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"Now, you need an x-ray examination. . . ."

Almost everyone who reads this journal would expect to have an *x*-ray examination if they were injured in an accident, had a cough which did not respond to treatment, or had recurrent abdominal pain. Probably around half the main medical decisions in Western countries are guided to greater or less extent by *x*-ray examinations, yet 70% of the world's population cannot have such diagnostic help.[1 2]

There are two major problems in the developing world. Firstly, *x*-ray machines are clustered in the major cities and, more particularly, in the major hospitals. Many suburban populations are served by small hospitals which do not have any *x*-ray equipment. Secondly, many of the existing *x*-ray units do not work. At any given time probably 30% of all units in South America are out of order, and the figure may well be higher for most developing countries.

Procedures such as computed tomography, arteriography, and even barium meals account for less than 20% of all *x*-ray examinations, even at university hospitals, and they are of minor importance in the context of health care for most of the world's people. What matters to most people is the diagnosis and correction of trauma, the care of chest infections, and, to a less extent, the diagnosis and cure of simple renal or gallbladder disease. Common diseases are still common, and many require straightforward diagnostic radiological examinations.

The World Health Organisation is aiming at "Health for all by the year 2000," and that includes diagnostic radiology. Until now a major difficulty has been the lack of any *x*-ray units specifically designed for use in small isolated hospitals or the clinics of developing countries.[3] In the past two years the World Health Organisation's Basic Radiological System Advisory Group has been working with the co-operation of manufacturers in various countries to devise a true "basic" *x*-ray system.[4] This sytem is now becoming available—and will have many uses in fully developed countries, in the cottage hospitals of England, the community hospitals of America, and health centres anywhere.

The Basic Radiological System Advisory Group believes that many mistakes in diagnostic interpretation result from poor radiological technique. For example, an underexposed chest radiograph taken in poor inspiration may show many of the radiological characteristics of cardiomegaly, cardiac failure, and pulmonary oedema; a radiograph of the wrist at the wrong angle may disguise a fracture or dislocation; incorrect angulation of the *x*-ray tube may suggest dislocation which is not actually present. Fully trained radiographers will not, however, be available for many years in all the rural hospitals which require *x*-ray sets: nor would any fully trained radiographer be happy to work in isolation, examining mainly fractures and chests with a load of five to 10 patients at the most a day. Common radiographic practice is simple, routine, and often repetitive—but that does not in any way make it less essential for the individual patients.

The technical solution combines simplification with the latest available knowledge. The first presumption is that a good chest *x*-ray film needs a short exposure and a substantial distance between patient and tube: the second is that adequate radiographs of the lumbar spine will be one of the heavier exposures required. The *x*-ray unit must therefore produce at least 100 mA at 110 kV—11 kW—and not one or the other but both simultaneously; so the power supply must be sufficient for this demand without fluctuations under full load. The Basic Radiological System unit achieves these requirements. The distance (roughly 140 cm) between the tube and the film is fixed. This is satisfactory for chest radiographs and the slight magnification of the heart shadow can easily be accepted. Such a distance is ideal for all other examinations, and being fixed allows the use of an accurately focused, very high quality stationary grid. The tube and the film are always exactly centred one to the other and cannot be angled independently. The supporting arm for the tube and the film can be revolved through at least 270°, so that the horizontal or vertical projections are easy, and angled views are possible. Erect views of the skull, sinuses, shoulders, or abdomen are as easy as routine views of the chest. Because the tube and the film are always centred exactly, positioning the patient becomes very simple, and, more important, routine radiographic views are exactly repeatable.

Most isolated or small hospitals do not have a reliable electricity supply, so that the Basic Radiological System specification also calls for battery power. Every time the hospital switches on its own generator at night (or day) the batteries will be recharged.

To simplify operation and to reduce the supply and storage of many different film sizes, the Basic Radiological System Advisory Group recommends three film sizes only: those suitable for the chest, the skull, and the hand. By reducing the number of film sizes, collimation (the limitation of the *x*-ray beam to the film size) becomes easier and more accurate, and, equally essential, radiation is better controlled. Further radiation protection is provided by incorporating a radiation-proof shield in the back of the cassette holder, which will always absorb the main, central x-ray beam during any examination.

Only four kilovoltage settings (perhaps three, or, maybe, five—there is room for negotiation) are required: the almost universal stepless control from 40 to 130 kV is a luxury not in any way dictated by necessity. Some units use an anatomical exposure chart: a pointer or a lever is set against the drawing of the required part of the body and the correct exposure produced, with a positive or negative addition for the large or small patient. Radiologists and radiographers who care to consider this apparently frightening limitation and who then experiment for themselves will find that for the common examinations this range of exposures, particularly a limited kV setting, is entirely sufficient.

Maintenance has also been simplified: the x-ray generators must be of modular construction and so designed that replacement of one module does not require recalibration. In future much of these sets can be manufactured in developing countries and only the tubes, cables, and some of the electronic parts will need to be imported. Film processing is likely to be by hand and the group recognised that in hot and cold countries temperature control is difficult. The DuPont Company, of Wilmington, Delaware, have, however, devised a method of processing which uses an additive that can be mixed with almost any x-ray-film developer and will permit time-temperature processing from 20° to 35°C so that solutions will not need to be cooled. A simple time-controlled method of processing can easily be taught.

These Basic Radiological System units are now on trial in various parts of the world and four or five different commercial units will soon become available. In the rural or cottage hospital any nurse, orderly, pharmacist—or even a doctor—can be taught to use the unit with the aid of a manual of radiographic technique, already on trial, which uses a pictorial step-by-step sequence. The Basic Radiological System Advisory Group has concentrated on about 80 routine radiographic projections, which will supply the needs of almost every peripheral hospital.

The advisory group has had to face one other problem. Most medical students are taught elaborate, complex radiology. Aspiring physicians are asked to interpret barium-meal pictures, cardiac or vascular studies, or recognise bone tumours. These will be the province of specialists, not the concern of 99% of their patients. The advisory group is therefore attempting (a word used advisedly) to design a diagnostic handbook to match the radiographs produced by its machines. Knowing what to look for and where may be the most important part of radiodiagnosis, as it is with many other aspects of physical examination.

No one need feel threatened by the Basic Radiological System concept. Radiology cannot be a closed shop and especially if there are no radiologists. There will never be enough specialist radiologists anywhere: in developing countries there is sometimes one radiologist for one million people. In the circumstances for which the Basic Radiological System unit is designed little radiological support can be expected, but specialist radiologists should visit the hospitals, look at difficult cases, and discuss problems with local practitioners if standards are to be maintained. There is more than enough work for radiologists in the modern, complex radiographic procedures and in the whole topic of imaging with its technical advances: the Basic Radiological System at the periphery will probably free them to do this type of work more satisfactorily and is likely to stimulate more of the difficult procedures rather than reduce the overall work for all concerned.

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Fetal ascites and congenital heart disease

As a result of the decrease in both the incidence and the severity of rhesus haemolytic disease hydrops fetalis has become less common. Non-immunological causes of hydrops, however, are well recognised. Driscoll[1] has listed over 25 associations, including alpha-thalassaemia; twin transfusion syndrome; pulmonary lymphangiectasia; achondroplasia; maternal diabetes; and infections such as toxoplasmosis, cytomegalovirus, and syphilis, as well as cardiac and multiple congenital abnormalities. Cardiac abnormalities appear to be particularly common; and in a series of 42 infants who died with pleural effusions, ascites, and generalised oedema eight had cardiac anomalies.[2] The type of anomaly varied and most were associated with non-cardiovascular anomalies.

Although the incidence of hydrops fetalis is declining, fetal ascites is now diagnosed much more often. Ascites occurs for reasons similar to hydrops and may often represent an earlier stage of the same condition. Routine ultrasound scanning in pregnancy gives the chance of earlier diagnosis. Fetal ascites is most easily recognised from a transverse scan of the abdomen, the accumulated fluid presenting as an area that gives no echoes, usually crescentic in outline, between the abdominal wall and the viscera.[3] In severe cases the abdominal contents are compressed backwards and upwards and are reduced to a small knot of tissue floating in a large volume of ascitic fluid. If the abdominal circumference is measured it will naturally be increased in proportion to the amount of free fluid present. Obviously an attempt should be made to detect any other anomalies. In a recent case from Paris[4] ultrasound examination was carried out at 24 weeks because fetal movements were absent. The most striking feature of the sonogram was very large ascites, which resulted in a clear picture of the various viscera. The liver was midline and appeared to float in ascitic fluid and the intestinal loops were displaced along the whole length of the vertebral column; while on further examination the cardiac area was seen to have no intraventricular septum. A medical abortion was carried out on the basis of the ultrasonic findings and necropsy confirmed a major malformation of the heart, which had a single ventricle. This case clearly shows that the ultrasonic diagnosis of fetal ascites may suggest a cardiac abnormality even in the middle trimester of pregnancy, when termination may be considered.