# A basic radiological unit: WHO's system

## *The World Health Organization's X-ray system fills a need*

by Philip E.S. Palmer

Medical students everywhere are taught the need for X-ray examinations for most of their patients. This may be to find out if a bone is fractured or, if a joint has been dislocated, to see the exact position of the bone fragments and, after the injury has been treated, to make sure the final position of the bones is correct and that eventually they have healed well.

Other patients, perhaps with a cough, will need to have their chests X-rayed, and those with pain or vomiting may need to have a picture of their abdomen, possibly with an injection or tablets which will make the kidneys or gall-bladder visible. Radiology influences treatment for the majority of patients in large hospitals, and medical students become well aware of the advantages to be gained for their patients.

Yet these same students, when they have become qualified doctors, often go to work in rural areas or the suburbs of big cities and find that there is no X-ray set available. Even more upsetting, there may be an X-ray machine but it does not work, or there are no films or no chemicals to develop them: quite often there is no one who knows how to take the pictures properly. The World Health Organization (WHO) estimates that over two-thirds of the world's peoples cannot ever have an X-ray examination, and that in most developing countries at least one-third of all the available X-ray machines are likely to be broken. The doctors may well wonder how they can deliver proper health care.

### Answering the need

Faced with this dismal situation, WHO a few years ago called together a small advisory group of radiologists, all of whom had many years' personal experience of radiology in developing countries. They were helped as necessary by experienced radiographers (X-ray technicians). Their terms of reference were straightforward: "Devise an X-ray system for developing countries. It must be able to X-ray all parts of the body easily and efficiently. It must be reliable and strong. It should work even where the electrical supply is unreliable, and even when there is only a small hospital generator to provide the power. It must be easy to use by relatively untrained operators, yet it must be radiation-safe so that neither patients or operators are at risk of too much X-radiation. The system must include a method of developing the X-ray films after they have been exposed, and it would help if the doctors could have some guidance in interpreting the radiographs (the X-ray pictures) when they are ready."

This was quite a challenge for the group, who started by looking at many existing X-ray machines and many different ways of producing the final image. Was photographic paper better than film, for example? Could power be produced by solar panels, from small nuclear units, or from other ways of storing energy? None of the existing units was satisfactory, but there were some good ideas available. Some of the manufacturers of X-ray equipment already had units running from batteries or storing power by charging up condensers.

Dr Richard Chamberlain, professor of radiology at the University of Pennsylvania in Philadelphia, USA, had taken one of these battery-powered X-ray generators and combined it with an ingenious stand to hold the X-ray tube and the film in suitable positioning for most X-ray examinations. His original model, though, was too complicated, with many sophisticated gadgets which would soon go wrong without continuous maintenance, especially in the tropics. Then the Pan American Health Organization, the Regional Office of WHO for the Americas, held a week-long international meeting in Washington D.C., in 1974, which focused on some preliminary and very basic concepts. The participants discussed the minimum power of the X-ray generator, the sizes of films, the methods of film-processing, the minimum acceptable safety requirements, and some suggestions for the size of the X-ray rooms.

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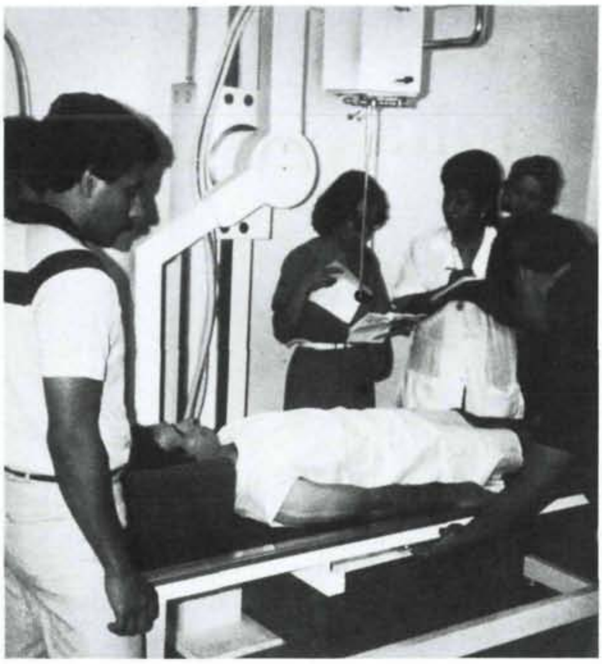
**Developing countries urgently need simple X-ray systems. Yemen was one of the first countries to adopt WHO's basic radiological system. (Credit: WHO)**



In Castilla, Colombia, staff of a small hospital learn how to use the simple units. With only two or three patients to X-ray each day there is no need for elaborate training. (Credit: WHO, P.E.S. Palmer)

## Ensuring safety, reliability

It was with all this information that the WHO advisory group started to work, and after many meetings, and correspondence all over the world, the final specifications for the WHO Basic Radiological System (BRS) were produced. Then the major X-ray manufacturers, following these design requirements, started to produce the actual units, while the BRS group went on to devise the radiographic technique manual, the darkroom manual, and the diagnostic manual for the doctors.

It would not be fair to describe the BRS X-ray unit as "simple" because technically the generator is one of the most advanced electronic designs. Yet, because of this, it is simple to use and repair and should be very reliable. It can be worked by car batteries, so that even if there is a very variable power supply (or electricity from a hospital generator which is only switched on at night), patients can be X-rayed at any time during the day, and the batteries can be recharged when there is electricity available.

The operators cannot make an X-ray exposure unless they are behind the protective screen which surrounds the control panel. Thus there is very little risk of anyone being harmed by the X-radiation. Of course, these operators must have some training, and should preferably already have some medical experience so they know how to look after patients and already know some anatomy. To become a fully qualified professional radiographer requires 2 or even 3 years full-time training, but this is not necessary for the small hospitals which only need to X-ray three or four patients each day.

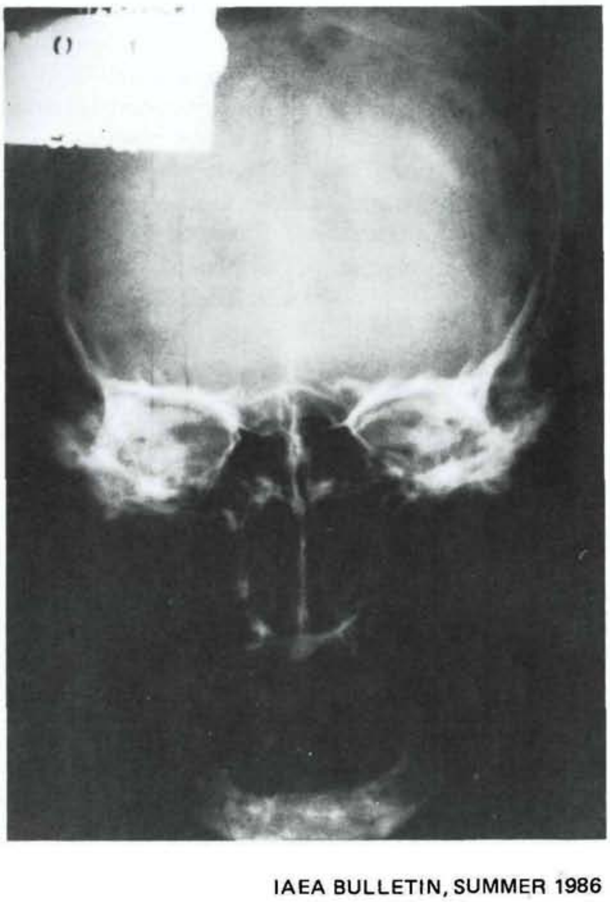
## Training in Colombia

Recently, four of WHO's BRS units were installed in small hospitals in Colombia, and each hospital sent two assistant nurses to be trained at the largest of the four. They worked hard for eight days, using the WHO manuals, and then went back to their own rural hospitals. From then on they have been able to provide the doctors with all the X-ray examinations needed by their patients. A follow-up review by one of the WHO radiologists showed that they did not make many mistakes, and only very few which might have made correct interpretation difficult.

The quality of the X-ray pictures produced by the BRS is excellent. A study made at the University of Lund, Sweden, showed that the BRS could produce 80% or more of all the X-ray examinations needed at a major university hospital without any loss of film quality when compared with films taken by complicated machines costing 10 times as much. Of course, small hospitals do not need the wide range of examinations which are necessary at a university hospital, so the WHO-BRS will satisfy well over 90% of the doctor-patient requirements in almost all hospitals. Seldom should the patient have to travel elsewhere to be X-rayed.

The BRS radiographic technique manual is easy to use. Each examination is described in pictures on facing

The very first X-ray photo taken in Caramanta, Colombia by a technician after four days of training. (Credit: WHO, J. Gomez-Creçpo)



**The whole village of Campamento, Colombia, turned out to help carry the radiological unit from the helicopter to the hospital. (Credit: WHO, J. Gomez-Creçpo)**

pages. When the book is opened, the operator starts at the top of the left-hand page and, by looking at the diagrams and pictures, can put the machine in the correct position, choose the right film size, place the film where it needs to be, set the correct exposure for any size patient, put the part of the patient to be X-rayed in the proper position relative to the X-ray tube and film, and then make the exposure. The last picture at the bottom of the right-hand page is a reproduction of the radiograph which should result after the film has been processed. The darkroom manual follows the same step-by-step procedure.

But in spite of these manuals, there is no substitute for actual experience and the operators must be taught by qualified radiographers, who must go back to each small hospital regularly to help with any problems and maintain quality control. No one working in isolation can be expected to get everything right all the time, and WHO recognizes how important it is to keep close contact with the main, professional department.

The doctor, who learned at medical school that his or her patients needed to be X-rayed, probably did not receive a great deal of instruction on how to interpret the radiographs. There are always specialist radiologists (doctors who have received special training and experience in diagnostic radiology) at all medical schools who interpret the films and help with all the problems of diagnosis. But in small hospitals each doctor must try to decide what injury or disease is shown on the X-rays, and how to treat the patient. So the WHO-BRS advisory group has devised a *Diagnostic Manual for General Practioners*, which is not a textbook of radiology but an easy source of reference showing the doctor where to look on the film and what to expect. If necessary, it offers advice on the severity or difficulty of the condition. Can it be treated in a small hospital or does the patient need all the facilities of the nearest big referral centre?

**Early results good**

Does the WHO Basic Radiological System work? There are many trials now taking place in Latin America, Iceland, Africa, Asia and the Middle East, as well as in Europe. So far the results are very good. The various manufacturers have almost all made satisfactory BRS units and are beginning to market them. In fact, the BRS produces such high-quality films that they are ideal for small community hospitals in many developed countries. Sweden has already accepted them enthusiastically. Perhaps this is an unusual example of reverse-appropriate-technology? An idea which was needed to solve a problem in the developing world is likely to have great significance for developed countries because it is cost-effective and the rising expenditure on health-care needs to be countered everywhere.

Many of us take family photographs, and with today's automatic and inexpensive cameras we record places, people, and events with excellent results and with little knowledge of photography. Point the camera and press the button, and for most pictures it works. It is only the occasional special picture, or the work of the professional, which demands that expensive 35mm camera with extra lenses and numerous gadgets. So it is with radiography. The BRS is the equivalent of those small, simple but really sophisticated cameras and has been so designed that, even for X-rays, it is almost possible to point the X-ray tube and press the button. Yet there will always be the need for that expensive and complicated X-ray machine, with highly skilled professional radiologists and radiographers to help with the very difficult and often unusual illness. Not least, they are needed to train the X-ray operator for small hospitals.

The WHO-BRS — a deceptively easy answer to the problem of bringing X-ray examinations to all patients who require them — is just one way in which WHO hopes to fulfil the vision of health for all by 2000.

# Convention on the Physical Protection of Nuclear Material

In view of the importance of the physical protection of nuclear material in domestic use, storage and transport, and to facilitate its safe transfer, the Convention on the Physical Protection of Nuclear Material was adopted in Vienna on 26 October 1979. It was adopted at the Meeting of Governmental Representatives, which considered the drafting of such a convention and met at IAEA Headquarters in November 1977, April 1978, February and October 1979.

The Convention was opened for signature by all States and qualified international or regional organizations constituted by sovereign States on 3 March 1980 at IAEA Headquarters in Vienna and at the Headquarters of the United Nations in New York until its entry into force, pursuant to Article 18.1. (The texts of the Convention and of the Final Act of the Meeting of Governmental Representatives are set forth in IAEA document INFCIRC/274/Rev.1.)

The Convention requires 21 instruments of ratification, approval, or accession for its entry into force pursuant to Article 19.1, and the IAEA performs depositary functions under the Convention pursuant to Article 23.

As of 15 May 1986, 43 States and one organization — the European Atomic Energy Community (Euratom) — had signed and 17 States had ratified the Convention. The list of Signatories and ratifications, together with indications of the dates and places of signing, are provided below in chronological order.

| State/Organization | Date of Signing | Place of Signing | Ratification |
|---|---|---|---|
| 1. United States of America | 3 March 1980 | New York, Vienna | 13 Dec. 1982 |
| 2. Austria | 3 March 1980 | Vienna | |
| 3. Greece | 3 March 1980 | Vienna | |
| 4. Dominican Republic | 3 March 1980 | New York | |
| 5. Guatemala | 12 March 1980 | Vienna | 23 April 1985 |
| 6. Panama | 18 March 1980 | Vienna | |
| 7. Haiti | 9 April 1980 | New York | |
| 8. Philippines | 19 May 1980 | Vienna | 22 Sept. 1981 |
| 9. German Democratic Republic | 21 May 1980 | Vienna | 5 Feb. 1981 |
| 10. Paraguay | 21 May 1980 | New York | 6 Feb. 1985 |
| 11. Union of Soviet Socialist Republics | 22 May 1980 | Vienna | 25 May 1980 |
| 12. Italy* | 13 June 1980 | Vienna | |
| 13. Luxembourg* | 13 June 1980 | Vienna | |
| 14. Netherlands* | 13 June 1980 | Vienna | |
| 15. United Kingdom of Great Britain and Northern Ireland* | 13 June 1980 | Vienna | |
| 16. Belgium* | 13 June 1980 | Vienna | |
| 17. Denmark* | 13 June 1980 | Vienna | |
| 18. Germany, Federal Republic of* | 13 June 1980 | Vienna | |
| 19. France* | 13 June 1980 | Vienna | |
| 20. Ireland* | 13 June 1980 | Vienna | |
| 21. Euratom | 13 June 1980 | Vienna | |
| 22. Hungary | 17 June 1980 | Vienna | 4 May 1984 |
| 23. Sweden | 2 July 1980 | Vienna | 1 Aug. 1980 |
| 24. Yugoslavia | 15 July 1980 | Vienna | 14 May 1986 |
| 25. Morocco | 25 July 1980 | New York | |
| 26. Poland | 6 Aug. 1980 | Vienna | 5 Oct. 1983 |
| 27. Canada | 23 Sept. 1980 | Vienna | 21 March 1986 |
| 28. Romania | 15 Jan. 1981 | Vienna | |
| 29. Brazil | 15 May 1981 | Vienna | 17 Oct. 1985 |
| 30. South Africa | 18 May 1981 | Vienna | |
| 31. Bulgaria | 23 June 1981 | Vienna | 10 April 1984 |
| 32. Finland | 25 June 1981 | Vienna | |
| 33. Czechoslovakia | 14 Sept. 1981 | Vienna | 23 April 1982 |
| 34. Korea, Republic of | 29 Dec. 1981 | Vienna | 7 April 1982 |
| 35. Norway | 26 Jan. 1983 | Vienna | 15 Aug. 1985 |
| 36. Israel | 17 June 1983 | Vienna | |
| 37. Turkey | 23 Aug. 1983 | Vienna | 27 Feb. 1985 |
| 38. Australia | 22 Feb. 1984 | Vienna | |
| 39. Portugal | 19 Sept. 1984 | Vienna | |
| 40. Niger | 7 Jan. 1985 | Vienna | |
| 41. Liechtenstein | 13 Jan. 1986 | Vienna | |
| 42. Mongolia | 23 Jan. 1986 | New York | |
| 43. Argentina | 28 Feb. 1986 | Vienna | |
| 44. Spain* | 7 April 1986 | Vienna | |

* Signed as Member State of Euratom, the European Atomic Energy Community.