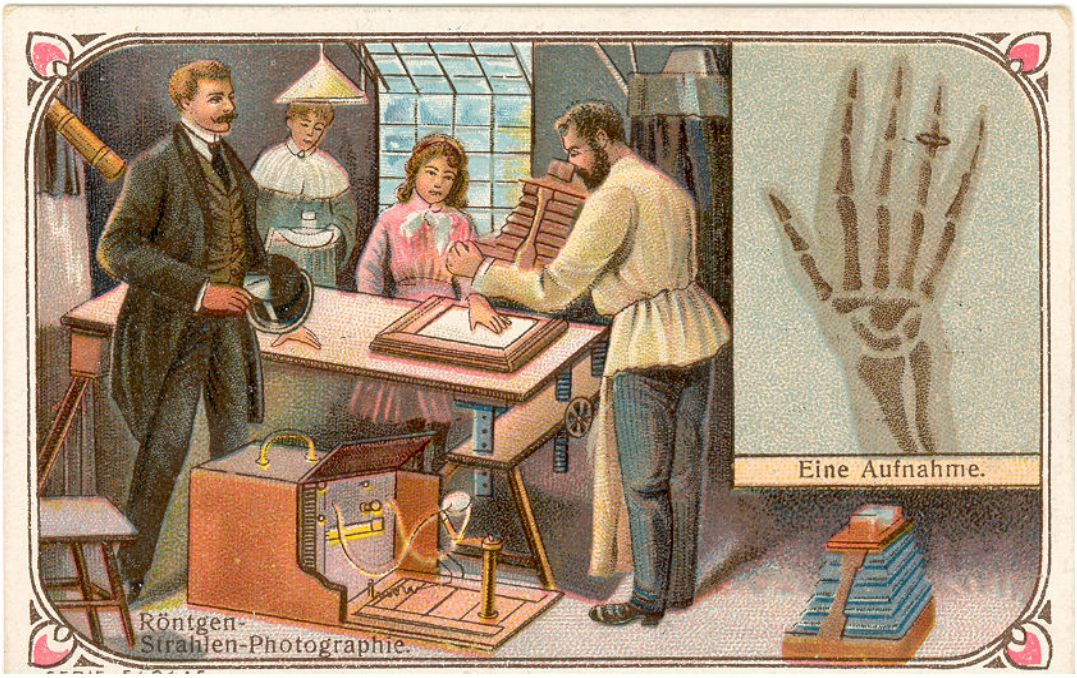
The Invisible Light



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Contents

Editorial Notes

I hope you like this issue of The Invisible Light. Thanks are due to Bob Burns for providing the article by Miss H. M. KING, M.S.R. If anyone has information about her I would be very interested to hear from you. Also thanks to Jean Guy and Steven Golding for their interesting paper on ENT radiology in Oxford.

Do please send me material for inclusion.

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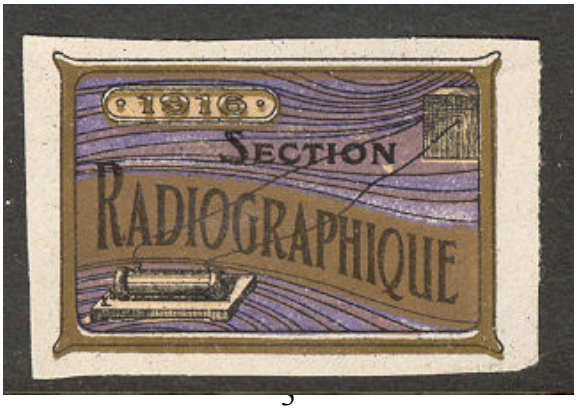


The British Society for the History of Medicine:
http://www.bshm.org.uk

The British Society for the History of Medicine was formed in 1965, by representatives of the Section of the History of Medicine of the Royal Society of Medicine, the Faculty of the History and Philosophy of Medicine and Pharmacy of the Worshipful Society of Apothecaries of London, The Scottish Society for the History of Medicine and the Osler Club of London. Its objectives are to hold a biennial congress, to arrange the biennial Poynter Lecture in alternate years with the congress, to represent the United Kingdom in the affairs of the International Society for the History of Medicine and to encourage study, teaching and research in medical history.
The Society has no direct individual membership, membership of an affiliated society automatically makes one a member. It is governed by an Officers and Representatives Committee, which meets annually and is comprised of the officers and one representative of each affiliated society or two if its membership exceeds one hundred. The Society publishes the annual BSHM News, which provides a link between its affiliated societies and a forum for the exchange of ideas, a notice board for meetings and queries, and the occasional book review. The BSHR is a member of the BSHM and our representatives are Arpan Banerjee and Adrian Thomas.

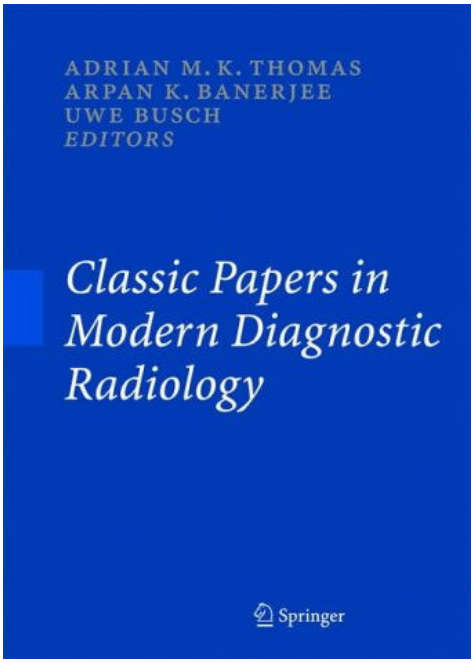
The 22nd Congress will be held in Dundee 5-8 September 2007. It will be at West Park Centre in Dundee. It is organised by the Scottish Society of the History of Medicine and will incorporate a joint session on 6th September with University of Dundee Medical School to celebrate 40 years since the establishment of Dundee as a separate University. The organiser is Dr David Wright, 20 Lennox Row, Edinburgh EH5 3JW, email dr.david.wright@virgin.net . There is to be a section on radiation medicine so do please consider submitting a radiological paper or poster.

The 23rd Congress will be held in Brighton in September 2009. Contact Professor John Richardson, email RichardsonDrJ@aol.com

The 21st Congress of the British Society for the History of Medicine was held on 1st - 4th September 2005 at the University of Exeter. The University of Exeter Centre for Medical History collaborated with the British Society for the History of Medicine to run this conference. It was organised by Dr Chris Gardner-Thorpe, Exeter Neurosciences, Royal Devon and Exeter Hospital, Barrack Rd, Exeter EX2 5DW and Prof Mark Jackson, Centre for Medical History, University of Exeter, Rennes Drive, Exeter EX4 4RJ.

Recent historical books and papers:

Classic Papers in Modern Diagnostic Radiology
Uwe Busch, Adrian M K Thomas, Arpan K Banerjee
Hardcover 692 pages (November 2004)
Publisher: Springer-Verlag Berlin and Heidelberg GmbH & Co. K
ISBN: 3540219277
Price: £115.50



Synopsis
The book reproduces the classic papers that form the foundation of modern diagnostic and interventional radiology. Radiology has changed almost beyond recognition in the past 40 years and is now central to the practice of modern medicine. We now have non-invasive diagnosis and minimally invasive imaging-guided therapy. Whilst we are all aware of the great names in radiology they are often only names, and the papers are famous but may be difficult to locate. This book brings together in a single and convenient volume the classics of our modern practice of radiology. The choice is obviously personal, but we feel that these papers have stood the test of time. Each paper is reproduced in its original format, with the original references and illustrations, and its significance is discussed.

From: Torsten Almen
Sent: 07 April 2005
To: Adrian Thomas
Subject: Re: ECR 2005

Dear Adrian,
I understand that we all very much enjoyed our (ECR) history session.
I like your book!
Best regards
Torsten

Michael Faraday and the Electrical Century
Iwan Rhys Morus
Hardcover 192 pages (May 2004)
Publisher: Icon Books
ISBN: 1840465409

Michael Faraday is one of the most recognisable names in the history of science. Faraday's forté was electricity, a revolutionary force in nineteenth-century society. The electric telegraph made mass-communication possible; hopeful inventors during the

1840s looked forward to the day when everything would be done by electricity. By the end of the century, electricity really was in the process of transforming everyday life. Iwan Morus has written extensively on nineteenth-century electricity and popular culture. The book is warmly recommended.

The Man Who Changed Everything: The Life of James Clerk Maxwell
Basil Mahon
Hardcover 254 pages (August 22, 2003)
Publisher: John Wiley and Sons Ltd
ISBN: 047086088X

IEE Review, February 2004: "..a sympathetic, eminently readable and interesting biography of one of the intellectual giants of the 19th century."

British Cardiology in the 20th Century
Mark E. Silverman (Editor), P.R. Fleming (Editor), A. Hollman (Editor), D.G. Julian (Editor), D.M. Krikler (Editor)
Hardcover 390 pages (August 31, 2000)
Publisher: Springer-Verlag UK
ISBN: 185233312X
Price: £29.95

Cardiology as a medical specialty originated in the twentieth century and Britain played an important role in its development. There is an excellent chapter by Derek Gibson on the Chest X Ray in Cardiac diagnosis, 1930-1960.

'Ex umbris et imaginibus in veritatem'

'From shadows and images into truth'

…… on John Henry Newman's grave at Rednal

……

RADIOGRAPHY IN SPAIN, JANUARY 1938—FEBRUARY 1939
By Miss H. M. KING, M.S.R.

Although I had wished to go to Spain from the first days of the war, my opportunity did not arise until the Spanish Medical Aid Committee were arranging to send out X-ray equipment in the winter of 1937.

A three-ton Bedford van was specially constructed to house the X-ray and lighting equipment. The apparatus chosen was a Victor portable model, one which packs in a wooden case and has a separate adjustable stand easily carried by hand. Both the case and stand fitted into a compartment in one of the cupboards within the van. This cupboard was lined with a substance similar to sorbo sponge to lessen the vibration when travelling. Fixed within the van were a Kohler stationary engine, a D.C. dynamo and a rotary converter. The dynamo had an output of 5 kW, 2½ kW being necessary for

the X-ray unit, leaving 2½ kW for lighting. 110-volt D.C. was used for the lighting, and 230-volt A.C. for the X-ray transformer.

I was enabled to choose all the accessory equipment myself. Naturally, there was a limit to my choice, as everything sent out by the Committee was paid for by voluntary contributions. Perhaps it may be of interest to some to see a list of what was sent:

Cassettes (all loaded with Ilford's Fluorazure Screens): Two 15x12; two 12x10; two 12x6; two 10x8.

Developing Hangers: Twelve 15x12; eighteen 12x10; eighteen 12x6; eighteen 10x8; eighteen 8½x6½. Six dozen dental film hangers; six dozen heavy film clips; four dozen light film clips.

Films: Ordinary wrapping, sizes: 15x12, l2x10, 10x8, 12x6. Double wrapped (Ilfex), 10x8, 8½x6½, 4½x3½. Fast dental films. Occlusal films.

Miscellaneous: Developer and fixer. Set of tanks for processing films. Wooden stand for same. Combined dark-room and viewing lamp. Immersion heater. Hand fluorescent screen (for use in light room). Two large enamelled jugs. Lead letters. Time clock. Thermometer. Metal tape measure (Woolworth's). Length of hose pipe. Large Primus stove. Sheets of lead. One pair Worth's forceps for holding dental films. Storage envelopes. Record books and card index.

In addition to the X-ray equipment there was cable, lighting flex, lamp holders, bulbs, etc., for supplying the light for any hospital in which we worked.

I left London on the night of December 29, 1937, with three nurses, one of whom was returning after a short leave. We travelled by train from Paris and arrived in Barcelona shortly after an air raid on New Year's Day, 1938. The X-ray conveyor arrived in January, shortly to be joined by a similarly built Bedford van which had been working at Teruel. This van, or "Auto-Chir," was fully equipped with surgical instruments, sterile drums, steriliser, etc., in fact everything necessary to set up a modern theatre, and together the two vehicles formed a perfectly equipped surgical and X-ray unit.

I did comparatively little radiography whilst in Barcelona, for the military hospital to which we were attached had its own X-ray department and staff. In Barcelona a dark-room was built by the huge joinery works in the service of the Jefetura de Sanidad, the chief medical organisation of the Spanish Government, to which we three English, the theatre sister, the driver of the conveyor and myself belonged. They also made a folding X-ray table with a slot the length of the table designed to take the base of the X-ray tube stand. The English driver whom I have mentioned, and to whom I will in future refer as J.S., was responsible not only for the upkeep of the vehicle but also of the stationary engine and entire electrical and lighting equipment. Throughout the time we were in Spain we assisted each other, and in the last weeks he was doing as much radiography as I. Had we not worked together, we could not possibly have got through the amount of work we did. In April we had our first orders to move. The two huge camouflaged vehicles were packed for travelling. We were introduced to our new surgeon and the rest of his team, and set off along the Valencia road towards Tarragona, our destination.

The military hospital of La Sabinosa, Tarragona, is built on a projection of rock about three-quarters of a mile north of Tarragona. It is a new hospital of about eight to nine

hundred beds, completed before the war but until then never used. The main building, a tall central block, contained the kitchens, boiler houses, etc., on the ground floor; administrative offices on the first floor; two theatres, sterilising rooms and specialists' rooms on the second floor; and above this two floors of wards. The X-ray room was dismantled when we arrived, and though a unit was later installed it functioned only spasmodically, for the main supply of electricity from Barcelona was continually being cut off during bombardments and also for economic reasons, owing to shortage of fuel. There were six other pavilions, two built entirely on ground level and overlooking the sea, containing approximately eighty beds each and divided into two wards, and four two-storied buildings. These pavilions stood apart from the main building, and it would have been impossible to push a portable outfit on a wheeled stand from pavilion to pavilion, as they were separated by a wide gravel drive. When doing ward work we drove the conveyor to the pavilion and passed the cable through a convenient window to reach the patient's bed; this was in the days before the attack in July, when we rarely had more than ten patients a day and plenty of time to spend on them. The weather was glorious, and we set up the X-ray table in a quiet place near where we parked the vehicle. Here, beneath the pines, we X-rayed those patients who could walk.

At the end of May we were sent to a front line hospital to relieve another surgical team for a fortnight. The hospital was a converted farm house, a beautiful old place high up in the mountains and surrounded by vineyards and olive groves. There were thirty beds and as soon as we arrived we helped to set up the theatre and installed the electric light. We were still not very busy. The River Ebro was our front and formed a natural defence. The films we took were washed in the tank set under a mountain spring!

I came home for a fortnight's leave in July, and arrived back at La Sabinosa on the eve of the Government's attack and crossing of the Ebro. It was now that our real work began. The days of working in the open or driving from pavilion to pavilion were over. We set up the table in an alcove in a wide passage between the two theatres on the second floor of central pavilion. Overnight we had prepared new developer and fixer. We were lucky, in the baking days of the following months, in being able to obtain ice from the kitchens, to keep the temperature of the chemicals down. The little dark-room in the vehicle got unbearably hot, for in addition to the high atmospheric temperature there was the heat from the stationary engine.

Our position, on the second floor of central pavilion was not altogether satisfactory, for not only did it mean that we were working in a passage way, but that the majority of our patients had to be carried up two flights of stairs and down again. Also a great deal of time was wasted by my having to run up and down these same stairs, whenever there was a film to be developed or a cassette to be changed. Ambulance load after ambulance load of wounded were brought in, the passages being lined with stretchers. Patiently the doctors went from one stretcher to another, and having made a rough list, we would start on the more urgent cases. We worked as quickly as possible. Nearly all the cases were 'difficult', but every patient, however badly wounded, did his utmost to help us. Most of the fractures were compound comminuted and many had metal present. There was no time to do depth localisation. We screened, marked the skin and took two views at right-angles to each other whenever possible. Often the surgeon extracted the bullet or metal after screening only, and we were called to one or other of the theatres many times to screen during the extraction of a foreign body or the reduction of a difficult fracture. The surgeons are to be commended on the remarkable speed and efficiency with which they extracted the foreign bodies. One very heavy day we had a number of civilian cases, women, children and old men. They had been

brought from a village close to where we had been working in the mountains, the village having been practically razed to the ground by bombs. We were very short of water at this time and every time one passed a stretcher one heard the whispered begging for a drink. I shall never forget turning as I heard a woman's voice calling for water, her form lay on a stretcher and a nurse was beside her. Her voice seemed to come from a pool of blood, for her face had been blown away.

I do not remember how long the spate of work from this attack went on; night followed day and day night, we worked until we finished, and then went to bed, often to be called up again. We slept on sorbo-filled rubber-covered mattresses in the vans, or in the hottest weather on camp beds in the open. There came a day in September when, owing to a breakdown in France of the lorry which was bringing out a month's supply from England, we were left without films. We had already wired for an emergency supply to be sent by air, and these were on the way, but while we were without we moved the apparatus into the plaster room of the fracture pavilion, and here we screened up to fifty patients a day for the orthopaedic surgeon alone. This surgeon would screen and call out in detail the diagnosis of the fracture, this would then be taken down, and later the surgeon would make a drawing in his record book. There were at least six persons working on plasters in this room, several patients being treated at one time. I was astonished at the remarkable bravery of these men, for owing to the shortage of anaesthetics, nearly all had their temporary plasters removed, fractures reduced and new plasters put on, without anaesthetics of any kind.

As we did more work for the fracture than for any other pavilion, the doctor in charge offered us two rooms, one with constant running water to be used as a dark-room and the other for radiography. At last we were nearing what seemed, to us, like perfection. The dark-room was spacious, the tanks and lamp were moved from the tiny dark-room in the vehicle. The hospital carpenter made pegs for the film holders supported in a long detachable board which could be taken down when necessary, switches were fixed so that the dark-room lamp could be worked from the mains or, when these failed, from our own dynamo; in winter I could now use the immersion heater.

We were installed in October. The surgical side of the hospital was less busy, but by now we had a reputation of being the only X-ray department on the Ebro front that could be relied upon to work at any time. This was because we had an electrical supply which was not turned off during air-raids, and a constant supply of films. (The Committee in London now had a standing order to send £80 worth of films per month.) In consequence more and more fractures were sent to La Sabinosa, and we rarely had fewer than forty on our daily list, and there were days when we took films of over a hundred patients. By working on the ground floor much time and a great deal of energy were saved as the two rooms were close to each other, and a tank full of films could be developing whilst we were X-raying further patients.

We now started a day's work at 9.30 a.m. or as soon as the doctor in charge of the fracture ward had done his round. He would give us a list of anything between twenty and sixty patients. We would start right away, and as soon as the first films were developed, fixed and washed, they would be taken and hung up to dry in clips strung on a taut wire in the room where the fractures were to be reduced, and in which there was a viewing lamp. J.S. kept all the records and wrote the labels whilst I was developing, so that the films went through correctly labelled, and were ready for evacuation with the patients as soon as dry. The labels were written on the strips of brown sticky-backed paper which are part of the packing of the half-gross boxes of films and then cut to size.

Often patients whom we had X-rayed in the morning would be treated and evacuated by the afternoon and more would come in. At intervals during our progress through the list of patients from the fracture wards, we would receive lists from other wards or from the dentist; oculist, or ear, nose and throat specialist. We worked these patients in with the others, so that each could receive the films as quickly as possible and be able to continue their work. I think what I loved most was the gratefulness of the patients and their pride in the radiographs they took away with them. One man I recall very well. When he came in he asked if we did not remember him. "You X-rayed me in August," he said, "but you were upstairs then." "Have you your old films with you?" I asked him. "Why, yes," he exclaimed and gave me the number of his bed. There I found them carefully preserved in a piece of newspaper. It had been his radius and ulna then, and here he was back again and still cheerful with a terrible fracture of the tibia.

As nearly all the stretcher cases were X-rayed on their stretchers, we kept one from the auto-chir specially for our own use, as it was very flat and we could often pack the cassette up so that it was not necessary to angle the tube. When we did angle the tube, I tilted it on the stand and held it in position. This was necessary for all stretcher cases of clavicles, scapulae, shoulder joint, humerus, etc., and many other limbs. Except when the patient could move easily, all lateral views were taken by moving the tube and not the limb, thus a lateral view of the tibia and fibula would often be taken through the wooden support of the stretcher, the film being held between the two legs. We took films of a great number of badly fractured mandibles, and, as many of these were stretcher cases and often under the influence of a drug, we got as good a result as possible with the film held against the required side and the tube angled from below on the opposite side. A dental cone was sent out as there was a considerable amount of dental work to do. Nearly all shoulder cases were taken with the patient sitting against a wall, the cassette supported behind him. Besides casualties from the lines there were many motor accidents, as Spanish drivers tend to drive with a minimum margin of safety. We X-rayed no fewer than six fractured spines, in two cases taking lateral views whilst the patient was suspended during reduction, obtaining very good results considering the power of the unit. The majority of fracture cases were sent to us from the front-line dressing station in temporary plasters, rather than metal or wooden splints. We usually X-rayed before the removal of these plasters, in case the fracture should be in good enough alignment to avoid further handling before evacuating the patient to a base hospital. The plasters varied greatly in thickness, and it was necessary to give an exposure of nine to twelve seconds for a shoulder in plaster against the two-second exposure for a straight X-ray of the same part.

In the room in which we worked there was always a bowl of Lysol and water and some waste gauze. The cassettes were cleaned after each exposure — a very necessary precaution owing to the condition of many of the wounds. The sizes of films which I found to be most useful were 12x6 and 10x8. The 15x12 films were the least used, being only employed when taking the thorax, spine, or pelvis — I did no intestinal work.

During November, December, and January, Tarragona was continually bombed. On one occasion two trains, one in-coming and the other out-going, were hit whilst in the station, with appalling results. Most of the casualties were naturally taken to the civil hospital in Tarragona, but a number were brought to La Sabinosa for X-ray examination.

At the end of December we prepared for the attack which the rebels had announced they were about to make. The wards were evacuated and everything prepared to receive the first casualties. We were far busier than we had been in the Ebro attack, but

the work was made lighter by the fact that we now were working in the two rooms, and J.S. and I could share the radiography. It certainly was not made any more pleasant by the continual presence of German and Italian planes over our heads — sometimes fifty at a time — bombing Tarragona, while at the same time the smaller planes drew swastikas in the sky by smoke writing. Many of the nurses came every morning from their homes in Tarragona, and only their strained faces as they went about their work, told of their feelings during these ghastly raids.

Nearer and nearer the rebels came, and still the wounded came in, though many were now being sent straight through to Barcelona. The hospital at Reus was evacuated, and we became a front-line hospital. We realised that it could not be long before we were moved back, and early one morning the order came to pack our things as quickly as possible. It did not take us more than about an hour and a half to remove everything from the two rooms and to get all the cable and lighting flex down. Just before we had finished we heard the quick ringing of the cathedral bell and the sirens warning us of a raid. As no planes could be heard we thought that possibly it was a false alarm, when suddenly, like a bolt from the blue, a plane, which must have had its engine shut off, dived from the sky at terrific speed, just skimming the roof of the central pavilion. Not twenty yards from where we stood fell a line of machine-gun bullets, a further line went in the sea. Had the bullets been released a fraction of a second earlier, dozens of the hospital workers must have been killed. Half an hour later we left, but twice on the journey had to leave the vehicle and jump into a ditch whilst more bombers passed.

Villafranca was our destination, and the hospital set up in what had been a convent. We found a room to work in, but had to use the dark-room on the vehicle, and keep the engine running all the time for the dark-room lamp, as our batteries were very low, and the shortage of petrol prevented us from running the engine of the vehicle to charge them. This X-raying was almost the last we did, as in a few days we moved again, to rest in a village called Pins, just outside Barcelona, and then on again to Tarassa. Here J.S. was taken ill, and had to retire to bed. I found a tiny room, just big enough to work in, and X-rayed about a dozen patients. We were continually bombarded, and only moved out of Tarassa an hour before the enemy occupied it. J.S. got up to drive, a terrifying drive in the dark on a road lined with struggling refugees and their little carts, packed high with as many belongings as they could manage to carry, past canons and through part of the lines, for now we were in front of, and not behind, our lines. A night in Sabadel and then on to Matero. We made our last journey several nights later, after Barcelona had fallen. J.S. was so weak that two of us had to pull on the steering wheel to get the vehicle round corners. After a terrible drive, during which we were twice misdirected, we reached the village of Casas de la Selva, fifteen kilometres south of Gerona. The last films I took in Spain were taken in this village; they were of women and children injured during the bombing and machine-gunning before the taking of Casas de la Selva.

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The development of radiology from the discovery of x-rays in 1895
Programme for the Diploma in the History of Medicine Course 2005-2006
22nd October 2005

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In 1895 Wilhelm Conrad Röntgen was Professor of Physics and Director of the Physical Institute at Würzburg. As part of his work using evacuated glass bulbs he noted that when a current was passed across the bulb, a barium platinocyanide screen was seen to fluoresce. He at once realised the significance of this observation. On the 28th of December 1895, his manuscript "On a New Kind of Ray" was submitted to the Würzburg Physical Medical Institute. The essential features of X-rays were described and the new discovery aroused considerable interest. The description of the ability to see through the body was greeted by many with incredulity and early accounts had to reassure the public that this was a serious discovery by a respected scientist.

Because the apparatus was readily available the experiment could be easily repeated. The Crookes tube was to be found in most physics departments. In the simple tube designed by Sir William Crookes (1832-1919) the tube consists of a partially evacuated glass bulb with the anode in a side arm. The electrons hit the end of the glass bulb which acted as a large target and resulted in a poor image. From 1895, Crookes had experimented with the passage of current across such tubes. There was an initial modification by Herbert Jackson of King's College to the simple tube, the Jackson focus tube. In his modification, the cathode became a dish which produced some focusing of the electrons and the anode was made of platinum and placed opposite the cathode. The Jackson focus tube produced a considerable improvement in image quality.

The apparatus gradually improved and hospitals started to acquire the equipment. Many hospital X-ray departments were located in the cellars and basements and were often poorly ventilated and damp. The dampness made it difficult to work the apparatus and made it more difficult to pass the current across the glass tube. The first

hour of the day was often spent in drying the apparatus. Event at the Royal London Hospital in 1897 there was no electric current in the hospital and the accumulator of Grove cells was taken out of the hospital by a porter to a nearby establishment to charge it. The initial apparatus was usually mounted on a trolley with the accumulator on the lower level and the induction coil and contact breaker on the upper level. The tube was held in a wooden clamp and was a bare bulb with no protection for the operator. The trolley could then be taken around the hospital.

Various individuals were involved in what was called "The New Photography" including photographers and general practitioners. At King's College Hospital, two medical students were sent to use the new apparatus. After some time, a Doctor Mayou was put in charge of them since it was felt they were spending too much money on plates! Financial considerations were important even then. He was warned by the students not to expose his hands to the X-rays. the advice was ignored and soon he had X-ray dermatitis on every finger. at that time, it was not obvious at to why these injuries were occurring and some workers thought that they were caused by the developer or the high tension. It took some time to realise that it was the X-rays themselves that were causing the injuries.

Unfortunately the absence of protection around the early X-ray tubes resulted in considerable injury to the operators. The problem was compounded by the common practice of fluoroscoping the operator's own hand to test the tube. these dangers were gradually recognised and standards for exposure and protection were gradually introduced. It was following the shock at the death at the age of 42 in 1921 of Dr Ironside Bruce from Charing Cross Hospital in London that the British X-ray and Radium Protection Committee came into being.

By 1905, the apparatus in the Department at King's College Hospital consisted of a 10-inch induction coil, a condenser, a Mackenzie Davidson mercury break and several Müller gas tubes with vacuum regulation. The induction coil provided the high tension. The mercury break interrupted the current by means of a motorised electrode dipping in and out of a pool of mercury. To prevent sparking, the mercury was covered with either methylated spirits or coal gas which often resulted in the apparatus catching fire or exploding.

The radiographs were initially made onto glass photographic plates which had to be placed into light tight cassettes or envelopes. The photographic plates were coated with emulsion on one side only. The emulsion had a habit of slipping off during developing and the job of a junior was to wax the edges of the plates to help to keep the emulsion in place. Film was introduced by Eastman in 1918 by Eastman, however film only came into general use from about 1923. It should be remembered that the image quality on glass was excellent and it took some time for film to replace the older technique. Unlike the glass plates, the film could be coated on two surfaces with emulsion ("Dupli-Tized"). The base was made of celluloid nitrate and was highly inflammable. This high risk property was tragically shown in the infamous Cleveland Clinic fire when the X-ray film store caught fire and 129 people died. In 1924 Eastman introduced the cellulose acetate base as safety film. This innovation was more expensive and it was only the accidents with the previous film that forced its introduction.

Most of the early X-ray work was performed by doctors and the departments were often combined with electro-therapeutic departments. However from about 1903, lay X-ray operators as they were then called were appointed to assist in the work. They had no

special training and learnt on the job. Gradually more and more of these lay X-ray operators were appointed and training courses were set up. The culmination was in the formation of the Society of Radiographers in 1920.

The gas tubes were difficult to use and the skill of the operator lay in proper seasoning of the new tube and caring for it during use. It was only following the introduction of the Coolidge tube in 1913 that predictable results were obtained. In the Coolidge tube, that could be completely evacuated and electrons were liberated from a heated spiral cathode. The results were far more uniform and it was possible to vary the current and voltage independently. In the early tubes, the high tension cables were attached to the ends of the tube producing a considerable risk of electrocution. Sealed and electrically insulated "shock-proof" apparatus was gradually introduced from the 1930s. The self protected Metalix tube was designed by Bouwers of Philips in 1924 and this tube also incorporated the principal of line focus. Bouwers also designed the first rotating anode tube, the Rotalix, which was first marketed in 1929.

X-rays were used for therapy from the earliest times. Skin lesions were easily amenable to therapy and gradually techniques evolved to treat deeper lesions. These techniques depended on the development of more powerful apparatus, the use of multiple therapy beams and in the use of Radium. The doctors in the X-ray department were involved in both therapy and diagnosis. It was only from the 1930s that doctors were appointed with specific interests in diagnosis or therapy.

In the 1950s came the development of the image intensifier and X-ray television. The initial systems produced a brightness gain of about 1000 and meant that the red goggles needed for dark adaptation when viewing a simple fluoroscopic screen could be dispensed with. the result was also that the operator looked at the television and not at the patient. The use of image intensification has stimulated the flowering of techniques in the last 20 years, including the associated development of catheters, needles and contrast media.

Many new techniques have been introduced in recent years and transformed clinical practice. The principles of CT scanning were discovered by Godfrey Hounsfield and the first prototype EMI scanner was installed in 1972 at Atkinson Morley's Hospital. Work was progressing on Magnetic Resonance Imaging in the 1970s and the first human image was obtained at Aberdeen in 1977. Ultrasound was started in the 1950s and gained popularity in the 1960s. "Real-time" ultrasound machines were introduced in the late 1970s. these new techniques have displaced many of the older X-ray techniques and this process will continue.

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HEAD AND NECK RADIOLOGY

IN OXFORD

A brief and incomplete history

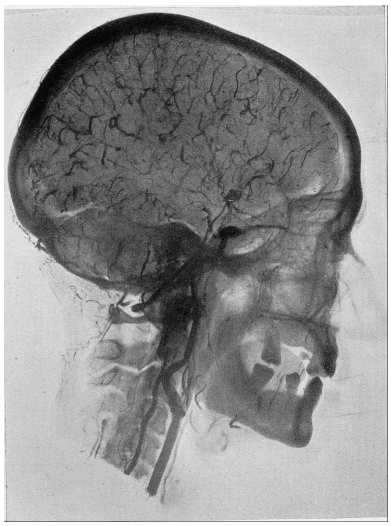
Jean M Guy and S J Golding

The background: the British Picture

Radiography of the adult head proved very difficult with apparatus available before 1900. The output of both current and voltage was low and unreliable. In 1896 only infants were small enough to be examined. The *Archives of the Roentgen Ray* published a 'skiagram' of a 3-month-old infant including a lateral view of the head and neck.

Swallowed foreign bodies were more easily seen in children, as Thurstan **Holland** showed in Liverpool, and John **Macintyre** in Glasgow in the same year.[i] By using autopsy material it was possible to avoid movement and radiation over-exposure, delineating blood vessels of the head and neck with opaque contrast media.[ii]

Infant head 1896



cranial vessels injected 1906

In 1898 Macintyre demonstrated soft tissues of the neck, clearly showing the hyoid bone and the epiglottis outlined by pharyngeal air. [iii] By 1907 Dr Ironside **Bruce** of Charing Cross Hospital, London was able to include lateral views of the skull and facial bones at 5, 15, and 25 years in his *System of Radiography with an Atlas of the Normal.*[iv] No structural detail was visible in the skull. Atlases of the skull appeared in 1918 and of the nasal sinuses in 1912. [v] Post-mortem stereoscopic radiographs of the arteries of the head and neck were published in an atlas of 1920.[vi] Normal structures and pathological processes were illustrated in Bertwistle's atlas of 1926. They included sinusitis, mastoiditis, an orbital tumour and a contrast study of the antra. [vii]

Russell **Reynolds** of Charing Cross Hospital spent several years experimenting with cine apparatus, publishing his results in 1927. His method was to photograph radiographic images on the fluorescent screen. Not until 1933 was his design taken up by the manufacturers Watsons as a commercial venture. Unfortunately the expense of the apparatus and film prevented cineradiography becoming a routine procedure. [viii] In 1935 Reynolds demonstrated slides and films of mastication and deglutition as well as films of the thorax to the British Institute of Radiology. [ix] In February 1936 Lord Nuffield paid for this apparatus to be installed in the Nuffield Institute for Medical Research, in a building which is now part of Green College, adjacent to the Radcliffe Infirmary.

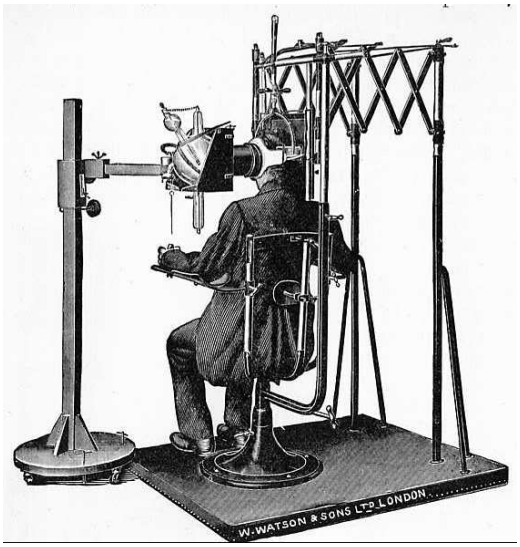
Technical improvements to the X-ray tube and accessory equipment produced a gradual improvement in image quality from the 1920s onwards. Standard views and standard measurements became possible. [x] Tomography was a vital technique for analysis of the skull base. More sophisticated movements of the tube, such as the hypocycloidal, were used to delineate the inner ear and auditory canal, paranasal sinuses, optic canal and soft tissue structures. [xi]

Eric **Samuel** was responsible for the sections on 'Radiology of the Paranasal Sinuses' and 'Radiology of the Ear and Temporal Bone' in the standard *Text-Book of X-Ray Diagnosis by British Authors,* fourth edition published in 1969. He emphasised the need for standardised views and positions and the need for reproducibility to allow the progress of a case to be followed. This was the last synthesis of head and neck studies before computed tomography (CT) produced its major revolution in imaging. [xii] Computed axial tomography was invented by Godfrey **Hounsfield** and first applied at the Atkinson Morley Hospital by James Ambrose, who reported his clinical findings to the British Institute of Radiology Congress in April 1972. [xiii]

The first experiments in magnetic resonance spectroscopy were made by Bloch and Purcell in the USA in 1948, and Lauterbur built on their work and on techniques from CT to produce imaging. British researchers in London, Nottingham and Aberdeen collaborated with manufacturers to produce commercial MRI scanners. Manchester had the first one in Europe installed in 1983.[xiv]

While working in Manchester **A E Barclay** pioneered contrast gastro-intestinal studies, starting with his doctoral thesis in 1912. He emphasised the importance of examining the fluoroscopic screen rather than radiographs. [xv] Until the hot-cathode (Coolidge) tube was widely adopted in Britain in the 1920s, the high current, high voltage, short exposures necessary for cine studies of moving structures were not possible. [xvi] Faint fluoroscopic images of the rapid movements of swallowing were not amenable to analysis. When he moved to Cambridge University, Barclay used a rapid serial camera that would take one to eight frames of five-inch square film per second projecting the X-ray beam directly onto film. He published his images of the act of swallowing in his new textbook in 1933. [xvii] Although he moved to Edinburgh in 1936 he was there for under a year before retiring on

health grounds to the Oxford area, starting there perhaps the most active radiological retirement in history.



head radiography 1915

A E Barclay

The Oxford Story

Experimental work using Reynolds' equipment was begun when Barclay moved to Oxford. [xviii] During the 1940s important research was done here on cardiac movement and renal function. The use of small animals avoided the problems of achieving short repeated exposures through the massive human frame. With the advent of image intensification the problem could be overcome. In the period from 1953 to 1962 several manufacturers, particularly Philips, developed image intensifiers and television chains. [xix]

After Barclay's retirement in 1948 Gordon **Ardran** headed the radiology department in the Nuffield Institute at Oxford. In the Radcliffe Infirmary Fred **Kemp** had been appointed as radiologist in 1935 and the two collaborated on the comparative anatomy and physiology of the throat and upper airways, using cine-techniques as their main tool. Their contributions were of international importance. The result was 80 joint publications, on technique, normal anatomy and movements and pathological states.

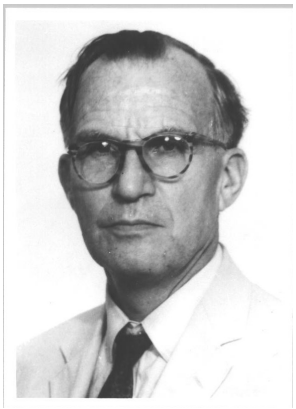
Under Ardran's direction the X-ray section of the Nuffield Institute became the University Department of Radiology. Generally, but not always, it was Kemp as the clinical radiologist who produced the clinically relevant objectives which Ardran explored. The relationship was not always smooth but each benefited from the stimulus of the other. Kemp's other interest was in musculo-skeletal imaging. Ardran was working on bladder function in the Institute, and radiation protection and quality control work which he performed as radiologist to the Atomic Energy Research Establishment at Harwell.

Gordon Ardran with the Zeiss projector

Landmarks.

On the main issue of swallowing their first paper on the mechanism appeared in 1951[xx] followed by a radiographic study of movements of the tongue in swallowing. They were the first to point out that lingual function is essential to effective swallowing.[xxi] (Their final study of tongue size was published in 1972.) Studies of biting and mastication followed in 1960[xxii] and analysis of the function of the lateral food channels in 1961.[xxiii] Suckling became of particular interest. Initially this consisted of cine radiography of infants suckling from barium painted breasts (something which would never be allowed today!). From there it was a simple step to study the efficacy of bottle feeding and, even easier to carry out, a radiographic study of the efficacy of mechanical milking machines.[xxiv] At the same time they published an article indicating the significance of adenoids and tonsils in swallowing.[xxv]

Ardran and Kemp made a particular contribution to the understanding of laryngeal protection. Their first paper on the closure of the larynx was published in the British Journal of Radiology (BJR) in 1953 and the work that followed over the next 13 years was summed up in a two-part publication on the mechanism of the larynx in the BJR in 1966 and 1967.[xxvi] The final phase of their work concerned important differences between the use of the airway in adults and children.



Fred Kemp

A feature of the Institute was the way it attracted co-workers, for example, their collaboration with singers. Lucie Manen, a German soprano working in England became interested in the possibilities of assessing singing by cine radiography and carried out an extensive programme of research on her students, subsequently summarised in her book on singing technique. Ardran worked on the counter tenor voice, elucidating its controversial aspects in collaboration with David Wulstan of the Clerkes of Oxenford. [xxvii]

Almost all this work was carried out using equipment which had to be developed for the purpose. High frame rates were needed in cine radiography to assess rapid physiological movements. The Institute which Ardran inherited from Alfred Barclay largely concentrated on 16mm cine fluorography and 5 inch direct serial radiography. When he arrived the department was being decorated and Ardran found the decorators resting one of their ladders against a black-covered, leather-bound case. Opened, this proved to be a Zeiss 35mm cine projector of 1930s vintage, believed to have been the instrument originally purchased by the physiologist Franklin in order to demonstrate Janker's work to Lord Nuffield in the mid 1930s, a move which resulted in setting up the X-ray section in the new Nuffield Institute. Ardran took inspiration from finding this equipment and converted the Institute to work mostly with 35mm cine fluorography. This projector was still being used to report cine radiography until the change to video in 1986, when the cine swallowing work transferred from the Radcliffe Infirmary to the Churchill Hospital.

Much of the equipment was home-made, constructed from pre-existing commercial elements intended for quite different uses, and at the end of that series of experiments the equipment was cannibalised for the next. A small technical workshop grew up under the stimulus of this work, headed by Colin Nichols, with a counterpart in the Radcliffe Infirmary run by Morris Tuckey.

In the 1970s Ardran and Kemp were hard at work on a major textbook on the comparative anatomy of swallowing and the airways. This concentrated on the human but incorporated information acquired from such diverse sources as studying wallabies and sheep suckling at bottles, and even locusts eating barium-impregnated corn.

In the late 1970s this book would have been a very significant addition to the literature on the subject. However Fred Kemp died in early retirement in 1976 when the manuscript was incomplete, although the volume of work that had been undertaken was large. Most regrettably, Gordon Ardran, although being a member of the team who undoubtedly kept up the smooth workflow, downed tools on the project and never touched it again.

The radiology section of the Institute transferred to the Radcliffe Infirmary (above) in 1978.

Ardran became the first Reader in Radiology in this the new University Department of Radiology, holding the post until he retired in 1984. Yet another move took place with the completion of the John Radcliffe Hospital in 1979. Swallowing and other cine studies have been transferred the Churchill Hospital. Now the major techniques in head and neck imaging are CT and MRI.

The former Nuffield Institute for Medical Research

Originally the Radcliffe Observatory, 'The House of the Winds',
now part of Green College

A version of this paper was circulated to registrants of the European Society for Head and Neck Radiology held in Oxford, 22nd-24th September 2005.

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