist to make his charges consistent with the patients' means than to attempt to direct or limit the examination.

One plate of a fracture is very deceiving and may mean a law suit. One plate, say of the right kidney—of what value is it if pain in the right kidney region is referred from a stone or disease in the left kidney? Of what use is a plate of the right kidney if the localized pain of the patient is due to chronic disease of the appendix, and so on down the line?

One commonly receives the request that a roentgenoscopic examination be made of the gastrointestinal tract, this method of examination being the choice of the consultant with a view to economy for the patient. It may be less expensive but often it is equally inexact. That is why I direct your particular attention to the drawbacks of this method of examination. Far better to indicate to the roentgenologist the clinical picture and let him choose the method of examination most likely to insure a correct diagnosis. Thus will the interests of true economy to the patient and the social order best be served.

Currently, some members of the medical profession appear to have made overmuch of "focal infection," and some of the dental profession to be surgically obsessed. In justice, much of it may be laid to the door of the roentgenologist. The terms, pericementitis, apical abscess, pus pocket, pyorrhea and necrosis are used with a freedom that is startling. Wholesale extraction of dentures or prolonged surgical procedures are initiated on the say so of the roentgenologist.

It should be written large upon the tablets of the minds of medical men and oral surgeons that a tooth that responds to vitality tests irrespective of the roentgen ray appearances of the same, is, to the best of our present day knowledge, not a cause, primarily or remotely, of morbidity.

Secondly, that every area of increased radiability seen in bony structure does not signify

necrosis. Just as one commonly witnesses, for instance, in a forearm that has been at rest, say for immobilization of a fracture, an increase in radiability due to atrophy of disuse, so in the alveolar process one sees areas of increased radiability due to the atrophy of disuse especially over bridges and about teeth that improperly impinge. Such areas not infrequently are called necrotic when they are nothing of the sort.

And the x-ray character of the much discussed apical abscess or granuloma must be carefully considered. My own experience has led to the belief that, if this area of increased radiability seen at the apex of a tooth is well defined, black in tone and delimited by an area of increased density meaning calcification, the probability is that such is an abscess cavity and not a pus sac or an active source of infection.

Again, in diseases of the lung, a definite roentgen diagnosis is made altogether too often on insufficient data. I am convinced and have given my reasons elsewhere for it, in detail, that a positive diagnosis of tuberculosis may be made in certain patients on x-ray examination alone and facts governing the prognosis gained in this way and no other way. The x-ray method of examination must be the correct one and, generally speaking, a positive opinion should be rendered by one competent to do it, only after considering all the clinical as well as x-ray evidence. During the past year, at the Boston Consumptives' Hospital, I have personally examined over 800 thoraces, including suspects, early and advanced cases, and it often has been far easier to determine those not having tuberculosis rather than to say definitely that chests presenting patent evidence of pathology were tubercular. If we recollect that most of us are tubercular it is plain that the important thing to determine is who are the tuberculous sick, and this, in most cases, is a combined operation of internist and roentgenologist.

In the examination of the gastrointestinal tract the x-ray method again looms large in relation to dependability of the diagnosis rendered by its means. Diagnoses made by the roentgenoscope must be carefully weighed. The method in general is applicable to areas showing gross pathological changes. Early changes that are macroscopical to be sure, but minute, are not picked up on the fluorescent screen except by men of prolonged experience and then it is the exception and not the rule. The roentgenoscope has no place in the direct examination of the biliary tract, small duodenal ulcers are constantly missed in clinics by men employing this method, and I have seen an inoperable carcinoma involving almost the entire stomach, diagnosed by the roentgenoscope as a probable ulcer when, on plate examination, the character of the pathology was at once evident.

The point to remember is that only gross changes are recognized by the roentgenoscope.

In American clinics, at least, it is not the custom to employ the roentgenoscope in examining the genito-urinary tract or when suspicious of early bone disease. Yet when examining the lung fields and gastrointestinal tract, where the pathological changes are relatively and comparatively slight, this method is used without regard, by many, for its limitations.

The x-rays have helped us tremendously, but many parts of the body are still a closed book. We are not yet able to diagnose early acute osteomyelitis by x-rays, so that when you get a negative report pay only this much attention to it, that it means no x-ray evidence of disease was recognized. I wish we could do away with the word "negative" altogether and our work would be the better for it. Does this mean that in cases of suspected acute osteomyelitis the x-rays should not be employed? Not at all. For the x-ray examination at least gives you an opportunity to rule out other possible pathological conditions. If, clinically, you are certain that you are dealing with an acute osteomyelitis treat it surgically at once, irrespective of so-called negative x-ray findings. Sometimes positive evidence of bone change does not make its appearance for as long as five weeks.

So-called negative and positive diagnoses ought to be considered in relationship to the method of examination employed, the part examined and the one rendering the opinion. I would like to see the term "negative" disappear from roentgen nomenclature, because of the false hopes raised by it. Far better to say, "No pathology recognized," for then at once is attention called to the limitations of the diagnosis.

A negative diagnosis of gallstones is practically valueless when it emanates from a busy laboratory of a large general hospital where the gall-bladder region is examined casually. I thoroughly believe that the gall-bladder should always be examined as a matter of routine in gastrointestinal examinations, but if examined routinely and not carefully, according to the standards of the roentgenologists foremost in this work then, naturally enough, such a negative diagnosis is almost worthless.

Does all this mean that I have lost confidence in x-ray diagnosis? Nothing of the sort. It has not been my purpose to belittle, but attempt to obtain a perspective with proper alignment, which leads to the following conclusion:

X-rays are only a means to an end. Yet they may be the most important means, hence should be employed universally.

That x-ray diagnosis is directly proportional to the roentgenologist and the method employed to arrive at it.

That the fluoroscope is of decided but limited value and should not be employed alone when desiring to detect early pathological processes.

## SOME NOTES ON TYPHOID FEVER.

BY DWIGHT O'HARA, M.D., WALTHAM, MASS.,

*Assistant Visiting Physician, Waltham Hospital.*

IN the spring of 1921 there occurred, through an infected milk supply, an epidemic of typhoid fever in Waltham, Massachusetts. It will not be attempted here to present a complete résumé of this outbreak, but only to present certain features which were more particularly studied, a discussion of which may be worth while to the practitioner who is treating this disease.

### THE GRUBER-WIDAL REACTION. TWO METHODS.

Clinicians still adhere extensively to the microscopic method of demonstrating typhoid agglutinins in the blood serum. The explanation of this is that the microscopic method is the only one taught in many of the best medical schools. It is, nevertheless, an inferior method; it has only one advantage to the clinician and none to the laboratory technician. The one advantage of the microscopic method to the clinician is that a few drops of blood dried on the back of a visiting card, or a glass slide, are found acceptable to the laboratory.

The macroscopic method, on the other hand, has distinct advantages over the microscopic method. Among these may be mentioned the ease with which a uniform antigen can be kept on hand, the greater precision with which dilutions can be made, and the more sharply defined end-point obtainable between positive and negative reactions. The results have the accuracy of a single note instead of the whole scale. These factors bring back to the clinician a more scientific report, and should therefore be encouraged by him, even though he must needs submit 0.5 cc. of blood or more in a small tube, instead of a few dried drops on the most convenient thing he can find about the house.

### THE MACROSCOPIC METHOD.

Because the macroscopic method is not universally taught to us as students, I will describe a simple technique which gives good results.

Equipment—Ten test tubes, about 1 cm. in diameter; wire test tube rack; 1 cc. pipette, graduated in 1/100ths; water bath—(shallow agate dish, thermometer, and bunsen flame).

Reagents—Patient's serum; physiologic (0.85%) salt solution; antigen:—bullion culture, suspension of killed bacilli, or typhoid vaccine may be used. (The last is quite satisfactory, and is a useful way of disposing of vaccine which has run out of date. The polyvalent character of the usual triple vaccine must be remembered, however.)