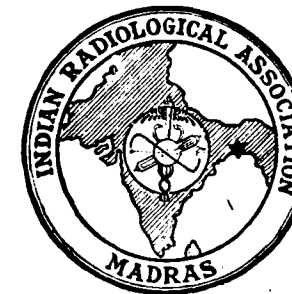


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Indian Journal of Radiology

A quarterly Journal
devoted to Clinical
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sensitive instruments and automatic recorders. He was essentially a biologist in his outlook, who interpreted his physical discoveries in terms of biological concepts and intuitively followed the line of investigation which formed a bridge between responses in non-living and living systems.

He was I believe the first person in India to reproduce Roentgen's discovery in 1895, of the generation of X-rays in a cathode ray tube. Reading a news paper account of Roentgen's discovery, Bose then Professor of Physics in Presidency College, Calcutta, set a young assistant Nagendra Chandra Nag, who later became the Assistant Director of the Bose Institute, to prepare Barium Platinocyanide screens with which he took X-ray photographs of different objects, like a human hand, coins enclosed in a purse etc.; some of them were produced in a juvenile monthly '*Mukul*' for which he used often to write popular articles on scientific topics. Later on, when he became immersed in his plant physiological investigations and discovered the similarity of reactions produced by different alkalis and anaesthetics on animal and plant organs, the opposite effects of minute and ordinary doses of such drugs on plant tissues, he was invited to give an address on this subject before the Royal Society of Medicine, Sir Lauder Brunton, the

well known physician and contemporary of Charles Darwin, after attending this lecture wrote to J. C. Bose "All the experiments I have yet seen are crude in comparison with yours, in which you show what a marvellous resemblance there is between reactions of plants and animals. Much light would be thrown on the action of drugs on animals by using your method." Bose also delivered similar addresses before the Hahnemann Society of England. My uncle at one time had investigations carried out in his institute on the possibility of producing antibodies in plants inoculated with virulent bacteria like typhoid etc. This investigation was not however successful.

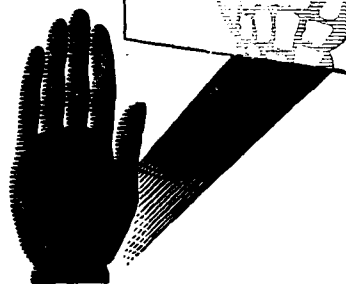
Early days.—Jagadish Chandra Bose was born on November 30, 1858 in the town of Mymensingh, in East Bengal, where his father Bhagawan Chandra Bose was a Deputy Magistrate. He spent the early years of his life in Faridpore and later he came to Calcutta for his College education. He studied Physics in St. Xavier's College, and came under the influence of Father Lafont, an inspiring teacher and like the latter Bose developed in later life a flair for experimental demonstrations. He was not particularly brilliant in his studies, he was interested in too many other things to find time for study. As a result he

passed the B.A. examination only with second class honours. At this time he was very much influenced by his brother-in-law, Anandamohan Bose, the first Indian to become Wrangler of the Cambridge University, who became later President of the Indian National Congress and a leader of the Sadharan Brahmo Samaj. Jagadish Chandra was very anxious to proceed to England for further studies, but the straitened financial circumstances of his father, who had bankrupted himself in his efforts to start industries in Bengal, created difficulties. It was his mother who by selling her ornaments provided the money for her son's visit to England. It was his intention to study medicine in London, but owing to repeated attacks of malaria, which he had contracted in Assam while out on shooting expeditions, he had to give up his idea of studying medicine in favour of natural sciences. He went to Cambridge, and was admitted to the Christ's College—the first College in Cambridge to admit Indians, Anandamohan Bose and the late Justice Syed Mahmud. There Jagadish Chandra came under the influence of such teachers like the late Lord Rayleigh, Francis Darwin, Sir Michael Foster, Sir James Dewar, and Sydney Vines. In the early eighties he graduated in Science both from Cambridge and London. His subjects were probably Physics, Botany

and Physiology. After returning home he was appointed in 1884 as Junior Professor of Physics in the Presidency College, Calcutta. His connection with this college remained unbroken till his retirement from government service in 1915 at the age of 57. He was still active and vigorous and he felt that he had a great deal of work to do in Plant Physiology. For two years he continued his research work in a small laboratory fitted up in the top floor of his house at 93, Upper Circular Road, and partly in Darjeeling. For his research work he was receiving some grants from the Government of Bengal. At this time he was also maturing his plans for the establishment of a research institute where his special line of biophysical studies could be continued. Since 1896, when he first visited England on a scientific mission and had given a lecture in the Royal Institute, London, he had cherished the idea of starting a similar institute in Calcutta. For a long time he had been saving and investing all his surplus incomes and collecting funds from personal friends and from the public. Promise of an annual grant from the Central Government enabled him to start building an Institute on a piece of land to the north of his house. The building erected under the founder's direction, is a beautiful adaptation of Hindu architectural design to the

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FEBRUARY, 1949

No. 1.

Acharya Jagadish Chandra Bose and His Scientific Activities

D. M. BOSE,
BOSE INSTITUTE, CALCUTTA.

MR. PRESIDENT, members of the Indian Radiological Congress, ladies and gentlemen, I have first to express my deep gratitude for the honour you have conferred on me by asking me to give an introductory talk on the life and scientific activities of my uncle, Acharya Jagadish Chandra Bose, as an introduction to the delivery of a Memorial Lecture by Dr. Barclay of the Nuffield Medical Research, Institute, Oxford. From my boyhood days I have been an interested observer and at times a participant of his many sided scientific activities, from his pioneer short electric wave investigations commencing from 1894 to his later well known plant physiological researches. Since his demise on 23rd November, 1937, the responsibility of directing the Institute has devolved on me, which has given me the opportunity of making a close study of his scientific researches. I hope soon to publish a monograph on the relation of his plant physiological researches to modern biological knowledge. The distinction of having a Memorial Lecture founded in his name by your society, rests on some more concrete grounds than in your desire to honour the memory of a distinguished Indian pioneer in physical and biological researches, famed for his rare experimental skill and capacity for construction of compact

purposes of a modern scientific laboratory. The formal opening of the Institute took place on 30th November 1917 on his 59th birthday. For twenty years he guided the activities of the Institute and his peaceful end came on the 23rd November 1937 in Giridhi where he had gone for change and recuperation.

Scientific activities.—Turning to J. C. Bose's scientific activities, we find that for the first ten years he was chiefly engaged in his teaching work and in the pursuit of scientific hobbies. At one time he used to go out during the holidays accompanied by Lady Bose, and armed with a full sized plate camera to places of archæological interest or of some natural beauty. The reading of Cunningham's and Rajendralal Mitra's books had aroused his interest in the archæological remnants of the former greatness of his country. He also was probably the first in this country to import in 1892 one of the early models of Edison's phonograph, with which he used to record the voices of well known singers and distinguished personalities. I have mentioned before his interest in Roentgen's discovery of the X-rays. It is not known what induced him to give up his scientific hobbies and to take up serious research. Probably Lady Bose influenced him in this direction. In one of his lectures he mentions that on the 36th anni-

versary of his birthday in 1894 he took the resolve to seriously take up scientific research. Considering the primitive equipment for instrument making and absence of atmosphere conducive to research then prevailing in the Presidency College, Calcutta, his decision must be considered very remarkable. His research activities, extending from 1894 to 1937, can be divided into three periods. In each of these periods his efforts were directed towards the solution of problems lying in the borderland regions of sciences. During the first period from 1894–1899 he was trying to produce the shortest of the then possible wave length of electro-magnetic radiation, and to measure their quasioptical properties by means of an ordinary optical bench arrangement.

The second period, extending from 1899–1904, began with his study of the fatigue effect in metallic coherers, used for detection of electric waves, from which he went over to the study of other inorganic systems which exhibit, under different kinds of physical stimulation, responses analogous to those exhibited by living organisms. This led to his famous generalisation on the similarity of responses in the living and the non-living. The third period starting from about 1905 was concerned with plant physiological investigations, where he tried to establish the similarity, if not the identity of response

to stimulation exhibited by animal and plant tissues.

First period.—It will be remembered that in 1865 Clerk Maxwell formulated his epoch making theory, that light waves are of electromagnetic nature propagated through space with a velocity 'c', which is equal to the ratio of the two systems of units in which electric resp. magnetic quantities are expressed. This theory found experimental verification in 1887, by Hertz's production of electro-magnetic waves of wave length 5.5 meters, whose optical properties he was able to determine by means of very large sized parabolic reflectors and prisms. For the detection of such waves Hertz had used a loop of copper wire, with a minute spark gap. Branly had shown later that these waves could also be detected by the measuring the change of conductivity which a tube containing metal filings suffered by absorption of such waves. Bose by reducing the dimensions of his wave generator system, was able to produce radiation of wave length of the order of 5 mm., which is about 1/10,000 that of Hertz's wave. For purpose of comparison I will state that the wave lengths of visible light, of soft X-rays, and of hard γ -rays, are of the order of 10^{-5} , 10^{-7} and 10^{-10} cm. respectively.

By reducing the wave length of his radiation Bose could considerably

reduce the dimensions of his optical appliances. He could focus his radiation by means of a small parabolic reflector, polarize it by means of wire grating, study its indices of refraction in air, water, glass, pitch, sulphur, show how its plane of polarisation could be rotated by passing through a bundle of twisted jute fibres and so on. Bose's compact portable apparatus for the study of the properties of electro-magnetic waves was very much admired, when he demonstrated it at different centers of research in England and in Western Europe. Many text books and monographs described in detail his apparatus, including J. J. Thomson's well known book on 'Electricity and Magnetism', his article in the 9th edition of the Encyclopædia Britannica and in Poincaré's book on electric waves. Investigations on the centimeter wave length region of e.m. waves remained in comparative oblivion for the last fifty years, and they have come again into importance during the last war, when the technique of production and detection of such waves were developed to an extraordinary degree, in connection with the radar method of detection and interception of enemy air planes. The use of the shortest possible e.m. waves, in which the maximum output of energy could be concentrated became of supreme importance for this purpose, first it enabled the

construction of portable reflecting systems concentrating the radio beam, to follow the track of the enemy air planes, and secondly the short wave length used enabled the incident waves to be reflected to an appreciable extent from the surface of the enemy planes. Profs. M. N. Saha and S. K. Mitra after return from their tour in the U.S.A. in 1945, informed me that in many university laboratories where radar personnel were being trained, apparatus similar to that developed by J. C. Bose were used for practical instruction. The measurement of the absorption of these centimeter waves by the constituents of the atmosphere like O_2 , N_2 , CO_2 , water vapour and other substances became of great importance. These recent measurements have verified some of those made by Bose with similar substances. The important advances in the present day technique has been the generation of extremely powerful pulses of centimeter waves of nearly monochromatic frequency, while Bose's generator emitted only feeble damped waves; otherwise the principles employed have not altered very much. Bose had employed amongst other detectors crystals like galena. At the present time it has been found necessary for the detection of such extremely short waves again to use in the first stage of the detecting unit, crystal detectors of different kinds, of which the most useful are

those of silicon and germanium. A new line of investigation on the absorption and emission of such microwaves by nuclei, atoms, molecules and crystals have been opened out by peaceful application of microwaves, and already several results of first rate theoretical importance have been obtained.

Second period.—*Responses in the living and the non-living.*—This was initiated during Bose's investigations with the coherer; in the form devised by Branly it consisted of metal filings, which under the absorption of electric radiation cohered together and thus increased in conductivity. Bose investigated a large number of metallic and semi-metallic substances and found that coherer action arose at the places of contact between different pieces of metal filings forming the coherer i.e. it was a skin effect for which he coined the name 'electric touch' using the last word as equivalent to the Sanskrit word 'twach'—skin. He found that with constant use the coherers showed signs of fatigue, and given some rest they recovered from fatigue. He simplified the design of coherers and in the latest form of apparatus which we still use in the Institute, the receiver takes the form of a single contact between a fine metallic point resting on a polished plate, the materials used for the purpose are steel nickel, and other metals.

Having studied the metallic coherer whose conductivity increases on absorption of e.m. radiation, Bose continued his investigation with other detectors of radiation like the crystal galena whose contact resistance diminishes with absorption of radiation, from micro electric waves to ultra violet light, semi conductors like selenium which change their resistance during light absorption, photoelectric cells made of silver plates activated by exposure to Bromine vapour etc.

At present this class of semi-conductors including crystals like galena, metallic crystals like silicon, and germanium, selenium, copper oxide films deposited on metal bases, are used for rectification of alternating current of frequencies ranging from say 50 per sec., to that of microwaves and of visible light; some of these substances have important application in the recent attempts at industrial conversion of solar energy to electrical power. Another recent application of Bose's discoveries is based on his last form of coherer, consisting of a sharp metallic point resting on a polished metal plate; this has the additional property of rectifying e.m. radiation impinging on it and thus has function similar to that of a diode valve like Kenotron so familiar to Radiologists. Recently an adaptation of it has been reported from the Bell Telephone Co. It starts as an arrange-

ment of a fine cat whisker wire electrode resting on a surface treated piece of germanium plate, and used for rectification and detection of high frequency e.m. radiations; if now an additional cat whisker electrode is made to touch the upper part of the germanium plate very near the first one, and a constant voltage is maintained between the plate and the second electrode, then it becomes equivalent to a triode valve, in which the first cat whisker plays the role of a grid electrode. The arrangement can be used to detect and amplify feeble A. C. currents, as well as to generate high frequency oscillations. This simple arrangement, denoted Transistor, promises to replace the glass triode valves in many circuits. I have given this account of the recent developments in the technical application of semiconductors to show how they were implicit in Bose's investigations of half a century ago.

The results of these investigations of the change of conductivity of contact resistances, the e.m.f. generation by absorption of short electric waves and of light, were considered by Bose as part of the general phenomena of response of inorganic substances to stimulation. Starting with Waller's dictum that in living tissues, the most delicate and universal sign of livingness is electric response to stimulation, Bose enquires whether inorganic

models may not also be devised which will satisfy this criterion. In this way he was able to construct models in which mechanical and light stimuli produce electrical responses. The proportionality which exists between intensity of stimulation and electrical response, the gradual appearance of fatigue in response after repeated stimulation, from which the system recovers after it is given sufficient rest, the increase of response on treatment with one set of chemicals and its inhibition by another set are similar to what occurs in living tissues. I shall describe here only one of his models; it is made of two wires of pure tin, whose lower ends are clamped to an ebonite block; the upper ends pass through an ebonite disc, and are joined through binding screws to the two terminals of a sensitive galvanometer. The arrangement fits into a cylindrical glass vessel, filled with distilled or tap water. On giving one of the tin wires a sharp twist, an electric current flows from the wire through the galvanometer system. The amplitude of response is enhanced when a small quantity of sodium bicarbonate is added to the distilled water; on the other hand if oxalic acid is added to the water the response is totally abolished. Many of the effects observed in animal tissues under stimulation, *viz.*, of the opposite effects of small and larger doses of a

chemical poison etc. can be obtained with this model of Bose. In a lecture delivered before the Royal Institution, London in 1901, Bose after showing a series of parallel experiments on the similarity in response shown in living and non-living systems, ends his lecture with the remark "Amongst such phenomena how can we draw a line of demarcation and say 'here the physical process ends and there the physiological begins?' No such barrier exists. Do not the two sets of records tell us of some property of matter common and persistent? Do not they show that the responsive processes seen in life have been foreshadowed in non life, that is the physiological is after all an expression of the physico-chemical and that there is no abrupt break but a continuity?"

Later investigations on plant responses, where he tried to show the similarity if not the identity of responses shown by plant and animal tissues under stimulation, Bose had to make some distinction between the physiological and the purely physico-chemical responses shown by living tissues.

Bose himself was not quite clear as to the real seat of the electromotive response produced in the tin wire system under mechanical stimulation—at one time he thought it to be at the surface of separation between the tin wire and the

electrolyte—this can explain the difference in the e.m.f. produced under constant stimulation, when the distilled water in which the wire dips is replaced by dilute solutions containing NaHCO_3 resp. oxalic acid. Later he thought it was due to molecular strain induced in the twisted wire itself. I shall describe two other inorganic models illustrating response of living systems, in which it is clearly established that a passive layer interposed on the surface of a metal dipped in an electrolyte is responsible for such response effects. The first is the famous Iron wire model of Lillie (1920–1936) which has its starting point on an observation of Ostwald in 1900. Wires made from specially pure iron, when dipped in strong Nitric Acid (sp. g. 1.4) enters into a passive state shown by its surface taking a bright metallic lustre. If however, it is touched by an active iron or by a zinc rod, a local action accompanied by effervescence and a darkening of the metallic lustre spread rapidly over the wire from end to end; the local action ceases after one or two seconds and the metal reverts automatically to the passive state. An electric disturbance accompanies this process and can be recorded by a string galvanometer. With such a system Lillie demonstrated a correspondence in the most unexpected details between the excitation of nerve and the activation of passive

iron. Bonhoeffer, the well known physical chemist who has been during recent years making an analysis of the activation phenomena, remarks "it is indeed most astonishing that iron wire and nerve, which from the chemical point of view differ so enormously, function in such a similar way. It does not seem credible that the various functional properties in which the two systems resemble each other could be independent or show such accidental similarities. The existence of a threshold of activation, of a refractory period, of a transmission of activation, of a tendency to give rhythmic reactions and a suggestion that the so called accommodation effect are not missing in the model, indicate that all these properties, so uncommon in ordinary chemistry, are in some way related to each other."

The other model which I shall refer to is that of Bredig (1903) illustrating the rhythmic pulsation of an animal heart. It is based upon the decomposition of hydrogen peroxide when spread over the surface of a mercury drop. When the peroxide solution is slightly acidic a stable golden brown film is formed on the mercury surface—this corresponds to the inactivation of the tin wire in Bose's model by dilute oxalic acid. At an appropriate degree of alkalinity, the film is stimulated to activity shown by its alternate breakdown and reformation with the

evolution of oxygen. This is accompanied by rhythmic alteration of the shape of the mercury drop, due to variation in surface tension, and of a propagated electric disturbance on the surface. This state corresponds in Bose's model to the making of the aqueous solution in which the tin wire dips slightly alkaline, by addition of Sodium bicarbonate. These reversible films formed on metal surfaces, correspond in the living system to the plasma membrane forming the outer boundary of living cells on whose both sides are present electrolytes with different ionic concentrations. The whole group of response phenomena shown by living systems, under chemical, electrical and mechanical stimulations, depend upon the change in conductivity and of ionic permeability of this plasma membrane, which is accompanied by an alteration of the resting bioelectric potential. This local change in bioelectric potential is propagated along cell surfaces especially of nerves as excitation current.

The similarity of response to stimulation exhibited in inorganic models is due to its make up of a conducting metallic core separated from a conducting electrolyte by a layer on the surface of the core in a passive state. The latter breaks down reversibly under mechanical, chemical and electrical stimulations, resulting in production of local cur-

rents between the intact and decomposed portion of the surface film. Bose was not familiar with the contemporary physico-chemical investigations carried out by men like Ostwald, Bredig and their school, and was therefore unable to undertake a correct interpretation of these borderline investigations of his. While his western contemporaries designated them as inorganic models of some properties of living system, Bose with his pantheistic background saw in this similarity an evidence that 'the responsive process seen in life have been foreshadowed in the non-living.'

Third period.—*Plant physiological investigations* :—From this study of the border land region separating organic from inorganic response phenomena, Bose was led to investigate plant responses, which again represent a border line region in the study of the highly organized and differentiated animal organisms. Bose starts with the assumption that in plant as in animals the underlying protoplasmic matter has the same fundamental properties of irritability, contractility, conductivity and rhythmicity. In the highly organized animal organisms, some of these characteristics are specialized in one or other of the tissues *e.g.* contractility in the muscle system, conduction of irritation in the nerve system, and rhythmicity in the heart

muscles. The tissues in the plant have never reached anything like the same degree of differentiation as in animals. It is only in a general sense that it is possible to apply the terms 'muscle' and 'nerve' to the contractile and excitatory tissues of the plant.

Bose in the course of his investigations selected three plants in which one or other of the three functions were specialized. For example the lateral leaflet of the plant *Desmodium gyrans*, even when detached from the parent plant, and kept with its cut end dipped in tap water, continues to execute regular gyratory pulsations of period varying between 2 to 4 minutes, depending on the age of the leaflet, temperature etc. These leaflets, like animal hearts, are myogenic *i.e.* the part originating and regulating its pulsation lies in the leaflet and the latter is very little influenced by stimulation applied to the rest of the plant. Application of cold, of chemicals, of stimulants and depressants, influenced its activity in a similar manner as when applied to the animal heart. The pulvinus and leaf system of the sensitive plant *Mimosa pudica* behaves under stimulation in a manner analogous to that of a nerve muscle unit. Stimulations, thermal, mechanical or electrical in nature, applied to the stem is conducted principally in the form of an excitation current with well defined velocity, which on reaching the

pulvinus leaf system cause the collapse of the pulvinus and closure of the leaf system. Many of the characteristics of response to stimulation shown by innervated muscles can be shown in a pulvinus leaf systems of the mimosa plant, like summation effect, stimulation by constant current, repetitive responses to strong stimulation, the influence of direction of flow of a small constant current in enhancing or abolishing the mechanical response of the pulvinus to stimulation, the reversible depression of conduction of excitation by means of cold by anaesthetics like chloroform and ether, and its abolition by poison.

In another plant *Biophytum sensitivum*, the all or none response to stimulation and repetitive response to strong stimulation characteristics of skeletal muscles are illustrated.

Bose has shown how by using delicate high magnification recorders, the mechanical resp. electrical responses of the so called insensitive plants could be measured and they are found to obey similar laws. In addition to the response of plants to these artificial modes of stimulation, the plants are subject to continuous environmental stimulation, like variation of temperature, of light intensity, humidity, irrigation of the roots etc. These result in responses of the plant in the form of growth, ascent of sap, tropic movements, like

the opposite bending of the stem and root system of a plant under gravity when placed in a horizontal position, called geotropism, the bending of a plant stem towards light called phototropism, the twisting of a growing stem round a support, called mechanotropism. He has shown that all mechanical responses shown by plant organs are accompanied by corresponding electrical disturbances; even where the former is absent, the electric response is always present. Further even in the anomalous mechanical bending of plant organs in geotropism, the direction of the electric field relative to the bending remains the same. It is always directed from the convex to the concave side. By means of the electric probe which was first introduced by him in physiological research, he has tried to localize the particular layers in plant organs responsible for a particular activity. For example, in the petiole of *mimosa pudica*, he identifies the phloem as the channel which is responsible for the transmission of excitation from the pulvinus to the leaf system. In young plants, he has localized a geoperceptive layer and even he has tried to localize in the stem of other young plants through which sap is flowing, a layer by whose pulsatory activity water is propelled from the root to the stem and leaf system *i.e.* he postulates a mechanism which plays a role analogous to that of the pulsating heart

in the circulation of blood in animals. This last finding of Bose lacks independent experimental verification.

Bose attempts to interpret all the phenomena associated with the response of plant organs to environmental and artificial stimulations, in terms of a few general laws which can be stated as follows: The act of stimulation is transmitted from the place of application to that of response by two kinds of impulses, *viz.* as a protoplasmic excitation which gives rise to a mechanical response of contraction and an electrical one of galvanometric negativity; the other is of a hydro-mechanical nature giving rise to an erectile response and an electric one of galvanometric positivity. Whether the positive response will predominate over the negative one will depend on the conductivity of the intervening tissue, the distance of the place of response from that of stimulation and also on the intensity of stimulation. In general with poorly conducting tissues, weak stimulation, and over large distances, the positive hydraulic impulse predominates over the negative excitatory one. Bose has made a very ingenious attempt to interpret all the various modes of plant response including growth, ascent of sap, and tropic movement from these few general principles enunciated by him. It can not be said however that he has been always successful. For one thing he did not

take into account the chemical processes which intervene between the act of stimulation and the resulting response, and which supply the energy of the responsive movement. To give some examples, he assumes that the spontaneous pulsations of the leaflets of *Desmodium gyrans* is due to continuous stimulation received by the plant from its surrounding, without specifying how the energy of stimulation is stored up in the plant. It has been found later that the source of energy of pulsation is derived from the breakdown of carbohydrates formed in the leaflet by photosynthesis. In the case of tropic movement of plants, it has been found that certain plant auxins act as chemical mediators in the metabolic processes resulting in the curvature of the plant organs. In every case however the direction of the bio-electric field determines the direction in which the plant organ bends. The transmission of physiological excitation in *mimosa* plant is not a purely physical process but a physicochemical one, with which an irritability substance is associated. It is very interesting to recall that in the transmission of excitation in nerve muscle units, a chemical substance acetyl choline acts similarly as a mediator. Knowledge of the mechanism of the physicochemical process associated with the transmission of excitation in animal organs has helped to bridge over the

controversy on the physical respectively chemical nature of transmission of excitation in *mimosa*. This arose from Rica's discovery in 1917 that an 'irritability substance' extracted from *mimosa* stem, when introduced in the cut stem of a *mimosa* branch will produce the collapse of the pulvinus and closure of the leaf system. In favourable cases it can even give rise to multiple responses. It is also known that acetyl choline produce similar contractile activity when introduced in denervated muscles.

Bose along with Lillie belonged to the generation of electro physiologists who attributed a supreme role to bioelectric potential and to its propagation as excitation current, in controlling all biological phenomena, including integration, growth, tropic movements, cell-division etc. The study of the energetics of such processes which are based upon chemical metabolism, their control by minute quantities of chemical substances like hormones, vitamins and auxins, had not come into being during their period of active research. It must however be pointed out that in many living tissues the essential constituents of metabolic processes, the substrates and enzymes which act on them, are present side by side, but it requires modification of local ionic concentrations induced by electric excitation either transmitted from a distant

region or produced locally, to start or inhibit these chemical reactions.

I have attempted to give a consecutive account of the different periods of J.C. Bose's scientific activities, to show how from a study of coherer effect he passed to investigation of the role of passive films on surface of conductors, of semiconductors, and crystals, in the detection and conversion of electromagnetic radiation into electrical energy. Further study led him to the discovery of the similarity of responses in certain types of inorganic models to that found in living tissues. This again led him to the study of plant responses in plants. He remains still the greatest experimentalist modern India has produced. Prof. S. K. Mitra calls him the Indian Faraday.

He was an intuitive thinker, who starting from certain inductively arrived principles, attempted to interpret deductively all his experimental results, but not always very successfully. He suffered also from the disadvantage of not keeping himself abreast with current scientific literature.

I, who have followed his experimental investigations and his theoretical interpretation of their results over a period nearing half a

century, of which during the last few years I have made a fairly close study, can say, paraphrasing the words used by Rev. Stanley Jones in his study of Mahatma Gandhi, that I have seen him sometimes go wrong in small matters of interpretation, but now I realize how intuitively great he was in his selection of the larger issues. The subjects investigated by him in Physics, Biophysics and Plant Physiology still retain their place in the foreground of scientific research and they have all been advanced by his contributions.*

I have no time to deal with his other activities. He was a dominating personality always carried forward by an inward creative urge towards the realization of certain ends, for which purpose he did not either spare himself or the men who worked under him. He represents a type of men thrown up during every renaissance movement, who are endowed with many sided gifts. For him scientific research became the main object of his life, but he could have achieved greatness also in architecture and literature.

*At turning points in the progress of science, sometimes it is more important to state problems and furnish tools for this investigations, than in giving the correct answer. After all in science, there is no finality in the solution proposed for any problem.

The Radiologist and His Work

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THE honour you do me, a fellow member of our Association in the invitation to give this, the first lecture in memory of that outstanding scientist, Sir Jagadish Bose, is indeed great. Humbly and with gratitude I accept the task. The pleasure it gives me to do so is all the greater in that many of your members in the Indian Radiological Association have either been students under me in Cambridge, or have passed through my hands as examination candidates. It has been one of my regrets that I have never been able to travel in India and to visit my old students and other radiologists who were striving to build up an efficient service of medical radiology, in adverse conditions. From what I heard, I sensed that they often had little collaboration and support from colleagues, that the essential finance to provide adequate up to date equipment, was not forthcoming, and that standards were not what they might be. To-day world supplies of films are so short that sometimes the radiologist in India is faced with reporting on injuries in which only a screen examination has been made, which inevitably means that the crack that is left untreated may be so disabling, and may not be noted. Such things are of course extremely bad for the prestige of radiology and more particularly of the radiologist concerned. These things I knew of, and it was my ardent desire to come to India and not only see things for myself but if possible to help the Indian Radiological Association which, starting in 1931, with only ten founder members was struggling into existence. The success of this association would be essential in placing radiology on a firm foundation in India. It was therefore with very great pleasure that I learned of persistent progress and I was overjoyed to learn of the drive and initiative that had led to the establishment of a journal, a journal that does much credit to all concerned. These things will work miracles and will make it possible later to establish an Indian Diploma in Radiology, just as similar activities did in England many years ago. It was the establishment of the Cambridge D.M.R.E. that was the crucial turning point in England. Suddenly, almost overnight, it made it almost impossible for any untrained person to practice radiology. The man who called himself a radiologist merely because

he had purchased X-ray apparatus quickly faded out. This followed shortly after World War I, in which ignorance and bad radiology had brought disastrous results. These bad results had received much publicity, I had almost said notoriety. So also it must be in India where, if my information is correct, there is still a great deal of ignorant and bad radiology. I sincerely trust that the next thing I hear of the activities of the Indian Radiological Association will be the intention to establish an Indian Diploma in Radiology, attached to one of your Universities and with one or more of your members holding the academic status of Professor. But the standards must be high, so high that the diplomate will be competent to stand on an equal footing with his colleagues in surgery and medicine.

Yes, your association, your journal, and when it comes your diploma, must have a profound effect on the prestige of the radiologist. But it will also be a challenge to the efficiency of his work. The quality of his radiological and technical work and the collaboration he will have with, and will receive from, his colleagues in Medicine and Surgery, will be on an entirely different plane when the radiologist stands on equal terms with his fellows in medicine and surgery. In close on 50 years I

have seen great changes happen in England and in all of them I have taken part, from the days when at a salary of £50 per annum, I produced X-ray plates for six mornings a week, and was, metaphorically and actually, told to mind my own business, if I ventured an opinion on the interpretation of the plates I produced. After some years of uphill work I one day suddenly recognised that I had won the long battle, when I had a note of three lines from the senior surgeon. I had sent him my long factual report on a gastric case, in which I had, as usual, left it to the surgeon to make his own deductions. His note said that he was not interested in my report, but would be grateful if in future I would confine myself to my opinion on all his cases. The lengthy reports of pages immediately came down to three lines, and always, if possible, giving definite opinions. I did not hedge, but when uncertain I asked for consultation. Work became a real pleasure, and the closest collaboration ensued. If my report failed to fit in with the surgeon's clinical findings we would discuss the case in detail and often I would re-examine the patient. There was never any question of the radiologist scoring over the surgeon, or *vice versa*: we are interested in one thing and one thing only, the service of the patient. I was welcomed in the operating theatre to

see the conditions at operation. It was personal work that established my position and led to my election to the honorary staff of my hospital, the Manchester Royal Infirmary. What a difference that made! I ceased to be the hired servant who did very good work in providing X-ray photographs, and became a colleague who was not only consulted but supported by all his fellows. No longer had I to fight single handed to get my old cellar department moved to adequate quarters and completely re-equipped, but in this I had the backing of all my colleagues. This came to me before the Cambridge D.M.R.E. took shape (in 1921). It was this Diploma that gave a general hall mark to Radiology and to the Radiologist throughout the country. I mention these bits of personal and radiological history, because I believe that in many parts of India, the fight for recognition is still far from over, and that for many of you there must still be years of patient and tactful endeavour ahead. But those years will assuredly be at least cut in half by the support that comes from the I.R.A., from its journal, and before long, I hope, from an Indian Diploma in Radiology. But as I have already said these things however will be of little avail if the radiologist is not competent to be a colleague. For this he must be no narrow minded

specialist who sees things only from his particular aspect. He must be adequately knowledgeable in the work of the surgeon and even of his operative techniques, and of the physician's laboratory and other methods of diagnosis. Unless he is familiar with the work of his colleagues he cannot be a colleague; he will merely be a technician. Somehow or other he must find time and energy to get to the operating theatre and see as many as possible of the operations on his cases. He should also attend ward rounds and be prepared at these to discuss the radiological findings in every case and be ready to uphold any views he puts forward, but always with an open mind in which there is not even a background of that worst of all faults in a radiologist, the wish to score a point at the expense of his colleagues. We need the very best men and with the widest possible training if radiology is to take its proper place as a full partner in arriving at a correct diagnosis. It were better to have no radiologist at all than to have a second rate radiologist for he does infinite harm to radiology.

During the war I was responsible for all the civil Radiology in England. Hundreds of new hospitals had to be opened and somehow or other the radiological work had to be shared out by a

much reduced number of radiologists. In spite of all difficulties, every department was controlled by a qualified radiologist. In the circumstances high standards were often quite unattainable, but what was far worse, was that owing to the impossible volume of work, consultations over cases became virtually out of the question, even if both the radiologist and his colleagues wished to collaborate. The results were in some cases deplorable. The radiologist became an itinerant film reader, rushing from one hospital to another, depending entirely on his radiographers, seeing nothing of the patients or of his colleagues. In some cases I found that things had become so bad that the radiological reports were not even read and the prestige not only of the radiologist but of radiology had fallen to a low level. What had happened as a rule was that the radiologist never had the opportunity of following up his cases, and consequently he never even suspected that he had made bad mistakes, mistakes that were not forgotten by his colleagues and which led to dissatisfaction and distrust of his work. It is however not only the possibilities for collaboration that are necessary but the willingness of both parties to collaborate in the most friendly manner. The radiologist must be *persona grata* with his colleagues. I believe

that most of these radiologists were quite competent but were overwhelmed by circumstance, the circumstance of insufficient time to do their work properly and to collaborate with their colleagues. This means that X-ray department must be adequately staffed both with radiologists and competent technicians. To those outside it may look as if the X-ray department is over-staffed but adequate staffing is essential if the radiologist is to do his work efficiently and give to the medical service the highest standard of consultant radiology.

The fight for recognition that you are engaged in is very parallel to that waged and won by Sir Jagadis Bose in whose honour this lectureship is founded. Having taken his degree in Physics in Calcutta, about 1880 he came to London to study medicine, but his health broke down. He was fortunate however, in obtaining a scholarship at Christ's College Cambridge in 1883, the College which I joined some 20 years later, when the name of Bose was already well known for his contributions to Science which were being much discussed. Already a very competent physicist he turned his attention in Cambridge to natural sciences, particularly the physiology of botany, bringing to this subject a wealth of knowledge of physics that was unique in a Botanist. Moreover he had a most exceptional

gift for adapting this knowledge to the service of botany. He constructed extremely delicate apparatus to record automatically the vital functions in plant life. He was far in advance of his time, for in that period the scientific departments in the universities had been in the habit of erecting walls around themselves in the attempt to be self-contained, not realising the limitations they were imposing on themselves or how vitally important it is that each branch of science should learn from others, and to adapt the techniques that would be so helpful to their needs. To-day, this atmosphere has completely changed. The sharply defined line that divided one branch from another has become fluid, while physics, particularly electricity, and even mathematics are freely employed in all the biological sciences. This change has brought wonderful advances.

Bose, as I have said, was far ahead of his period and few, understood the physics and mathematics that often took him into spheres that his colleagues in botany could not follow. In a long obituary notice in *Nature*¹ we find the following:—

“But it is at present not possible and will not be possible for some time to come, to assess the true value of his contributions to physiology.” Bose's physiological work still remains in an isolated

position in spite of decades of indefatigable work on his part, many volumes of published experimental work, and sometimes even unique facilities granted, not only in his own country, but also in Great Britain, the United States and on the Continent, to bring his results personally before the public by means of lectures and demonstrations. The reasons for Bose's isolated position in the Science of Physiology are many and varied. Although he was a pioneer in his own field, he seldom discussed his results with those of his contemporaries. His scientific work was at times almost dramatic, with the result that even at the early stages he attracted much attention from the non-scientific world.”

He toiled indomitably in his work and in his writings to gain acceptance for the theories he propounded. He was not content that his results should be placed only before his colleagues, but planned that they should be known by amateur botanists and even by the public. He gave many public lectures, but this publicity was not approved by some of his European colleagues. His intentions however were sincere, it was natural that he sought to obtain recognition for his work, but it was even more important to him, to establish research in India that was

carried out by Indians and for this he needed public support, particularly finance. In this he sought to combat the impression that an Indian Student was not original minded. From my personal experience in examining Indian candidates I have found a tendency to trust to memorising text books and lectures rather than to seek to understand and absorb the material, so that it becomes their personal knowledge. As an examination candidate he had usually learned too much and thought too little. But I do not blame this on the mentality of the students themselves, but to a background of preliminary education that is taught in terms of memorising what other people have said rather than to learning the subject and forming their own deductions. It is this background that requires readjustment and when readjusted I am confident the Indian Student will be just as original minded and capable of independent thought and judgment as his European counterpart. He might well take for his own use the prayer that is attributed to Scotsmen "Lord give us a good conceit of ourselves"—but that conceit must be well founded.

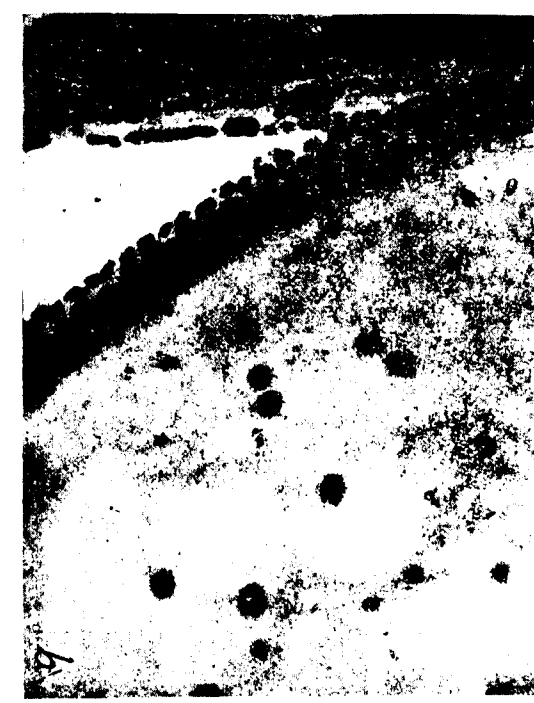
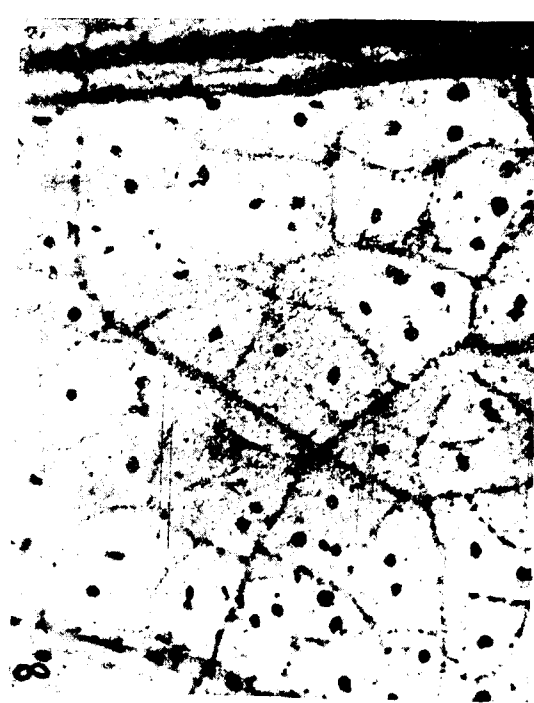
Bose was an exceptional man. He developed personality, individuality and independence of judgment very early. His contributions to Science were many and of a very high order

though some of his deductions are, I am told, not accepted by all botanists, some of whom think that certain of these might well have other explanations. Unfortunately my knowledge of Botany is elementary, but his work on the Flow of the Sap appeals very strongly to me. By a strange coincidence just at the time when I received the invitation to give this lecture, I had more or less accidentally made a digression into his field of Botany. By means of micro-radiographs I have been enabled to show how in plant life metallic and other substances of high atomic weight are drawn up from the soil, into the plant and distributed into and between the venules of the leaves in certain species.⁽²⁾ Lantern slides will show what I have found up-to-date.

Description of slides.—These radiographs were made possible by the use of soft X-rays from a diffraction tube such as is used in crystallography, and a photographic emulsion film that is practically grainless, and is thus capable of great enlargement.

1. *Micro-radiographs of a rose leaflet X 50.*—On the lantern slide. It shows "spots" in the venules of material of higher atomic number than the structure of the leaflet. You will note that these "spots" are confined to the venules in this rose leaflet. These "spots" are





heavy minerals that are drawn up from the ground into the stem and distributed into the leaves.

2. *Rose leaf X 120*.—Showing that the spots are of two fairly definite sizes, the larger ones 250μ and the smaller ones 150μ (approx).

3. *Rose leaf X 120*.—This is a spring leaflet that had faded and dropped later in the year. The size of the spots is very much smaller (the magnification in this slide and of slide 2 is X 120, while the first slide was only X 50). It will be noted also that many of the spots are now between the venules. The suggestion of this radiograph is that the spots have been diminished in size because their substance has been used in the economy of the plant. For this purpose also it seems likely that the spots have been moved out of the venules into the intervenular spaces.

4. *Leaf of Berberis X 120*.—This, although it begins to show cell structure shows no sign of spots. If they are present they are of very low atomic number, i.e., approximating to that of the leaf structure.

5. *Prunus leaf X 100*.—This shows the distribution of the spots in the midrib as they flow to their distribution.

6. *Potato leaf X 100*.—Note the small spots in the venules and the very large spots, 500μ approximately, in the intervenous spaces.

7. *Tomato leaf X 100*.—This is very similar to the potato leaf. In both of them the spots were of relatively low atomic number, requiring the use of much softer X-rays to show them than in the case of the rose and prunus.

8. *Rhus cotinus X 100*.—The spots in these leaves are small but of fairly high atomic number and are all located in the venules.

9. *Bean leaf X 100*.—Showing the spots in the midrib and their distribution into the leaf. Note the moulding of the spots to the length of the vessels in which they lie.

10. Another example from a bean leaf X 100.

11. *Asparagus leaf X 100*.—The spots are moulded to the vessels and are of low atomic number.

12. *Rose leaf X 100*.—Showing how lead acetate, in which the cut stem was placed for a day or so, has passed up into the leaflet. The presence of spots, masked by the lead acetate, can be detected.

I can well imagine that these preliminary studies would have interested Bose, for it would have enabled him to carry his work forward, and to prove or disprove by direct observation his contentions as to the ascent of the sap. So far as I know, this is the first time that Radiography has been brought into the service of Botany, and I am

very hopeful that Sir Jagadish Bose's successor, Dr. D. M. Bose who is now Director of the Bose Institute, and is also primarily a physicist, and also a Christ's man, will take up this work, and apply it in the way that Sir Jagadish himself would have done.

The life work of Sir Jagadish, who was the first honorary member of this Association, of which you have also made me an honorary member must be an inspiration to us and set the tone to our own endeavours. We must not be content to be mere stereotyped interpreters of radiographs and screen pictures; we must look at each case individually and think of it in terms of research, research into the problem as to how far and how closely do our observations of the X-ray material fit in with the clinical condition of the patient. Only by so doing can we take our full share of responsibility for the diagnosis of the case and be real colleagues in the team.

May I tell a story of Dr. Thurstan Holland? Many years ago he had a partner; this man came excitedly into his consulting room one day, with a radiograph. He maintained that it showed a dislocation of the thyroid, which had been dislocated, and was above the hyoid bone! Holland looked at the radiograph and at once saw the fundamental mistake; his partner had not recognised calcification of the hyoid

ligaments. Turning to his partner he said, "Where is the patient?" "In the waiting room Sir" "You fool" said Holland, "go back and look at the patient; the condition which you describe is not compatible with life." That of course is an extreme case, but it typifies the attitude which the radiologist must take to every case. Failure to do so has led to very grave tragedies. Some of these I summarised in a paper, "Radiology, Empiricism or Science"⁽³⁾ some years ago, and perhaps I may traverse some of this ground again.

Those of you who are relative new-comers into Radiology will find it difficult to envisage the conditions under which we early workers had to find our way in entirely uncharted fields. Obviously when a new technique is discovered the proper thing is to test it out on normal subject, and try to learn something of the normal before attempting to apply it to the diagnosis of pathological conditions. This however, was not possible in Radiology, for our clinical colleagues wanted our help at once and, whether we liked or not, we were forced to attempt the diagnosis of pathology before we knew anything about the physiology. We had no help whatever from the physiologists or anatomists who seemed to be blind to the possibilities of progress opened up by the use of X-rays. We therefore had to

depend entirely on our own resources and to build up as best we could a background of what we guessed to be normal. Little wonder that we made many mistakes and that the prestige of Radiology often suffered thereby. Let us take one or two examples of this.

The introduction of the opaque meal method of examining the alimentary tract happened to coincide with the decline in popularity of the now forgotten Glenard's disease in which symptoms were ascribed to displaced or mobile viscera. This was a diagnosis which had for some years been much in vogue. The new X-Ray method of examination revived interest in this syndrome, and radiologists were called in to demonstrate the condition. The radiologist was now seeing for the first time the contents of the abdomen in the living subject, and what he saw was not the anatomy he had been taught in the dissecting room. Since therefore, he argued, the picture did not conform to that of accepted teaching, it could not but be abnormal (for years were still to pass before he had gained either the necessary self-confidence or the position to question the holy writ of anatomy). Accordingly, on the strength of radiologists' reports a variety of operations were undertaken for slinging up the viscera, some surgeons even excising portions of the stomach if this organ

was reported to extend well below the umbilical level!

A natural corollary to Glenard's disease was the conception that mobility of the viscera was pathological, and here again the slightest hint from the radiologist was often acted upon by the surgeon, who adopted many different methods in an attempt to secure fixation. It was fortunate that in those days there was no technique for detecting the normal movements of the kidney, the organ which chiefly attracted the surgeon's attention in this connection. In his procedures the surgeon was acting quite rationally for he believed implicitly in the anatomy he had been taught. This, however, was anatomy of the cadaver, and the fact that the abdominal anatomy of the dead bears little relation to that of the living subject was not yet appreciated, even though surgeons had been operating on the abdomen for years and actually seeing the varied positions in which its contents lay. Very few surgeons realised that the anatomy on which they relied was based on the wholly wrong premise of a definite fixed position for every organ. Naturally, the radiologist had the same out-look as the surgeon, and regarded as abnormal anything which did not conform to the anatomy he had been taught. Thus he was an accessory to some of the pitiful results of surgery which were

primarily due to the descriptive topographical teaching of the anatomists. Some credit however, must go to those radiologists who, gradually recognising the truth but with as yet none of the prestige of an honorary position or teaching status, tried to stand against the traditional teaching of anatomy and did their best to demonstrate what they saw to be a fact, namely that normally the viscera are freely movable and that they must be so if they are to maintain function. For many years radiologists strove to find out for themselves the anatomy of the normal, and this research had perforce to be carried out in the course of their routine work on patients and on such normal subjects as would collaborate with them. If anatomists had only appreciated the potential value of X-ray methods and at once applied them to the study of the viscera in the normal living subject, this dark period of surgery would have quickly ended, instead of dragging on for years in spite of the tragic results of so many of these operations.

A similar lack of interest in X-ray methods prevailed in the schools of physiology and was primarily responsible for another fashion in surgery which overlapped and succeeded that of fixation operations. This was based on certain aspects of the current teaching which would have been abandoned out of hand had

the physiologists embraced and explored the great opportunity afforded by X-rays. Physiological teaching suggested that the alimentary tract was a tube, almost a test-tube, in which certain definite chemical actions and movements took place, and in it everything should work according to a fixed schedule. If this schedule was not adhered to, stasis occurred in various parts, toxic products were absorbed, and symptoms would result. Constipation was the bogey of the day, and the bowels were bullied into frequent action. Advertisements of laxatives and purgatives absorbed a large proportion of the advertisement space, and the public became constipation-minded.

This was bad enough, but some surgeons invoked the aid of radiologists to decide where the stasis occurred, for seemingly any and every disease—particularly arthritic conditions, and even cancer—could be traced to toxic absorption from intestinal stasis. Some radiologists were equally obsessed with the idea of stasis, and instances are recorded of clinicians receiving full reports on the alimentary tract when they had merely asked for a radiograph of an arthritic wrist! The regions to which stasis was commonly attributed were the terminal ileum, cæcum, and various parts of the large intestine, and the radiologist was asked to determine whether there

was delay in the passage of the food and if so, in which section of the gut. The radiologist was of course, in no position to give an opinion, for he did not know the normal, but some plunged blindly and working with "stasis-minded" surgeons, issued their reports as oracles. In those days it was not easy for a radiologist to retain his honesty of purpose. Often a surgeon would bring him a lot of prints of X-ray plates that were labelled all over "stomach", "colon", "ileum", etc., and a report of many pages describing what the various shadows meant to the radiologist who issued it. He would be asked, "Why can't you give me reports like this?"—that is to say, reports which relieved the surgeon from his responsibility and took all the onus for excising this or that portion of the alimentary tract, or for slinging up, say the cæcum so that it would drain better—for the cæcum was passing through a bad time and was by this school regarded as a cesspool.

There is no need to dwell on this ghastly phase of surgery, in which large portions or even the whole of the large intestine were excised. It brought much discredit to surgery, much loss of life through utterly unnecessary operations, and the tragedy of life-long invalidism to many of those who survived. In Manchester the end of this phase was largely brought about by the

students who are always keen critics of the work of the surgeons and physicians under whom they work. One of the surgeons on the staff of the hospital was a keen advocate of the stasis school and carried out numerous excisions of intestine operations, sometimes even exsecting the whole of the large intestine. He also did far more fixation operations than any of his colleagues, most of whom were far from satisfied with the results that these operations were giving. The opportunity for criticism and ridicule was afforded by the Christmas pantomime that was produced by the medical students and which was always attended by the honorary staff each of whom was pilloried all their little weaknesses being good subject matter for the undergraduate humour. It was always a most amusing entertainment, in which I, personally was let off very lightly. On the occasion in question it so happened that two or three of the students were exceptionally gifted and produced a pantomime with dialogue, lyrics and music that would have done credit to professionals. These producers let themselves go on the surgeon who excised intestines and made this a major scene in the pantomime. The surgeon was short, stout and with certain turns of speech and manner that made him an easy subject for student wit. One of the most gifted

of the students impersonated the surgeon who, padded out with a pillow, strutted affably into the scene where all was set for an operation with the patient lying on the table, his abdomen rising high. With all due solemnity the operation was performed and from the "abdomen," the surgeon withdrew yard after yard of inflated intestine which soon lay in piles on the floor. The "abdomen" was closed with thick cord and the surgeon surveyed his work with the pride of accomplishment. Then turning to the sister he enquired as to the patients on whom he had been operating so successfully in recent days but to each enquiry the sister replied "I am sorry to say that the patient died" varying the reply to "the patient did not recover from the anaesthetic." It was the most cruel and exaggerated of parodies that could have been devised and it was done with great skill. It brought the house down of course but what the feelings of the surgeon were could well be imagined, for there was unfortunately more than a substratum of fact for the phantasy that these students had staged. Thereafter no surgeon would have dared to put on his list an operation for excision of the intestine. All this misery could have been avoided had radiologists known the actual facts concerning the passage of food through the alimentary tract in

healthy, normal subjects, and the enormous range of variation that may be found without giving rise to symptoms. I myself once saw a perfectly healthy girl whose normal bowel action was once a month, while on another occasion I found an extreme instance of duodenal ileus in a member of my class who had never had any gastric or intestinal trouble. The possible variations in anatomy are equally surprising. One of my students, who was in perfect health and played in his college teams, had, I discovered, a complete absence of the left side of the diaphragm—the stomach and hepatic flexure extending into the region that one would expect to be occupied by the upper lobe of the left lung. Had symptoms been present in such a case the connection would have appeared to be obvious, and the obvious might have been completely wrong. I could multiply such instances but even these should surely be a warning against attributing symptoms to minor deviations from what one regards as the normal. Gastritis and duodenitis have for some years now been diagnosed on the strength of relatively small changes in the mucous membrane pattern. Are we justified in saying that these changes are responsible for symptoms when we do not yet know the possible variations that may be found in health? Quite definitely I hold that we are not so justified.

It was not only in the abdomen, however, that lack of knowledge led the radiologist astray. In radiographs of the chest little detail could be made out until improvements in apparatus and technique made it possible to obtain plates with an exposure measured in fractioned seconds. About 1912, so far as I remember, it was pointed out that the shadows at the roots of the lungs were more prominent in some subjects than in others. It was argued that this must mean enlargement of glands, and that such enlargements must be tuberculous. Clinicians, and even radiologists, thought that these root shadows would not be seen in country dwellers and that they were a product of city life. The ordinary medical man envisaged the morbid anatomy as glandular enlargements rendered opaque by the soot of the city; at that time few radiologists realised that these shadows were mainly vascular, and few searched the cortical field of the lung in such cases for a primary focus of infection. Hence, even a slight prominence of the root shadow was regarded with grave suspicion, and some radiologists began to make a diagnosis of "hilum phthisis". It was several years before it was realised that these shadows might be just as prominent in the rural as in the town dweller, but unfortunately the concept of "hilum phthisis" had

gone forth and for some time, particularly in the disorganised years of the first world war, "hilum phthisis"—as an entity and not necessarily as secondary to a peripheral lesion—was an accepted diagnosis. It slowly died a natural death because the patients many of whom were treated in sanatoria and subjected to the risks of infection, did not develop clinical phthisis. It had been a mistake, an X-ray diagnosis of a disease that did not exist. The clinician, with his weak armamentarium of clinical methods, could not stand against the diagnosis, even though he had no belief in it. The objectivity of even those poor X-ray plates was too convincing, although in point of fact the meaning of the shadows that were seen was no more definite to the radiologist than was the meaning of "slight dullness" to the clinician.

I could quote many other lessons but surely these are enough for the present purpose *i.e.*, to emphasize that it is up to each one of us as radiologists to look at every case for diagnosis as an individual problem of research. It is up to us to try to solve the problem in the light of our own experience. The experience of others will of course be helpful but we cannot take a radiograph and compare it with an illustration in an X-ray atlas and expect that the diagnosis which was correct in one

case will necessarily be correct also in another. The X-ray picture must always be compared with the clinical condition in every case and even then without clinical judgement it will not always give the correct answer.

The great strides that have been made in recent years in the radiography of the chest have revealed a wealth of detail in the lung fields that is embarrassing in the present stage of our knowledge. More and more of the lung structure is revealed, smaller and smaller opacities are detected, slighter and slighter differences in radio-translucency can be observed, and the better the quality of the film the more intricate is the picture which it reveals. The interpretation of these delicate shadows becomes increasingly difficult and more and more dependent on a sound basic knowledge of the anatomical detail of the normal lung structure. The structure of the normal lung has its general pattern on an X-ray film, but he would be a rash man who said that any one particular pattern represented the normal, for the possible variations of detail within the normal are probably as considerable in the chest as they are in the abdomen, a region with which we are much more familiar thanks to the confirmations of surgery. There is no definite line of demarcation between the normal and the patho-

logical—the one slides imperceptibly into the other and, as in other fields, it is not the gross pathology which causes difficulties in interpretation, but those border-line cases in which pathological processes are only just beginning. We may guess that a certain appearance is evidence of pathology and our guess may be right, but a guess is a very different matter from a logical deduction from a known base-line.

Let us consider the case of silicosis. A few years ago I analysed the chest films of some 560 miners working in an anthracite coal pit. On the evidence of the radiographs I should have passed only 46% of these men as being within the limits of normality; 19.2% appeared to be borderline cases, while 34.8% were definitely pathological. Some of the films in this last group showed very gross changes. In another series (55 coal trimmers) the proportions of normal, border line, and definitely pathological cases were approximately equal. Now all these men were at work and, for the most part, were perfectly well; yet if any one of those in my pathological category had reported sick, the radiographic picture of his chest would have rendered him eligible for compensation. On the other hand I have seen men who were really ill and presented all the clinical evidence of silicosis but who could not receive

compensation because of the negative findings of the X-ray examination. The most extreme case of this kind that I know of occurred only recently. A miner was admitted to hospital apparently suffering from silicosis. X-ray examination showed not the slightest evidence of disease; the most critical study of the films (taken with a rotating anode tube) failed to reveal anything that was even suspicious of silicosis. A week later the man died, and the pathologist reported that this was a case of typical silicosis. We re-examined the films but could detect no evidence of the disease that had killed him. It seems obvious that in silicosis and other lung diseases our radiographs show only end results, fibrosis, nature's efforts at healing, and that they do not show—or else we do not yet recognise—those changes in the lung radiographs that are responsible for the symptoms. Yet legally, compensation could not at that time be paid to a man unless the radiograph of his chest presented certain characteristic features. In this particular disease public opinion has forcibly imposed a degree of reliance on X-ray evidence that is quite unjustified by the facts. Until we can actually detect those changes in the lungs that are responsible for the symptoms, no matter how weak the clinical methods of detecting the disease may be, it is not only unsound,

but it is unjust on the patient that the onus for the diagnosis should virtually be vested in the interpretation of the X-ray film. In this disease once again circumstances have compelled the radiologist to interpret pathology before he has really been in a position to do so, and it may well be that we must revise some of our ideas.

The late Sir Pendrill Varrier-Jones of Papworth, perhaps the greatest star that has shone in the tuberculosis firmament, wrote in an article, which was published in the *Lancet*¹ shortly after his death, of the value of an X-ray film:—"We take an X-ray film and are filled with wonder at the complications of nodes and shadows, not sufficiently realising that what we are gazing at is the picture of past battles, filled-in trenches, exploded mine-craters and the like. What we imagine we see, but do not, is the advancing army of disease. . . . We have interpreted the X-ray film wrongly. . . . we have used it as a picture of the present battle, whereas it is but the shadow of past conflicts."

Or take the the commonest of all chest diseases, bronchitis. Which of us can make a diagnosis of this condition with certainty? We see large masses of muco-purulent material brought up, and cannot even detect whence they came. It may be that the evidence is in fact present in the

X-ray film, and that when the whole complex background has been carefully analysed and each shadow traced to its proper source, this evidence will be seen and recognised for what it is. But without the fundamental knowledge provided by such a study, a diagnosis of bronchitis is sheer guess-work.

How simple would radiology be if we had a yard-stick of normality and knew just what was within the limits of the normal. The fact of the matter is that the diagnosis of normality and of health is far far more difficult than that of disease and, most unfortunately our medical training is all in hospitals and in an atmosphere of pathology. We are educated with the avowed intention of being trained to detect disease. This is fundamentally wrong, for our function in life as medical men is to cultivate health in our patients, and to combat disease. Our outlook should not be that of regarding every unusual shadow as necessarily pathological. We should always be questioning what a shadow really represents and whether or not it is compatible with health. Our ideal should not be the detection of possible pathology, but of health. Does an unusual shadow represent a threat to health or is it of no real pathological significance and can it be safely ignored? That is a major problem that we should constantly have in mind. Quite frequently it

were best that we should take a risk that we are wrong rather than draw the attention of the clinician and the patient to something that was best undiscovered. Yes, every case may be a problem case in which it is up to the radiologist to form an opinion and exercise his clinical judgement. Can we do that greatest of all services to a patient, assure him that he is well and need have no fear? That assurance, coming from the magician who, in the dark, sees through the body, carries perhaps an unjustifiable weight with the patient. Yet it is not for the radiologist to tell the patient his findings: these must be conveyed to him through the physician or surgeon in charge of the case. There is however no reason why the radiologist should not be at the consultation and be able personally to reassure the patient. Time and again I have found that what was really worrying a patient was the fear of cancer or tuberculosis and have been able, with the consent of the physician, to tell him that there was no suggestion of these dread diseases. That word came with far more force and conviction from me than if it had come to him second hand. We must never forget that we may do a great deal of harm unwittingly, by allowing the patient to suspect that we have seen something unusual. It is much better that he should know nothing about such things until we have made up

our own minds definitely, probably after consultation with the clinician in charge of the case, whether or not it is wise to tell the patient. Moreover, although it may be all right to tell certain patients of abnormalities found, it may be entirely wrong in others, particularly the neurotics. Years ago when duodenal diverticula were first recognised I saw a perfect example in a young girl who had slight indigestion. Unfortunately I got so excited about it that I called my partner to see the beautiful diverticulum. Also, the patient's curiosity was aroused and she had to be told about it. In spite of my repeated assurances that the condition was not of pathological significance she became diverticulum conscious and for years thereafter suffered from severe gastric trouble for which I always blamed myself. I do not think the diverticulum had anything to do with the symptoms. Had she known nothing about this abnormality, she would easily have forgotten the slight gastric trouble. The connection of mental suggestion with the bodily health is very close and in no part of the anatomy is the connection of the mind and body more intimately connected than in the case of the stomach and duodenum.

Much of what I have been saying as to the mistakes of the past has passed into the realm of history, and is of no importance to us today,

for the lesson has been learned. But how much more rapidly would these lessons have been appreciated if the radiologists had had some knowledge of the normal, and the collegial status on which to guide his clinical colleagues.

Some of what I have been saying however, belongs to the problems of the present day, throughout the world of Radiology. I am thinking of the diagnosis of many diseases of the chest particularly in their early stages. There is no branch of diagnosis of more vital importance to the patient. Our opinion may determine prolonged hospitalisation or a decision that he can carry on with his work. In this field, moreover, clinical diagnosis is so extremely weak, that, to my mind, too great a responsibility is thrown on the radiologist, a responsibility that he has had to accept though in point of fact he has not been in a position to do so. This is not the fault of the clinical radiologist but is due to two things; he seldom really appreciates that he is reading in his films the story of past battles, that although probably influencing the present disease, are not the evidences of the disease that is the present cause of symptom. Information as to the pathology giving rise to the present symptoms may well be there on the films but as yet the recognition and interpretation of such shadows, if they are present,

is beyond us and we continue to look at and draw deductions from the records of spent conflicts. That is one side of the picture. On the other is the lamentably weak state of our knowledge of the detailed anatomy of the lungs in spite of the life time of work Snow Miller⁵ gave to its study. One cannot help feeling that in all his works he has built up a picture of the anatomy of the dead and that this may well be as misleading as is the anatomy of the abdomen of the cadaver. A detailed study of the *living* anatomy of the lungs is one of the constructive researches that is very urgently needed. Moreover this research should be on parallel lines, *i.e.*, anatomical and radiological. By running such a research in parallel the recognition of each anatomical feature would forthwith be related to its radiological appearance. It would probably need years of work by a team of workers; it is too big a subject to be dealt with by individuals. It needs a laboratory specially equipped and staffed for the purpose of the study of the normal. The study of the lungs must be complete if it is to give us all the information we so urgently need in clinical medicine. Patchy research may well be misleading.

What can we do now? I fear we can do nothing except analyse our own successes and failures by following up cases. We can however

recognise our limitations and insist that clinicians, even if their armamentation is weak, should take their fair share of responsibility. They at least know the clinical condition of the patient and should be able to gauge something of the activity of the disease.

Perhaps this may sound to those of you who are not radiologists, as if I was belittling the achievements of radiology. When both the clinical and the radiological diagnosis of early lung disease is weak it is up to us as radiologists to see if we cannot make progress, and I am convinced that with greater knowledge of the normal we should in time be able to do so. But in the meantime the value of the chest radiology in established conditions has become of a high order, and has advanced the accuracy of diagnosis out of all recognition. As one looks back to the pre-radiological era one thinks of the cases in which at the bed-side we had found a little "impaired resonance", the meaning of which we did not understand, and in the P.M. room found gross lesions that we had not even suspected. These cases made us completely sceptical of the detection of pathology within the chest by clinical methods. Today we follow our cases to the P.M. room and seldom find that our radiological assistance in diagnosis has led us far astray. No, it is not the

attainments of radiology that I question but the fact that our progress is limited by lack of background knowledge. I want radiology to stretch out beyond the present sky line and open up new fields in the detection of early disease, and that we may be pioneers in an as yet uncharted country. If we could make certain of the diagnosis of early lung disease, or even more important, the absence of such disease we would lay humanity at great debt to us. I often wonder if medical men as a whole realise the magnitude of the debt that they owe to Radiology in almost every field of medicine.

The attainments of radiology are great, but we must not rest on our laurels. We must utilise to the limit, the wonderful facilities that the use

of X-rays places in our hands. It is a great responsibility. This is the spirit in which Sir Jagadish Bose would have tackled these problems, using any and every means of approach to further knowledge. And on this note of appreciation of his spirit, and of the inspiration it should be to us, I will end this lecture, and once more express my gratitude to the Indian Radiological Association for the privilege given in honouring me as the first lecturer. My one regret is that I cannot be with you to deliver the lecture in person.

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Messages

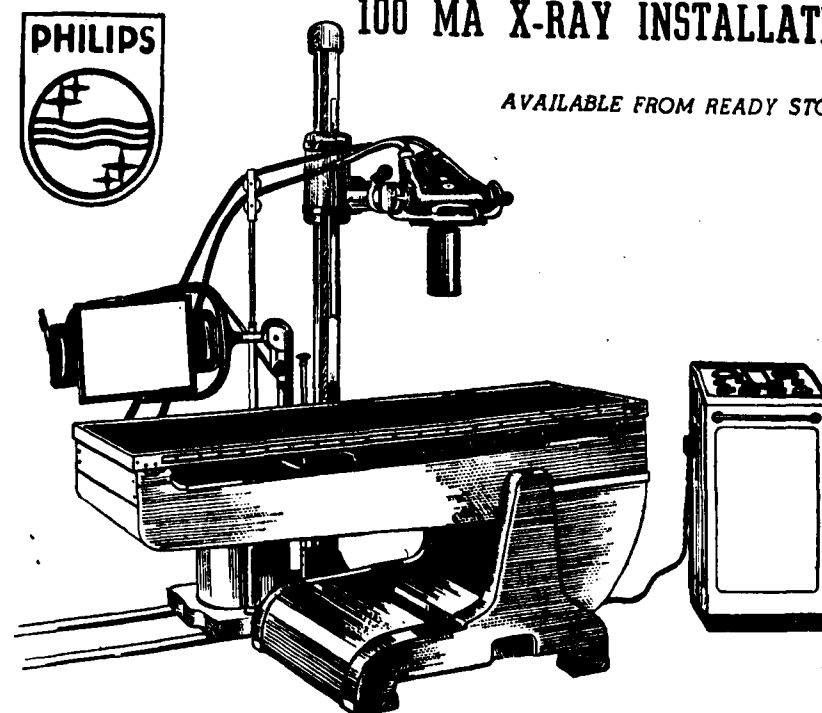
Messages congratulating Dr. P. Rama Rau on his election as President of The Indian Radiological Association and best wishes for the success of the Third Indian Congress of Radiology have been received from the following:—

1. Dr. Arthur C. Christie, M.D., Washington, D. C., President, V International Congress of Radiology.
2. Dr. Ralston Paterson, President-designate, VI International Congress of Radiology, and Director, Christie Hospital and Holt Radium Institute, Manchester, 20.
3. Dr. D. W. Smithers, Director, Radiotherapy Department, The Royal Cancer Hospital, London.
4. Major General J. P. Huban, former Surgeon-General with the Government of Madras, now at London.
5. Dr. Max Cutler, M.D., Chicago Tumor Institute, Chicago.
6. Dr. Henri Coutard, M.D., Glöckner-Penrose Hospital, Colorado Springs.
7. Dr. J. H. Mather, Liverpool.
8. Dr. Karl Presser, M.D., New York, N. Y.
9. Dr. U. Krishna Rau, M.B., B.S., ex-Mayor of Madras.

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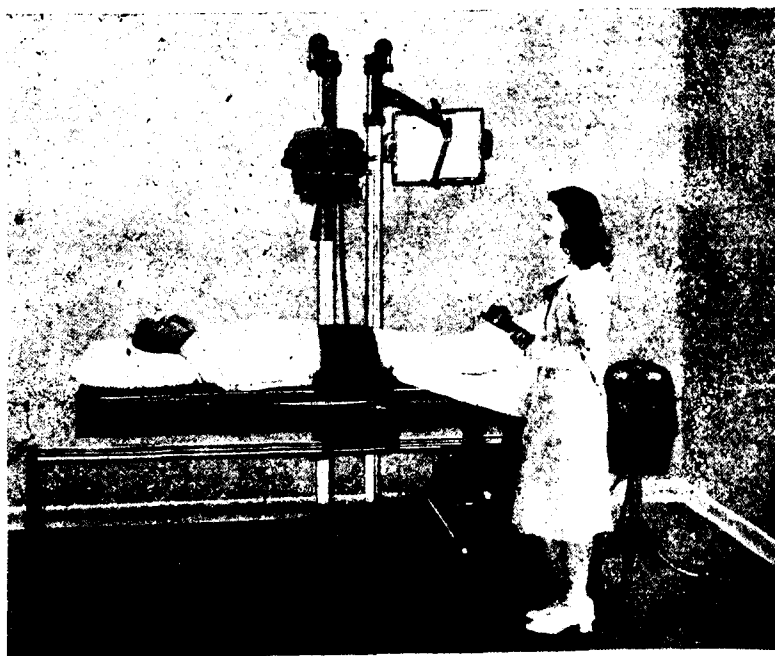
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EDITORIAL

Our Needs

THE address of Dr. D. M. Bose on the life and work of the late Sir J. C. Bose left me in a thoughtful mood. The address was both inspiring and depressing in its effect—inspiring because of the great scientific achievements of one of our illustrious countrymen even as far back as the early part of this century—his extraordinary ability to conceive and construct such delicate scientific instruments as were used in his experiments out of pure local talents—their ingenuity and craftsmanship which are marvels even to-day—depressing because of our present absolute dependence on foreign manufactures for our requirements of scientific instruments. But it did not take long before this gloom was dispelled. A casual acquaintance dropped in at my hotel and pressed on me an invitation to visit his X-ray factory and show rooms. Having had a little spare time on my hands at the close of the Congress Session I readily agreed to accompany him and I am glad to say that the visit was fully rewarded for I saw what was possible even under the uninviting conditions he was working in. I saw there to my great and pleasant surprise some finished X-ray apparatuses which were in no way inferior in appearance or elegance to any of the foreign makes; the only parts imported being the X-ray tube and the cables. I considered this was no mean achievement as the price of the unit was about 40% less than that of a comparative foreign make.

X-ray and other electro-medical equipments are costly to import and every day the cost of these are increasing. This is a large drain on the finances of the country. We cannot expand the facilities of X-ray examination and treatment to the extent necessary unless we make it cheap

enough and the only way to meet this growing demand and to keep it within our financial means is to start manufacturing these equipments in our own country. The last Great War has taught many of us—who have been in responsible positions of running and maintaining large X-ray services—the bitter lesson of depending upon foreign countries for our requirements. No equipments were available, no spares and not enough X-ray films and chemicals. There was a hue and cry in the country for these facilities, but we had to wait on patiently and grab at whatever little supply dribbled through to this country during these many weary war years and after. These difficulties and tribulations were not too few to be forgotten so soon. With the contemplated large expansion of medical relief in the country Radiology has to play a great and important part. Diagnosis and treatment of diseases will not be complete unless these facilities are made available. Every district and taluq headquarters hospitals and the larger dispensaries have therefore to be provided with these facilities. Unless X-ray equipments, films and accessories are made available in large quantities and cheaply, this contemplated expansion will not be possible under the existing financial conditions. The only way to achieve this very desirable object is to manufacture them in this country and this has to be done and done as soon as possible if the contemplated wider service to the masses is to become an accomplished fact.

When we last met in Madras in 1946 for the First Congress of Radiology, we during that session passed a resolution regarding manufacture of X-ray equipment, films, accessories etc. We duly communicated these resolutions to the Central and Provincial Governments. But there the matter ended. The Third Congress of Radiology is now over and the Fourth one will be soon on us. But what have we done? It is time we take up this matter now more seriously. This is the second year of our independence. An independent India has to be self sufficient at least in matters so vitally concerning the health and welfare of the Nation. Shall we not start moving about, do something, and make a beginning and get over the habit of appealing to the Government for everything. It is our Government and to the extent we help them and relieve some of these responsibilities to that extent they will be freer to tackle bigger problems. There is ample talent both within and without our Association. The capital required will flow if only we prove we are in right earnest. It is time that a beginning is made.

K. M. RAI,

Third Indian Congress of Radiology

Capt. M. MUKHERJI, M.B., D.M.R.E.,

General Secretary and Treasurer, Reception Committee.

THE Third Session of the Congress was held during the Christmas week from the 25th to the 28th of December, 1948, in Calcutta at the Calcutta Medical College—the most ancient of medical colleges of India. As in the previous year, the Congress had its meeting synchronously, and at the same place, with the annual conferences of other medical organisations, namely, the Indian Medical Association, All India Medical Licentiates' Association, and the Cardiological Society of India, thus affording the radiologists a splendid opportunity once again to meet a very large number of medical men and women—general practitioners and specialists—from all over India, Pakistan, Ceylon and the United States of America, to relate experiences, to exchange views, and discuss matters of common interest as far as the crowded programmes of the annual conferences of the different associations would permit.

For the purpose of the Radiology Congress, the Bengal Radiological Association formed into a Reception Committee and made all the necessary arrangements. The magnitude of the work that devolved on me as the General Secretary, was stupendous, but my burden was considerably lightened by the very willing co-operation and assistance of Dr. P. K. Guha, Radiologists of the Mayo Hospital. Major S. Basu, Drs. S. K. Bhar and N. M. Banerji also lent a helping hand. We worked in co-ordination with the organising sections of the other medical associations. Overlapping of the programmes had been sought to be avoided, but could not be achieved owing to circumstances of unusual and sometimes unforeseen difficulties that we had to contend with. We were

forced to be content with only 4 days for all the conferences and each had a heavy agenda. I would here recommend to the future organisers of the annual medical conferences to provide for more number of days for the sessions which will effectively and profitably eradicate the overlapping, in preference to the method that some friends have in view of holding the conferences in different places and at different times. The annual opportunity of meeting of a large number of the members of the profession from the far-flung parts of India and the neighbouring dominions, which goes to build up and consolidate a feeling of real kin-ship, should persist.

Inauguration of the Congress

In the evening of the Christmas day after a cordial welcome from the Chairman of the Reception Committee, Capt. R. P. Banerji, to the assemblage of medical men about a thousand strong, gathered in the beautifully decorated vast Conference Pandal flood-lit with powerful fluorescent lamps, the Congress was formally inaugurated by Major General A. C. Chatterji, Director of Health Services, West Bengal Government. In their addresses, both of them stressed on the need of systematic training of medical men and students in Radiology, the employment of suitably trained and sincere young men in the fundamental researches into this progressive science, and promotion of indigenous radiological industries, so that India did not lag behind the Western countries in the knowledge of radiology and nuclear science, that, adequate and efficient radiological service could be made available to the bulk of the Indian population who live in the small towns and rural areas and at present are perforce

denied this essential medical aid, and that India could become not only independent of the Western countries in the matter of supply of the apparatus and accessories, but also bring down the prevailing apparently prohibitive costs to an economical level. Major General Chatterji also made certain concrete suggestions as to how the training may be given.

After the inauguration, the President-elect of the Third Congress, and of the Indian Radiological Association for 1949, Rao Bahadur Dr. P. Rama Rau was installed in his position by Dr. K. P. Mody, the retiring President of the Association, who then addressed the meeting, and among other topics, cautioned the medical men against a rising predilection in favour of million volt X-ray therapy because of *expected* optimum results in malignant diseases, on physical grounds. The published experience of leading radiologists working with supervoltage apparatus in some of the big clinics of the West for the last 10 to 12 years does not justify the adoption of million volt therapy in the routine treatment of cancer by X-radiation. The results are in no way superior to what is obtained with the classical and much less costly 200 to 250 k.v. apparatus. In his opinion, a million volt apparatus may be one of a number of therapy apparatuses in an elaborately equipped institution, for *purposes of research*, but for affording cure or relief to the great mass of cancer-afflicted people of India, the available funds should not be spent on a single million volt machine but should be profitably invested on a battery of the orthodox 200 k.v. plants whereby a larger number of patients may be benefited.

The newly installed President Dr. Rama Rau then delivered his address in the course of which he dwelt on various matters of radiological interest.

Inauguration of Sir Jagadish Memorial Lecture

This Session of the Indian Congress of Radiology was marked by the special event of inauguration of the Lectureship that was founded four years ago in memory of and as a mark of homage and respect to the departed Indian scientist—Sir Jagadish Chandra Bose, who in his life time interested himself in the welfare of the Indian Radiological Association, and had graced it by becoming its first honorary member.

This Memorial Lecture is to be periodically delivered at the Congress of Radiology, by any renowned medical man, radiologist and scientist on a subject intimately related to medical radiology, and carries a gold medal as a token of appreciation by the members of the Association.

Dr. A. E. Barclay, O.B.E., M.A. (Cantab), M.D. (Cantab), D.M. (Oxon), D.Sc. (Hon. Oxon), F.F.R. (London), F.R.C.P. etc., one of the premier radiologists of the world, and at present Chief of the Radiological section of the Nuffield Institute for Medical Research, Oxford, who is also one of the Honorary Members of our Association, was elected to give the first Memorial Lecture.

Dr. D. M. Bose, M.A., Ph. D., Director of Bose Institute, Calcutta treated the audience to a very edifying address on the Life and Scientific Activities of Sir J. C. Bose as a prelude to the Memorial Lecture. There have been three distinct periods in the scientific activities of Sir Jagadish from 1894 to his demise in 1937, which were related in detail by Dr. Bose, and "in each of these periods his (Sir J. C.'s) efforts were directed towards the solution of problems lying in the borderland regions of sciences." In the *first* period, he produced the shortest of the then (about 1895) possible wave length of electro-magnetic radiation, which after remaining, in comparative oblivion for nearly half a century, came to be utilised

with apparatus similar to that developed by Sir Jagadish, in the training of personnel for the radar method of detection and interception of enemy airplanes during the last World War. In the *second* period, he studied the fatigue effect in metallic coherers and responses of the inorganic system under different kinds of stimulation, culminating in his famous generalisation, on the similarity of responses in the living and the non-living. In the *third* period, his work was concerned with plant physiology "where he tried to establish the similarity, if not the identity of response to stimulation exhibited by animal and plant tissues."

Dr. Bose's address was followed by the Memorial Lecture—but as unfortunately Dr. Barclay could not be present, his paper was read by my humble self. Dr. Barclay had taken up for his theme a general dissertation on the evolution, growth, status and future development of medical radiology from historical, ethical, academic, and scientific aspects, under the caption, "*The Radiologist and His Work*."

From his own experience, Dr. Barclay has drawn a very impressive pen-picture of the forward march of Radiology and the Radiologist from a position of neglect, indifference and obscurity half a century ago to the present when both the speciality and the specialist are in the very front rank in the medical world, where diagnostic and therapeutic applications of radiology in suitable cases are *sine qua non* in the practice of Medicine, and the Radiologist is regarded as a trusted and indispensable ally of the other specialists in the fight against Disease. This singular change has been possible through honest and diligent application to the special work by the pioneers in Radiology, systematised training in the subject, of the later generations by university-controlled special diploma courses of a high standard, and a

possession by the radiologist of such a degree of knowledge in Medicine, that when required, he could speak the languages of the other specialists in the various branches of Medicine and Surgery. Dr. Barclay therefore strongly recommends the Radiologists in India to follow the same course for the uplift of their speciality in their country.

His paper abounds with illustrations of wrong interpretations of the findings in X-ray examinations of the alimentary tract and the chest, which in the past, have been responsible for many unwarranted surgical operations, ending in disaster, and for branding perfectly normal individuals, "tuberculous," thus not only taking them off from their usual avocations, but even hospitalising, and subjecting at least some of them to the risks of actual infection in tuberculosis sanatoria!! Such tragedies are due to teaching of anatomy and physiology in the orthodox way, which is defective as it engenders in the minds of the future medical men erroneous conceptions of the *normal*, thus influencing the radiologist to conclude every variation in the form and function of the organs which he observes in the living human being as abnormal, and so pathological, inasmuch as these do not conform to his knowledge of the normal gathered from the cadaver in the dissecting room, or from the phenomena in the test tubes and experimental animals in the physiology classes. From the same cause, the physician and the surgeon also concur with the opinion of their radiological colleague! Dr. Barclay therefore makes out a strong case for the application of radiology to supplement the usual mode of teaching these fundamental sciences in Medicine, by which alone a correct evaluation of the variations can be made. He advocates research on parallel lines, anatomical and radiological, on the *living* anatomy of the lungs to correlate every anatomical feature with the radiological

appearance so as to get the requisite knowledge for diagnosis of early chest disease. The radiologist should always bear in mind the enormous range of variations within the normal, and, that there is no sharp line of demarcation between the normal and the pathological. He must not attribute the symptom to minor deviation from what is regarded as the normal. Nor should the onus of diagnosis rest on the interpretation of the X-ray picture; the clinical condition of the patient must always be considered, and the clinician should share in the responsibility of a diagnosis.

Dr. Barclay has impressed on the radiologist never to entertain any idea of scoring over the clinician, but through free and frank discussion supported by his own reasons to cultivate a spirit of mutual understanding and good feeling. He has also emphasised on the necessity for the radiologist attending as many of the operations and autopsies on his cases, as possible, to improve his diagnostic abilities. In the absence of such whole-hearted team work, an otherwise competent radiologist, will not succeed in turning out first class work, and earning the confidence of his colleagues. In his paper, he has also discussed when, how and to what extent the radiologist is to tell the patient the result of his examination; in some cases, especially, to patients of the neurotic temperament, it is most injudicious to tell any thing, whereas in others it is expedient to tell the patient that he or she is not suffering from any of the fell diseases like cancer or tuberculosis. The information received directly from the "magician who in the dark, sees through the body" is far more assuring than if it were obtained second hand from the clinician.

In addition to his many well-known epoch-making discoveries in the realm of animal physiology, Dr. Barclay has only very recently launched into investigations on the

physiology of the ascent of the sap in plants by his ingenious radiographic methods. This is the first time that radiography has been pressed into service in the study of Botany. It is a striking coincidence that the Memorial Lecturer should all unwittingly, take up the very subject, decades afterwards, on which the late Sir Jagdish had done by other methods, voluminous work and achieved wonderful results as published in his numerous papers that were subsequently collected and presented in his book, *The Ascent of the Sap*. Some of the thrilling results already obtained in this line by Dr. Barclay are described in his paper: the prints from his original micro-radiographs were circulated amongst the audience showing how in plant life metallic and other substances of high atomic weight are drawn up from the soil, into the plant and distributed, into and between the venules of the leaves, and also how these substances are used in the economy of the plant by storage in the inter-venular spaces. Dr. Barclay hopes that this new line of research would be taken up by Sir Jagdish's successor—Dr. D. M. Bose.

After the lecture, the President showed the memorial medal to the audience, and announced that it will be presented to the Lecturer through the post, in the first instance, reserving the ceremonial presentation for the summer of 1950, when the Indian Delegation goes to London to attend the International Congress of Radiology.

The inaugural meeting terminated after a vote of thanks to Major General Chatterji and Dr. D. M. Bose.

Scientific Section

The activities of the Congress under this section consisted of:—

- (1) Holding of three scientific sessions.
- (2) Exhibition of interesting films.
- (3) Demonstrations in scientific institutions.

(1) Three scientific sessions were held in the lecture theatre of the School of Tropical Medicine attached to the Calcutta Medical College, under the presidency of Drs. M.D. Joshi, K. M. Rai and R. F. Sethna consecutively. Altogether 14 items comprising presentations of scientific papers and case records accompanied by exhibition of relevant skiagrams, projection of prints, clinical photographs, diagrams and tabulated results, and also cinematographic demonstration, embracing diagnostic, therapeutic, physical and electro-technological fields in radiology, were disposed of. It was very gratifying to observe the presence of many non-radiological members of the medical profession during these Sessions, thus testifying to the interesting and instructive nature of the contributions and the discussions that followed. In fact some of the papers were of an original character.

It was felt by all that the time at our disposal was too short for a fuller presentation of the subject and adequate discussion in the case of some of the papers. One of the papers had to be taken as read for want of time. I can only hope that this will be borne in mind for the future, for suitable action by providing for a larger number of hours if feasible, for the Scientific Sessions.

The contributions at the Congress will be published in the issues of the *Indian Journal of Radiology*.

(2) A large number of interesting films were exhibited on an illuminator improvised for the occasion with muslin fabric stretched on slanting wooden frame and lighted by a battery of tubular fluorescent lamps and capable of showing 150 skiagrams at a time. The illuminator was installed in the Electro-therapy Department of the Calcutta Medical College. This constituted the Scientific Exhibition of the Congress.

(3) *Scientific Demonstrations*.—At the Bose Institute, the Director, Dr. D. M. Bose and

some of his colleagues showed and explained to the visiting radiologists a few of the experiments of Sir Jagdish and the various original and ingenious apparatus invented and used by him for the purpose, in his different investigations in the three periods of his scientific activities, and also various other investigations now being carried out at the institute, one of them being, the effect on the growth of certain plants by irradiating, their seeds with X-rays.

At the UNIVERSITY COLLEGE OF SCIENCE, Dr. N. Das Gupta explained the construction and mode of action of the "electron microscope", the only one in India to date, and then demonstrated to the radiologists degree of magnification possible with this instrument. The various components of the "cyclotron" were also shown, and their method of action explained.

The last series of demonstrations were given at the INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE, possibly the oldest of private scientific institutions in India, and the cradle of many of the world renowned Indian physicists like Sir C. V. Raman and Dr. Krishnan. The medical fraternity of India ought to be proud of the fact that this institution was founded through the efforts and sacrifices of one of their number, the late Dr. Mahendralal Sarkar, M.D. Here, the radiologists, were treated to demonstrations of Raman effect, X-ray spectroscopy and crystallography by the Director, Dr. K. Banerji and his associates.

Social Activities during the Congress

The social and entertainment side was not neglected. Commensurate with the prevailing austerity conditions, the radiologists and some of the friends and well-wishers could gather together on two occasions only, for the "cup that cheers but does not inebriate" through the hospitality of Drs. P. Rama Rau and Subodh Mitra, and sit twice round a

a festive board for only a frugal lunch provided by the Bengal Radiological Association and Capt. R. P. Banerji respectively.

Songs, music, dramas and cinema show every night, as also a boat trip on the Hooghly had been arranged for the entertainment of the visitors.

Recognition of the Indian Radiological Association

The Government of Indian Union has been graciously pleased to recognise the Association as a competent advisory body for the Government in their policies and actions with regard to matters intimately connected with medical radiology. The Director General of Health Services in India met the members of the Central Council of the Indian Radiological Association, in his official capacity, and had some preliminary talks on that subject, during the session of the Congress, on the 27th December. The Hon'ble Health Minister of India Government, Raj Kumari Amrit Kaur in her address at the concluding joint session of all the conferences, was pleased to make an appreciative reference to the services of the Association, in the cause of Radiology.

This cannot but be very gratifying for the radiologists of India in general, and the

members of the Association in particular. It will, we hope, stimulate such of our colleagues as have not yet joined the Association, to flock without delay under its banners.

As one of the two who nearly 20 years ago, conceived the idea of forming this Indian Radiological Association and actually brought it into existence, I take a special pride at this recognition of our Association, and feel that I have been amply rewarded for my small services.

No account of the Congress can be complete without expression of sincere thanks to such of our friends who helped us immensely by their co-operation for the smooth working of the Congress Session, to our well-wishers in the West who had sent congratulatory messages that were read out in the Inaugural meeting, to the Directors and Professors of the Scientific Institutions who gave to our members the demonstrations, and to Messrs. Richardson and Baker of Messrs. Philips Electrical Co., and Kodak Ltd., respectively who provided us with fluorescent lights, film viewing boxes, prints from the micro-radiographs of Dr. Barclay, and cinema projector for the different sections of the Third Indian Congress of Radiology.

THIRD INDIAN CONGRESS OF RADIOLOGY

Welcome Address

Capt. R. P. BANERJI, M.B.,

President, Bengal Radiological Association, Calcutta.

Director of Health Services, Government of West Bengal, Ladies and gentlemen :

I have great pleasure in welcoming you all to the Third Indian Congress of Radiology in Calcutta. This Congress is entirely due to the efforts of the Indian Radiological Association which had its humble origin in this City. The Association came to life on

the 21st of February, 1931 and the number of initiating members were only ten. I am very glad to see some of the original members present in this gathering. We find in this annual congregation, medical men from all over India—representing almost all branches of medicine—meeting together and exchanging notes, a very healthy sign of

co-operative progress in medicine. I hope this spirit of co-operation would go on increasing from year to year to the benefit of advance in Medical Science.

The world is going through a tremendous upheaval. Well regulated and smooth existence appears to be as far away as ever. We have tried to accommodate our brethren coming from distant parts of India as comfortably as possible. But, I am sure there would be many shortcomings in these days of stress and strain, which I hope our brethren will not mind. We sincerely want to make them feel at home.

In the Scientific Section there would be film exhibits of interest, and papers will be read by eminent Radiologists, and Physicists of India and Ceylon, which I am sure cannot but be instructive for the medical men in general and the other attending radiologists in particular.

A special feature of this Congress, will be the inauguration of Sir Jagadish Memorial Lecture by the renowned Physicist Dr. D. M. Bose, Director of Bose Institute. This Lecture henceforth will be an annual event in our future Congresses; its foundation was mooted by us a few years ago as a mark of our homage and tribute of respect to the departed great Indian savant, who in his life time used to take a great interest in the welfare of the Indian Radiological Association, and had honoured us by condescending to become one of Honorary Members.

India is now free. Nuclei of higher training in all branches of Medicine should be built up in our country instead of looking to foreign for the purpose. Radiology though a comparatively, young branch of Medicine, yet has come to occupy an important and indispensable position. I hope the remaining Universities of India would recognise this

position of Radiology and follow without further delay the steps already taken by Madras and Bombay Universities.

India in bondage had always to look forward to foreign countries for all radiological requirements e.g. X-Ray plants, films, chemicals and all other accessories, on a prohibitive cost and so perforce denying this essential service to countless poor millions in our country. I hope the National Government in Free India in its scheme of industrial development of the country would give a priority position to the X-Ray industry, so that radiological services would be available all over the country at a lesser cost, and thus within the reach of our impoverished and suffering millions.

My next duty is to introduce to you Major General A. C. Chatterji but such is superfluous. He is his own introduction. He has been always great though always humble. We are contemporaries and belong to this *alma mater*, the Calcutta Medical College. He was great as a student, great in the services, an efficient administrator, a store-house of knowledge in matters of sanitation and public health and was the Director of Public Health in Bengal, before he left India in the early years of the last world war. But his outstanding greatness lies not in all that I have said so far, but in his love for his country. He is the same Major General A. C. Chatterji who was a trusted lieutenant of Netaji Subhas Chandra Bose and was Netaji's Financial Adviser in Azad Hind Government. He is now the Director of Health Services with the Government of West Bengal.

With these few words, I request Major General Chatterji to inaugurate the Third Session of the Indian Congress of Radiology.

Inaugural Address

Major General A. C. CHATTERJI,

Director of Health Services, West Bengal Government.

Mr. President, and Members of the Radiological Associations,

In the beginning let me express my sincere thanks for affording this opportunity to me of associating myself with the Third Annual Conference of the Indian Radiological Association and for asking me to inaugurate it. It is a pleasure and a privilege which I greatly appreciate.

The applied science of Radiology takes two different shapes when utilised for the treatment of diseases, namely Deep X-Ray Therapy and the Radium Bomb and other apparatus utilising radio-active energy, but in the diagnosis of diseases the Roentgen Rays are almost exclusively employed and are of utmost importance. Roentgen Rays have opened up a tremendous vista for diagnosis and research though at present it is largely confined to Anatomy and Physiology. Although the potentialities are so great, still we know comparatively little at least in this country. X-Rays have brought in great hope in the early diagnosis of many diseases, particularly Tuberculosis, which can only be tackled successfully if they are detected in the very early stages. Similarly, Radium has brought in hope in the treatment of Cancer which seemed to be incurable only until recently. Here too the success of the treatment would depend on its commencement at the earlier stages.

This brings us on to the question of training suitable medical persons in the science of Radiology. To begin with, we should include a short syllabus in the Undergraduate Course so that the students may know the existence and utility of Radiology in the early part of their medical life. In this way some youths may be fired with the imagination to devote themselves to the

study of this science. This training should be carried out under the direct supervision and guidance of experienced persons who are well versed in this science.

The second item in training should be the Post-Graduate training for those Medical Graduates who are interested in this science. Proper syllabus should be drawn up:—

(a) for a complete Post-Graduate Diploma Course which should be recognised by universities.

(b) a short Refresher Course for those practitioners who are interested in this subject.

The third item in this training should be for those who look far beyond and want to do research work. As I have mentioned before this science may have very great potentialities, but in this country very little has been done or is known. We want proper research workers who would devote, if possible, their life-time in the study of this subject.

This raises the question of the Institution where such training could be given. Such training can only be imparted satisfactorily in a special Radiological Institute either working independently, or forming an important part of a teaching Medical Institution. Considering the finances of the country and also the advantages of a close connection with a teaching Medical Institution, the second course is likely to be advantageous. Perhaps in course of time radiological institutions like that of Tata Memorial Hospital at Bombay and the Barnard Institute of Radiology in Madras may come into existence in more than one province; it may take time. In the meantime we can make use of the existing institution—there are 8 of them in India—

and utilise them to the fullest extent, not merely from the point of view of treatment, but also from the point of view of teaching and training.

The matter of training of teachers of this science is also important, for, without proper teachers no radiological institute can be run. At present there is a very great dearth of suitably qualified and experienced radiologists not only from the point of view of treatment required by the public but more particularly who are fit to occupy Professorial positions in radiological institutions. In the first few years we may have to do ground work in the country and send some of the more successful radiologists to foreign countries in order to gain the widest possible experience in the technique and research in this science.

If I may mention here, that at present there is too much concentration in the large cities regarding the diagnosis and treatment. To the vast mass of population living in the rural areas the benefit of radiological science is practically not available. We must devise ways and means by which we can provide them with facilities at least for early diagnosis. For that purpose there must be a certain amount of decentralisation. In this respect I would like to mention the use of mass X-Ray photography, particularly amongst school children for the detection of early stages of Tuberculosis. But in its trial the question of providing suitable treatment for those whose bodies are found damaged arises at once. At present such provision of beds is wholly inadequate. Further, radiological treatment requires comparatively longer time which may extend from a few weeks to a few months. Wherever institutions are provided for special radiological treatment, we have to provide not only a certain number of beds in the institution but it would be advisable to provide living accommodation

for the large number of patients who come for such treatment. It is just waste of time, energy and money if, because of lack of such accommodation, patients cannot carry on the treatment to its logical end.

In order to carry on proper research work, separate beds will have to be provided for the research workers in this science.

In order to carry out the treatment, diagnosis and research work in Radiology, there must be closely connected team-work between the radiologist, physician, surgeon and the physicist. Without this co-operation the radiologist alone cannot achieve the amount of success which is desirable or possible. For example, the interpretation of many of the skiagrams even today are not in conformity with the clinical manifestations of the patient which are in reality the actual conditions that are existent in the body of the patient. Therefore, it is of utmost importance that interpretation of skiagraphy must conform to clinical manifestations. If there is a divergence it should be carefully studied, and the difference explained.

Further the development of nuclear energy and harnessing it on medical purpose is another possibility in the treatment of malignant growth. Atomic energy is being harnessed for utilisation in industry and it would be a great advancement in medical science if with the co-operation of the physicists and medical men this energy could be harnessed for the relief of the suffering humanity.

I regret to say that there is far too much dependence on just mechanical interpretation. This becomes all the more accentuated where there is a lack of team-work. I would therefore like to re-emphasise that in all radiological institutions there should be the closest co-operation between all concerned.

Lastly, in the interest of growth and

development of Radiology, we should wherever possible give every encouragement to local manufacturing plants so that we may become less and less dependent upon foreign countries, and in course of time may be able to become completely self-sufficient. Even if this may cost more at present, it is worthwhile doing so from long range point of view, for ultimately by developing our own industries in this connection our country will benefit. This may mean State aid or sub-

sidy or some preference in some cases—but it is worth it.

I hope you would consider the various aspects of growth and development of radiological science in connection with which I have tried to make certain suggestions.

I thank you for listening to me patiently. I thank you again for the pleasure and privilege that you have given me. I now declare this Conference open, and wish you a very successful session.

Retiring President's Address

DR. K. P. MODY, B.A., L.M. & S., F.C.P.S. (Bombay), D.M.R. (England),

DIRECTOR, DEPARTMENT OF RADIOLOGY, TATA MEMORIAL HOSPITAL, BOMBAY.

"MODERN TRENDS"

WHEN I took up the presidential chair I was under the impression that all I would be expected to do would be to act as an ornamental head. I was delighted at the prospect as I felt I would have the satisfaction of being able to say that I belonged to a long line of Presidents who had made their mark in the field of international science. That placid attitude soon gave place to a sense of realism that after all there were duties attached to the appointment. Some of the problems I was asked to tackle were of an unpleasant character but on the whole it has been a very enjoyable experience. One of my most pleasant duties is to have the privilege of introducing our new President for the year, my distinguished friend Dr. Rama Rau.

A very useful tradition is for the President to address you before he hands over charge and review the year of his office. So far as our country is concerned it has been a period of serious unrest and turmoil, and our leaders were called upon to deal with problems of unprecedented magnitude. That

they have succeeded in their efforts is borne out by the comparatively settled and peaceful atmosphere prevailing at present, and there are signs that within a short space of time India will settle down to an era of peace and prosperity inspite of ominous clouds hanging over the Western World. One unfortunate result of all this unrest has been the severe financial stringency that is facing the country to-day, this is not an isolated phenomena affecting India alone but is widespread and universal all over the world. The tragedy of the financial situation is evident in the curtailment of essential post-war programmes and the shelving of important schemes affecting the health and welfare of the teeming population of our country. We were promised a millennium and instead we find ourselves rotting in the same old groove with but minor variations. Death and disease are rampant and there seems no prospect of amelioration in the near future.

One of our chief problems is Tuberculosis. Whereas in foreign countries an all out effort is made to tackle it we are just

tinkering with it. In 1900 Tuberculosis stood 2nd on the list of mortality figures in the U.S.A., to-day it occupies the 9th place. Years ago I had the opportunity of attending the International Conference on Tuberculosis in London. In inaugurating the Conference the Prime Minister of the day, the then Mr. Asquith made an important announcement that since Tuberculosis was preventable it shall be prevented at any cost. As a result of this anti-tuberculosis dispensaries were opened out all over the country and vast sanatoria were provided, with the result that in a period of 5 years the ravages of this so-called white plague were much minimised.

In those days mass radiography was unknown. Though discovered before the war, it was the World War which brought it into prominence. Canada was the first to use it in the fighting forces. Each recruit had his chest X-rayed and mass radiography was extensively used. It was their experience that 2% of recruits were found to be suffering from tuberculosis often in a latent condition. It is a potent weapon in our fight against the disease, early and latent cases can receive effective treatment at a stage when it can be completely cured, the late advanced and open cases which are the real danger to society can be segregated. What about the cost to the country? To give an idea, the City of Bombay alone with its 3 million population would require 10 units and a period of 3 years to complete the chest survey of every man, woman and child. The capital cost would be 8 lakhs, the cost of personnel, running expenditure and films would come upto about 3 lakhs per year. It would be beyond our means to survey the whole country, and I believe it would not be necessary. Selected groups could be examined, such as school children and college boys, the industrial population and above

all the contacts. Moreover the burden of expenses should be thrown on the industrialists, the mill owners and large scale employers of labour such as the Railways. It is very gratifying that social service and medical benefit schemes are compulsory in our industrial organisations. We ought to emphasise that mass radiography should form part of such schemes.

This time last year a great deal was said on this subject and high hopes were raised by the utterances of the then Director-General of Health, who inaugurated our conference. It is regrettable that very little has been done, such schemes of national importance should have priority over others. We are wasting millions of rupees in trying to save an occasional drunkard but here are men women and children dying by the millions and we let them die. How backward we are in matters of health can be gauged from the fact that in America the expectation of life is about 60, in India it is a meagre 26.

Cancer is another problem which interests us most. It is a very sad story that inspite of progressive advance in surgical technic and improved methods of Radiation we have not been able to make appreciable headway in the percentage cure rate. Million volt and supervoltage machines at one time held alluring prospects of guaranteed results. In this connection I would urge upon medical men not to be carried away with fanciful notions about these much advertised newer methods of treatment. We must keep our sense of perspective and bring our balanced judgement to bear up on the evaluation of such radical innovations. Now being used for 12 years and more, the results have not justified the great optimism that was felt when they were first introduced. The Department of Radiology, Tata General Hospital reviewed 1800 cases treated by million volt machine during 8 years from 1937 to 1946.

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The conclusions they came to were that "there is very little evidence to show that a greater number of tumours can be destroyed by treatment with the supervoltage units than with routine 200 Kvs. The lay press is very much to blame in publishing sensational accounts and raising false hopes in the minds of the sufferers themselves. When radium was first introduced high hopes were raised and patients flocked to Paris from all parts of the world. The same thing happened at Erlangen when deep therapy was introduced. It is our duty as men of science to curb fantastic statements and work with an open mind free from bias, free from unwarranted optimism. The million volt is like every other deep therapy unit, a useful unit which has its own place in a modern laboratory, like every other machine.

The reasons for our failures in malignant disease are not due to our lack of ability in employing suitable methods of treatments but are due to the inherent nature of the disease, its essential characteristics of dissemination from a primary focus and our helplessness in dealing adequately with such widespread ramifications. Moreover, in several locations the disease cannot be detected in the early curable stage, in other locations early diagnosis is possible but unfortunately for one reason or another the real nature of the disease is missed and the patient comes for treatment too late. Different line of approach has been attempted, so far not with encouraging results, such as injections of radio-active substances and chemical agents like Nitrogen mustard and Urethane. Their action on the cells of the body is similar to that of radiation. The chromosomes are broken up, nucleic acid synthesis is inhibited and there is a far reaching metabolic disturbance. Unfortunately these substances affect normal tissues as well as abnormal and hence suffer from the same limitations as radiation. Hormone therapy

has also not helped us out except for producing palliative results. But the very fact that chemotherapy has influenced malignant disease to some extent is a very gratifying feature. More effective compounds may be found and may bring about a revolution in our ideas of the treatment of malignant diseases. It is not too much to hope that a time may come when the treatment of these diseases will be on the same lines as Sulpha, Penicillin and arsenical group and that a whole group of newer compounds will be made available for effective treatment of malignant processes. One very great advantage of such type of treatment would be that not only the primary focus of disease but its ramifications wherever they are in the system could be simultaneously influenced.

Early diagnosis is our only hope of a radical cure and here we are confronted by serious limitations. What we may consider an early case with all known methods of diagnosis, may not be in the early stages at all, there may be ramifications and metastasis already of which we are not aware. Why for instance do we have so many failures with say an early Breast Cancer? It is because when the case comes to us there has already been metastatic foci in the bones or mediastinum of which we are not aware and which cannot be diagnosed with any known methods at our disposal. Intensive research is being done in devising blood and serum tests for cancer, unfortunately all these tests are positive only for the advanced cases. When we succeed in devising such tests for the early cases even before the clinical manifestation of the disease, we will have progressed a great deal in our fight against the scourge of cancer.

Amongst the newer methods of attack is the treatment by Neutrons. They have been extensively tried out and have been found not only valueless but positively dangerous. Amongst other shortcomings is the

lack of a spirit of research, which forms a very important aspect of all science and human activities. Medicine without the appropriate background of research is apt to stagnate and remain empirical. It is erroneous impression that only supermen and men of genius can do research and that research workers are a class by themselves. We have ample material and ample facilities for doing clinical research which should form an important and integral part of hospital routine. It is very gratifying that the Government of India recently set up what is known as the Upgrading Committee which is touring the country and helping in the establishment of research facilities in our hospitals. While we may welcome it as a good beginning, the grants set aside are woefully inadequate for the needs of the country.

When we pass on to what is known as fundamental research the problem is entirely different and the proposition is of enormous magnitude, particularly in the field of malignant disease. Here are required the services of specialised people, the establishment of high grade specialised departments and above all the planning and centralisation of all activities in large institutions, supplied with ample funds, and all the latest equipment. It has been the experience of foreign countries particularly the United States of America, that it is waste of time, money and energy to attempt to do cancer research in its fundamental aspects in small scattered laboratories. If results are to be achieved of any appreciable value such research should be planned and centralised in large institutions supplied with ample funds, fitted with all the latest equipment, with well equipped departments of Chemistry, Biochemistry, Physics, Radiation Physics, Animal Experiments all under one institution with a large staff of men specially trained for the purpose, and what is more, under the direction of one man, the Director. One such institution is

the Sloan Ketteridge Research Institution established in New York in association with the New York Memorial Hospital. The building and equipment alone cost 2 million dollars, a round sum of 70 lakhs of rupees. The American Government spend annually 5 crores on medical research whereas in India we do not spend more than 14 lakhs.

Lord Horder's address to the British Empire Cancer Campaign Society should be referred to by all who are interested in such activities. Research is carried on in different spheres. First of all, there is the training of men in virus research for 2 years under experts on the subject. The laboratories are fitted with the latest instruments such as the electron microscope and the ultra centrifuge. Another big item on their programme is the study of chemical agents and chemotherapy. The harnessing of atomic energy and problems in radio-physics are also intensively studied and investigated. Lastly there is an extensive programme of education of the public and the doctors.

In conclusion, I thank you for having elected me as your President for the year which has just concluded.

It is now my pleasant duty to introduce to you our new President, Dr. Rama Rau. He is a distinguished member of our Society and scarcely needs any introduction. He is well known figure and is known to many more than any of us here. After qualifying from the Medical School, Madras in 1923 with distinction, he was engaged in general practice which gave him vast experience in the all-round problems of medicine and thus formed a valuable background for the practice of Radiology. He belongs to the European School, he studied at Vienna and other centres and on his return established a large and flourishing practice at Madras. He is a member of two foreign societies and has travelled extensively. But his greatest qualification for the presidential appointment

is the valuable work that he put in as General Secretary, a post which he filled with integrity, energy and great distinction. Over and above all his professional activities, he is a prominent rotarian and held the highest

office as District Governor. I have great pleasure in initiating him as President of the 3rd All India Radiological Conference and of the Indian Radiological Association for the year 1949.

Presidential Address

Third Indian Congress of Radiology, Calcutta, 25th December, 1947.

Rao Bahadur Dr. P. RAMA RAU of Madras.

Major-General Chatterjee, Ladies and Gentlemen,

Immediate Past-President Mody, I thank you with all sincerity for the generous and charming terms with which you referred to me. It is indeed my very pleasant duty to profusely thank my colleagues of the Indian Radiological Association for doing me the very high honour of electing me President of the Association for the coming year and this Third Indian Congress of Radiology. It is this expression of friendship and regard of my colleagues that gives me even greater pleasure. I shall endeavour, with God's Blessings, to give of my best in this Office of trust and responsibility, you have called on me to shoulder.

Under the caption "Heads bent low" I read the other day the following poem:

"A stooped old man and a young man
Chanced to meet one day;
The young man said to the elder,
In his usual braggart way;
"Why don't you walk up straight like me?
That's no way to grow old;
It's all a form of habit;
At least, that's what I'm told,"
The old man gave him a knowing look,
And said: "My dear young friend,
Have you ever examined your wheat-field,
And noticed the heads that bend?
If not, just look them over.

As the harvest-time draws nigh,
You'll find the heads that are empty
Are standing tall and high
But the heads that count in the harvest
Are filled and bending low
Awaiting the reaper's sickle,
Their time is short, they know."
And as the young man passed on by,
He slowly bowed his head;
No doubt he pondered many a day
On the things that old man said."

With my head bent humbly and with fortitude, I shall now proceed.

I thank Major-General Chatterjee for so kindly inaugurating this Congress. He is the head of the medical administration in this Province of West Bengal and great are his services to the medical progress in the country. To have heard him and his address is a great inspiration to us all. To my good friend Capt. M. Mukherjee, gratitude from us all—he has spared no pains and has worked hard to bring this Congress to fruition. To my colleagues in Bengal and the Chairman of the Reception Committee, Capt. Banerjee we are deeply indebted. With the same spirit of cordiality, I respectfully welcome the authorities and members of the Indian Medical Association who have gathered here on the occasion of their Silver Jubilee.

I am following two illustrious sons of India—Doyens in Radiology—Dr. M. D.

Joshi, President of the First Indian Congress of Radiology, and Dr. K. P. Mody, President of the Second Indian Congress of Radiology, both senior and eminent in the Profession and depend on their guidance during my year of office. They have given all the support and advice during my years of office as General Secretary and have fostered our activities.

It is but right that we should meet this year here in Calcutta, as the Indian Radiological Association was born in this great city in the year 1931; February 21st, that year was the first meeting. The late Dr. Ajit Mohan Bose was founder-President and Dr. Subodh Mitra, founder-Secretary. At that first meeting were present, Col. Shorten, Capt. M. Mukherjee, our Congress-Secretary now, Drs. K. B. Ghosh and Moitra. Then, the membership grew to 30 from all over India. I remember coming over to Calcutta in April 1932 for the Eighth Annual Conference of the Indian Medical Association. The Indian Radiological Association met that year as the Radiological Section of the Indian Medical Association. Dr. M. D. Joshi presided then and I happened to read a paper. The late Sir Nilratan Sircar was the President of the Indian Medical Association, and I remember, vividly, the grand banquet we had at the Town Hall here—food served in earthen pottery—very hygienic, but new it was to me. I was given a place of honour to the left of Sir Nilratan and was asked to respond to the toast of visitors from Madras—great honour indeed. I am mentioning all this to recall my associations with my colleagues of Calcutta and Bengal, and the several courtesies and hospitality I had received at their hands.

On 30th March 1937, this Association was registered at Calcutta and there were 24 members at the time. Activities declined somewhat during the war years, but no pain was spared to revive them. Attempts were

made to hold the First Indian Congress of Radiology during the time of the Obstetric and Gynaecological Congress at Calcutta in 1940; and again in 1945 at the time of the Science Congress at Bangalore. With the assistance of Dr. Rai and late Dr. Pillai, it was possible to start a South Indian Branch with Dr. S. A. Jabbar of Hyderabad as President, and myself Secretary and 37 members on the rolls. This was inaugurated on the 4th of August 1945 by Major-General J. P. Huban, then Surgeon-General with the Government of Madras. Subsequently the headquarters of the Association was shifted to Madras by a resolution of the Central Council and we had the First Indian Congress of Radiology in February 1946 at Madras.

I shall be failing in my duty if I do not refer to the keen interest taken and support given by Major-General J. P. Huban, which and which alone, made it possible to form The South Indian Branch and thence to the revival of the Indian Radiological Association. It was on account of his support that the First Indian Congress of Radiology was possible. And from letters I receive from him—he is now in England—he is still interested in our Association and its progress. It is not an exaggeration when I express that Human Huban is father of the Indian Radiological Association at its rebirth, and it is he that was responsible for forming the Cancer Association of Madras, the first of its kind in India. Another enthusiastic worker in the cause of Radiology is my very good friend Dr. S. A. Jabbar of Hyderabad who (he) is here with us this evening.

At the time of the First Congress we had 136 members on the rolls. On account of a change in rules for Associate membership and some not-paying subscriptions we are now 111. If all members of the Bengal Radiological Association join us, we will be about 150 in membership and I wish to see

the Association grow from strength to strength. We enrolled some members at the Bombay Congress last year. We hope with every Congress more will join, and work in harmony and unity, in promoting service to the community in our great motherland and in the progress of the Art and Science of Radiology.

My theme tonight is consolidation. There are ten good things for which no one has ever been sorry :

For doing good to all ;
For speaking evil of no one ;
For hearing before judging ;
For thinking before speaking ;
For holding an angry tongue ;
For being kind to the distressed ;
For asking pardon for all wrongs ;
For stopping the ear to the tale-bearer ;
For disbelieving, most of all, evil reports.

With this 'food for thought' always before us, and devouring plenty of it too, recalling to mind the guidance given and the suggestions made by our past-Presidents, Joshi and Mody, in their Presidential Addresses as well as in Editorials in our Journal—we should, during the ensuing year, consolidate ourselves in a programme to achieve unity. Get united in the search for Truth, which is but Science. Medical Radiology is but another limb of Science. Let us not be too narrowly national, provincial or communal in our approach, in our search for Truth within our sphere. Let us be humble and grasp Truth from whichever source we could get it.

From our colleagues from other parts of the world and from our own colleagues at home here, however senior and reputed, or junior and insignificant, let us calmly assess and 'reassess' by intimate study of facts suggested by them, before brushing those aside in an 'I know best' attitude. We may lose the 'Truth' and may have to travel a long way to get at it—and even then may fail.

We all are aware that great discoveries were made by observations of minute and simple phenomena. Let us retain and develop, the intelligence, the instincts and the other 'Gifts of God', and tell our colleagues in other countries of the world, through columns of our journal, what attempts we have made to achieve, or what our achievements have been, so far, in this direction. May the 'niche' we create for ourselves in this world of Science (I quote the words of my friend Sir Jnan Ghosh) "contain more enterprise than inaction, more knowledge than ignorance, more harmony than discord, more love than hate." Let us work towards that ideal.

Dr. Joshi, President of the First Congress in his Presidential Address at Madras dwelt on the 50 years of progress made in the art and science of Radiology, since the epoch-making discoveries of Roentgen, Becquerel and the Curies. He dwelt on how we could improve ourselves, on Radiological teaching and practice in India, and said "Up to now India has made very little contribution to the advancement of the world knowledge of radiology. Now that there are many big Institutions equipped upto date, staffed with experienced and qualified radiologists, I hope India will be able to make her own contribution to the radiological knowledge of the world in the near future." Before Dr. Joshi laid down his Office he saw to it that the resolution at the General Meeting of 1946 to start an Indian Journal of Radiology—primarily to publish work of Indian radiologists—was put into effect.

The first issue came out in February 1947 as a quarterly.

It would be appropriate to refer to the encouragement given to us by the British Journal of Radiology one of the oldest radiological journals in the world.

I hope our members will come forward and contribute to the journal not only origi-

nal articles submitting their experiences, but also reports on interesting cases that they are bound to come across in their daily practice.

I hope my appeal will go home to you all; it is then, and then only, when we discuss our experiences in the journal, that we can develop Indian Radiology. Brains, opportunities, material and equipment, we have in plenty, but we still have to utilise these fully. Let us be united and strive to raise the standard and the service of radiology, through the medium of our journal.

Dr. Mody, the immediate past-President, as Chairman of the Therapy Section at the 1946 Congress at Madras, reviewed the foundations of and progress in, radiotherapy and discussed the subject in its entirety. Then again, in his Presidential Address last year, at the Bombay Congress, he referred to radioactive isotopes and their therapeutic value in conditions like leukaemias, thyroid cancers, and generalised lymphomas, and as tracers in the study of metabolic processes and normal functions of the body. He referred also to synthetic products that act on neoplastic cells, not only on the primary lesion, but on generalised deposits as well, by selective absorption. He covered the large field briefly and adequately, so that, there is little for me to mention as an advancement during these twelve months. Experience alone, will enable us to accept the methods that are being tried now. Dr. Mody also referred to certain advances in diagnostic radiology, and I wish to take this opportunity of drawing your attention and that of our Government to his pointer to 'mass radiography' and the 'cancer problem'. In his Editorials in our journal during the year, Dr. Mody has given us such a lead for progress in our endeavours—to work diligently, to help to give relief to our suffering countrymen, to live honourably by doing our duty to the Science we are wedded to, and to see

that our younger colleagues, our successors in the practice of the Art and Science of Medical Radiology, are adequately equipped with *not just machines*, but with the basic and practical knowledge, which could only be achieved by years of training and experience. Only when the radiologist is in possession of knowledge and experience to deal with problems, medical, surgical, gynaecological, and such others belonging to the specialities; will he be in a position to maintain his own status as a specialist in Radiology. It is also essential that the radiologist should have a practical knowledge of anatomy, physiology and pathology.

I now make bold to express certain personal views on our endeavours so far, to reach the goal we hope to reach in radiotherapy. There are varying methods of approach to the problem, varying views in the practice thereof and discussions continue to throw more light. But, how far have we progressed?

It is true, we have achieved a scientific approach which has enabled us to assess dosage in the tumour to a degree of accuracy as present knowledge permits. Have we looked into the individual human factor?

We have no doubt, established a minimal and maximal dosage in the tumour.

Do identical conditions, but in different individuals, react uniformly to any drug or medicine prescribed by our physicians? Do all surgical wounds heal in an identical manner in all individuals of obviously identical constitution, when a stereo-typed technique has been adopted? Likewise, do all patients referred for radiotherapy respond equally well in spite of identical histological classifications, gradings, radio-sensitivity and such like? These are the problems that face us radiotherapists.

Now regarding the physical dosage—all findings from investigations done for

malignancy being identical as to site, stage, type, grading, age and sex-groups, can radiotherapy be so mechanical, that a same predetermined dose be given to any tumour, deep or accessible without reference to the clinical and the naked eye appearances, the focal and general reactions to radiation of the tissues involved? Considering all factors like depth dose for deep-seated tumours, time factor involving daily loss of effect, and the skin reactions (which I still believe is the criterion for assessing normal tissue reactions) do we get uniform results? I shall not go into detail over the question of higher voltage and heavier filtration in X-ray therapy in this address, but I believe, that if these have contributed to the adoption of larger skin dose and lesser number of fields and adequate homogenous distribution with minimal reaction, they should be preferred. I have no experience on higher voltage than 400 k.v. with which I have worked for ten years now, and so do not refer to million volt therapy and more. Increased depth dose effect may be a minor consideration. So also suggestions that particular types of tumour cells respond favourably to radiations of particular wave-length. Ralston Paterson has emphasised the 'roentgens' delivered to the tumour, *irrespective of wave-length*. But with voltages higher than the conventional 200 k.v. one can develop a technique of lesser number of fields, and after planning, deliver the tumour dose considered adequate, both physically and clinically, thereby saving unnecessary irradiation of normal tissues around the tumour.

However, the clinical reactions of the growth treated should not be lost sight of; actually, it is a very important factor. For example, in carcinoma of the cheek or floor of the mouth or anterior two-thirds of the tongue, soft palate and lips—the physical dosage is recorded, but therapy is continued, until not only the usual 6000 or 8000r is

delivered, but also until all induration due to growth disappears and the involved tissues become soft and pliable, restoring mobility to a degree. Incidentally, for growths mentioned above, I prefer 'chaoul' type of contact therapy directed carefully, and at the same time, external radiation to lymphatic drainage areas. Only last week, I received a report on carcinoma of the tongue from the Radiumhemmet, Stockholm. They treat the primary tumour and lymphnodes as if they formed one continuous tumour. Back in 1940 Roux-Berger of Curie Foundation in 60 cases without clinically involved lymphnodes, found by operation that 33 had metastasis, all microscopically verified. So, it is essential to treat lymphnodes at the same time as the primary. The plan is to complete the whole course in two to three weeks until clinically the response is considered satisfactory.

Radiotherapy is a rapidly evolving speciality and we know certain methods may become outmoded in time. As such, I do not wish to make any dogmatic statements. But to evolve a method of approach to treatment of a particular condition, it is essential to have a knowledge of the basic principles of the mode developed so far. At the present time, a working hypothesis, as accepted by the majority should be clearly inculcated in the minds of those who desire to study radiotherapy. There is growing evidence now, in England and in the United States, of concentrated studies of X-ray therapy and radium therapy, or both combined as radiotherapy and X-ray diagnosis. Radiation physics has become a still more developed and specialised branch of that science. So we have to be precise as to how we should prepare our colleagues who wish to be trained in the speciality of Medical Radiology. Lethal effects of radiation on normal and malignant cells, factors determining radio-sensitivity, real influence of time and inten-

sity, biological and clinical reactions to the physical dosage administered and the fundamentals of the procedures should all be clearly enunciated. We should have uniform standards in all our Universities and examining bodies. In India now, only the Universities of Lucknow and Bombay have instituted diploma courses in radiology. The Governments of Bombay and Madras also have such Diploma courses. The College of Physicians and Surgeons of Bombay, I understand, are contemplating institution of such courses. The courses are more or less in pattern with those for the former Cambridge and London Diplomas in Radiology and is spread over a period of nine months to one year. Is this adequate? Smithers posed the following queries in his Presidential Address to the British Institute of Radiology last year:

"Do we teach our students how to handle patients?"

Do we speak to them of physiology and pathology?

"Do we ask our senior clinicians to take part in their course of lectures? or

Do we merely turn out a superior brand of technician?"

Should these students be expected to attend the post-mortem room, the surgical out-patients, and the operating theatre, or will the physics laboratory suffice?

Where is the biological department in every training centre where they may gain some knowledge of the effects of radiation on the tissues of the human body?

Is there not still a danger that some may go out from our training centres with no more knowledge of the clinical dosage problem than a vague idea of so many roentgens

in so many weeks to continue the toll of necrosis which has done so much to retard the progress radiotherapy in the past?

"Should we give some instruction in the indications contra-indications, dangers and biological effects of radiation to undergraduate medical students?"

"If the charge of inadequate clinical experience can be levelled at radiotherapists, who have at least some knowledge of clinical medicine, how much more certainly can the counter-charge be made?"

There is no medical speciality that is so little understood by the general body of medical men as radiotherapy."

I shall not add to Smithers' queries, but would merely say as a *hospitant* at Vienna. I had to be present at surgical theatres and post-mortem rooms for every case of mine and my colleagues. In Vienna particularly, on account of Socialisation of medicine and statutory cremation of the dead, the causes of death, accidental or otherwise, were to be checked up by autopsy findings. Gross pathology classes of Erdheim and Chiari were so very instructive. That is how a *hospitant* gathered more dependable data than elsewhere, and I think this was the main reason why Vienna was styled 'Mecca for Medicine' those years gone by.

Dr. Joshi at the First Congress pleaded for establishment of Chairs of Radiology in our Universities. Dr. Jivaraj Mehta inaugurating the Second Congress at Bombay suggested the appointment of a small Committee to draw suitable programmes for training in Radiology for undergraduates and post-graduates for being submitted to the Universities, Governments and other concerned authorities.

Sound teaching cannot be divorced by from research; and so, adequately staffed and equipped departments for proper instruction and research in Radiology should be provided. Training should, therefore, cover a minimum period of two years.

The curricula prescribed by the American Board of Radiology is more thorough and worthwhile emulating. In America, examinations at present cover practical and oral only, to test clinical experience, knowledge of basic sciences and acquaintance with current literature. I had detailed the same in the Editorial of the 1947 May issue of our Journal. In Canada, the Council of Royal College of Physicians and Surgeons control certification of specialists. They insist on five years of specialised study in the major departments of the hospital, or general practice, including one year's internship before admission into courses for radiological studies. This includes pathology, radiographic anatomy, radio-biology, radiation-physics and radiographic techniques for the first part; and covers diagnostic and therapeutic radiology and general medicine and surgery for the second part. The tendency in Canada and the U.S.A. seems to be to widen the courses to three years. If the hospital physicist demands that each student of radiology should attain a minimum standard in physics, it will be equally incumbent on the physicist to acquaint himself with the elements of anatomy and physiology, the fundamental biological principles and technical terms commonly employed by the clinician.

Dr. Mody last year in his Presidential Address laid stress on the necessity of a broader programme of training and the compulsory internship of the student in all the major departments before being admitted to courses in Radiology. I fully endorse the above suggestions and shall not dilate further as to how we should train our future colleagues and successors.

However, there are a large number of our colleagues *now* serving the community, in the clinics and hospitals, large and small. What of them? Here again, I suggest that refresher courses, which will be of educative value, should be held at the time of our annual Congresses and Conferences. Many of our members have done special work in the various aspects of diagnosis and therapy. They should volunteer to talk on these subjects which would be not only of educative value but would also stimulate consolidation of our efforts to raise the standard of radiological services to the community. For years now the Radiological Society of North America, has, at its Annual conventions organised these courses. They have the simple 'film reading' sessions, courses such as 'biological foundations of radiotherapy, diagnosis and treatment of lymphoma group of cases, practical problems in X-ray dosage and in radium dosage, tumour therapy, and in the diagnosis of, diseases of the various organs of the body, to mention only a few. Courses are held between 8 and 10 a.m. in the forenoon, and do not interfere with other programmes, and whoever is interested in particular subjects is welcome to attend those. Instructors are those who are competent to treat the particular subject in a thorough manner.

Let us make a beginning at least at the coming Session. This could be combined with practical demonstrations. These educational courses will serve as an incentive to the lecturer and is bound to attract larger attendance at our gatherings, when members are told of the programme and know details of the course and identity of the lecturers.

Let us not be blind to the fact that there is much scope for us to improve. Let us, therefore, collaborate with our colleagues in other countries who have no doubt been making greater progress. I suggest inviting a select few of them from different countries to train

our young men. In spite of all unhappy things Japan did in the East or elsewhere—I was in Japan in 1937 and had visited the four Imperial University centres for Cancer Research and associated Radiological Institutions—Japan progressed in Science by inviting Scientists from other countries to train and help their youths to work on lines of research. Our Government should, devote serious thought on this aspect of the question—whether it would not be appropriate to invite and offer travelling Professorships for a fixed period on covenant, to eminent foreign colleagues to go round to the Universities in India and train our men, not only in the case of Medical Radiology, but also in all branches of medical and other Sciences. The money that is spent in sending our young men and women abroad is enormous. Better results will follow, if we emulate Japan's example in this direction. It has been repeatedly announced from Government quarters that they want their boys and girls to learn and gain experience—"not so much degree or diploma hunting." Therefore, in the interest of relief to our suffering communities and scientific research and advancement. I beg that serious consideration be bestowed by the authorities to the suggestion that we invite foreign celebrities to help train our young men and women.

Arthur Christie, President, Fifth International Congress of Radiology in a message to our First Congress of Radiology, expressed that these Congresses not only plan further progress, but also secure the inspiration which comes from contact with leaders of our speciality and also with those in other branches of Medicine. We should further consolidate our organisation so that radiological practice is elevated and maintained in this great motherland of ours, to the glory of our medical profession and the relief of the sick. Every radiologist should remember that he is first and foremost a physician, but

a physician with a specialised knowledge of Radiology. He may also have a specialised knowledge of Surgery or Gynaecology or Dermatology, but it is his status as a physician and his specialised knowledge, that gives him the moral right to undertake medical investigation and treatment of patients. In teaching Radiology the important part is clinical Radiology and for this he must be in charge of beds in the hospital to which he is attached. He must be a physician in the widest sense of the word, to enable him to study and treat the cases.

I hope in the meeting of this Congress there will be free, full and frank discussions; that it will mean making new friendships, renewing old ones and repairing broken ones. I feel certain, that, when our Government of Independent India is freer from the preoccupations of National importance, they will devote more of their energies to improving the health of our countrymen and it is needless to affirm, that we of the Indian Radiological Association, would extend our full support to our Government in any such scheme.

Röntgen and the Curies sleep, careless alike of eulogy or vituperation. They blessed the world with an imperishable boon, and their names liveth for evermore. Monuments of stone and bronze commemorate their worth, but the greatest of all memorials are the countless thankful hearts whose sufferings have been made lighter by the ministrations their discoveries made possible.

General Chatterjee, ladies and gentlemen, before I resume my seat I wish to once again express my grateful appreciation of the high honour done me by my colleagues of our Association, to Dr. Mody for the kind words he said about me, to Dr. Joshi for all the guidance, and to Capt Mukherjee, and our Bengal colleagues for the great deal of work they have put in in organising this Third Indian Congress of Radiology. I thank you all for your very patient hearing—JAI HIND.

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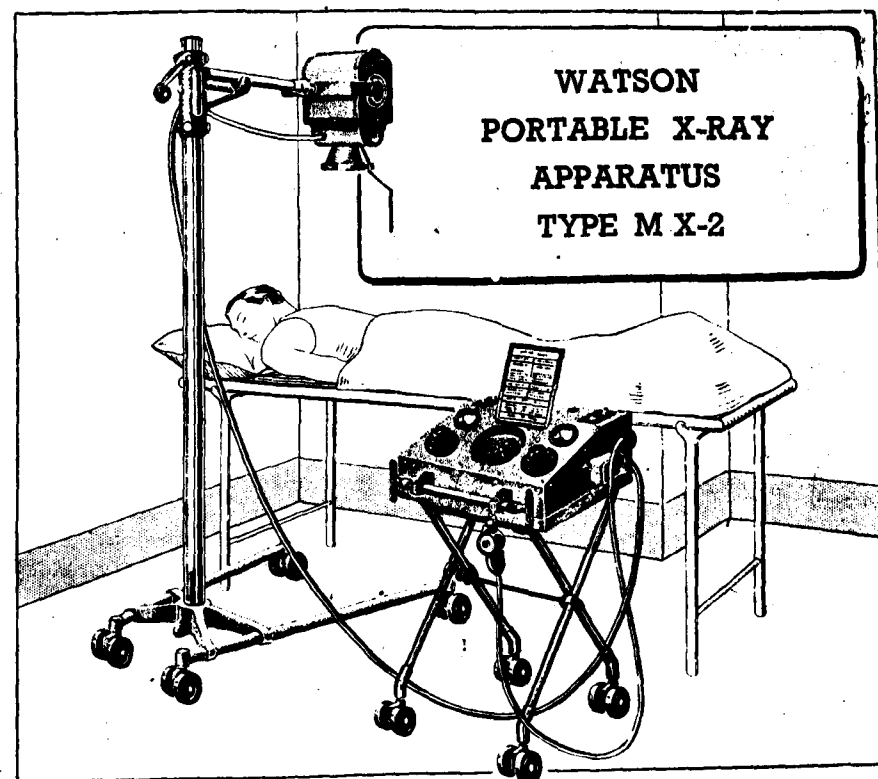
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