Local (Ministry of Health) guidelines and publications
Some countries are beginning to develop professional bodies (e.g. paediatric societies, obstetric societies, groups for nurses and midwives). Some of these professional bodies are developing guidelines and have access to resources which will be useful.

In addition, some Ministries of Health are working with organisations such as the WHO, UNICEF, the Johns Hopkins Program for International Education in Gynecology and Obstetrics (Jhpiego) and Save the Children to develop programmes and guidelines to improve local healthcare. It is important for those working in low-resource countries to be aware of the activities of the relevant government.

Courses and conferences
These will differ from one country to another, and will be linked with the Ministry of Health and professional bodies.

Web-based membership organisations: HIFA 2015 and CHILD 2015

The goal of these organisations is that, by 2015, every person worldwide will have access to an informed healthcare provider.

HIFA 2015 is a campaign and knowledge network with more than 5000 members representing 2000 organisations in 167 countries worldwide. Members include healthcare workers, publishers, librarians, information technologists, researchers, social scientists, journalists, policy makers and others – all working together towards the HIFA 2015 goal.

HIFA 2015 contributes to the broader goal of the Global Health Workforce Alliance: ‘All people everywhere will have access to a skilled, motivated and supported healthcare worker, within a robust health system.’

Members interact via two email discussion forums: HIFA2015 and CHILD2015. Together these organisations are building the HIFA2015 Knowledge Base, a picture of information needs and how to meet them. Membership is free and open to all.

1.4 Essential imaging facilities

Introduction
Despite the fact that the use of ionising radiation (‘X-rays’) for diagnostic purposes was discovered more than 100 years ago, up to two-thirds of the world’s population still have no access to primary care diagnostic imaging services. Some rural clinics may be located in remote impoverished areas such that imaging equipment is impossible for the population to access. However, clinics in larger towns, and certainly every institution that merits the title of ‘hospital' should have, at the very least, simple radiographic and ultrasound equipment available. This will necessitate the training of healthcare workers to use the equipment appropriately and safely. Local healthcare workers will also interpret most of the examinations performed, and therefore need training in radiographic interpretation. Many African countries, for example, do not have a single radiologist. As most radiographic equipment is now digital, in the absence of a specialist opinion, teleradiology services are an option in...
a few areas. Various teleradiology solutions exist in different regions and are expanding, but they are not widespread. For the under-resourced setting, charitable specialist opinions would need, of necessity, to be provided free of charge.

A basic service
In the context of severely limited resources, health planners have to be selective in their choice of imaging technology. Some radiographic equipment can be so expensive that its purchase might be to the detriment of other important components of a basic health service. The radiographic equipment should nevertheless reflect the standard of care in each clinic or hospital. Albeit suboptimal, very basic orthopaedics can be carried out utilising plain radiographs alone. Proper fracture reduction necessitates that a C-arm fluoroscopy unit should ideally be available. A CT scanner should be on site at a regional centre where there are surgeons available with basic neurosurgical skills (e.g. capable of making Burr holes for extradural haematoma evacuation).

- The majority of radiographic studies in hospitals everywhere are plain radiographic examinations. In a small rural or suburban hospital, plain radiography will account for approximately 90% of all the necessary examinations and, where available, ultrasound will meet the needs of much of the remaining 10%.
- Good diagnostic imaging frequently leads to less hospitalisation, allows for quicker and more accurate diagnosis, and results in less suffering and pain. The WHO recommends that even small hospitals and clinics with only one doctor should have imaging equipment.
- Access to most of the equipment described below should be available to all sick and injured children.

Diagnostic radiographic equipment
- Radiographic equipment that is easy to operate and maintain, such as the World Health Imaging System for Radiography (WHIS-RAD). This is based on much practical experience, and is ideally suited to radiology departments in disadvantaged countries.
- WHIS-RAD was fully specified in 1995. A WHIS-RAD unit is easily applicable to children and small infants, is relatively inexpensive, is safe for patients and operators, and produces high-quality images.
- In recent years the cost of obtaining and processing X-ray film has become problematic, particularly in developing countries. Fortunately, WHIS-RAD is now available in digital format or retrofit. The use of computed radiography (CR) with reasonably priced liquid crystal display (LCD) monitors allows for easy data storage, archiving and retrieval, as well as the potential for utilising teleradiology resources.
- A CR plate has the added advantage of a large dynamic range such that repeat X-rays are seldom necessary.
- Radiation doses from a WHIS-RAD unit are typically lower than those from many conventional radiographic machines, which is particularly appealing where standards of radiation protection, the use of cones, lead protection and dosimetry may be variable and often non-existent.
- The X-ray generator specified for WHIS-RAD may be used with almost any power supply, however variable. WHIS-RAD batteries can operate for up to 3 weeks before they need to be recharged.
- Patients can be examined in a standing, sitting or recumbent position.
- The WHO has produced a range of radiology manuals for the developing world setting. The WHO Manual of Diagnostic Imaging: Radiographic Techniques and Projections provides a very clear explanation of how to use the equipment, even for those with no formal training in radiography. Operators can be trained in a matter of months. This and other useful information is available from the Diagnostic Imaging for Clinics and Small Hospitals website (www.dicas.info).
- The proposed publication of the WHO Manual of Diagnostic Imaging: Paediatric Examinations has unfortunately been severely delayed.
- Donations of old but functional radiographic equipment by well-resourced countries, although laudable, are often worthless. Bulky outdated equipment often cannot be installed, operated or maintained locally. The service manuals are often missing, obtaining spare parts is a major problem, and many of these machines break down irreparably.
- Portable X-ray equipment typically requires reliable power sources and expert radiography, such that its use is only practicable in larger centres.

A comprehensive list of the indications for diagnostic radiography is too long to include here. Suffice it to say that all children with a serious pneumonia, suspected tuberculosis or fractured limbs, to name a few examples, merit radiography. In practice, chest and skeletal examinations are the most frequent indications for diagnostic imaging worldwide. Where resources are less stretched, radiographic machines with slit-beam technology could be considered. These units, such as the LODOX Statscan, are also fully digital, have sufficiently low radiation doses to permit their use within a ward without special protective barriers, and offer flexibility for those with little radiographic positioning skill. In addition, they provide rudimentary CT information which is useful for head trauma patients, at a fraction of the price of CT scanners.

Diagnostic ultrasound scanning equipment
The wide range of applications of ultrasound in children and pregnant women, its versatility and its safety probably make it better suited to disadvantaged countries than any other imaging modality. Sonography is harmless – it does not generate ionising radiation, and is thus particularly suitable for imaging children, adolescent girls in particular, and pregnant women.

- Ultrasound machines are simple to operate, but the images are also easy to misinterpret. It is therefore critically important that the person performing and interpreting an ultrasound study is suitably trained and competent. Sonography must be taught on a supervised practical basis in a local environment. The WHO recommends a 6-month minimum training period for diagnostic sonography.
- Initiatives such as that by Imaging the World (http://imagingtheworld.org) allow for alternative basic sonographic training to be shortened to as little as a few days. Reliance instead is placed on transmission of images over the Internet to a secure server, from which the images can be accessed and read anywhere in the world.
The WHO recommends minimum specifications for a general-purpose ultrasound scanner.
- The scanner should be able to operate from the local electrical power supply.
- Servicing should be available locally.
- It must be possible to store the unit safely under adverse conditions.
- When scanning children, at least two different MHz transducers (sector and linear array) are desirable.
- Doppler techniques are included on all modern ultrasound equipment, such that exclusion of a deep venous thrombosis, for example, should be possible.
- Some form of archived permanent hard-copy record is recommended for patient follow-up, and in the interests of teaching and training in general.

Additional points
- Mobile ultrasound scanners can be operated at the bedside or in the Emergency Department.
- Abdominal and pelvic ultrasound has a well-established role in the assessment of adolescent gynaecological conditions and paediatric emergencies.
- Sonography plays a major role in the management of pregnancy, from dating the age of the fetus to identifying multiple pregnancies, ascertaining the position of the placenta and generally identifying potential problems, thus allowing the clinician to plan safe delivery.
- Sonography can quite simply resolve mass lesions from organomegaly.
- It is noteworthy that hydronephrosis is the commonest abdominal mass in the neonate and infant, and this is easily diagnosed with ultrasound scanning.
- Evaluation and drainage of pleural effusions or ascites is relatively straightforward, particularly with ultrasound guidance.
- Ultrasound scanning can be a useful tool for guiding other interventions, such as drainage of larger abscesses or an image-guided biopsy of a solid mass.
- Alternatively, evaluation of solid mass lesions and cysts should at least be possible, to aid patient referral to larger regional centres.
- Sonography of the infant brain is easily performed at the bedside, and can provide useful information in the infant who is febrile, unconscious or has seizures.
- In trauma patients, abdominal ultrasound scanning can prevent unnecessary surgery.
- Finally, ultrasound studies frequently reduce the need for plain abdominal radiographs and yield more diagnostic information.

### 1.5 Essential operating-theatre resources

#### Design of the operating theatre (OT)
- Ideally it should be located next to the labour ward.
- It should be of adequate size (minimum $7 \times 7$ m) for the placement of essential equipment and the unobstructed movement of staff.
- It should not be used for storing purposes, for which a separate side room should be available which can also be used for hand washing.

#### Essential equipment
- Ordinary OT table with a facility for the lithotomy position and lowering and raising the height of the table, preferably mechanically operated.
- A good focusing OT light is very important.
- A simple anaesthetic machine suitable for the resources available in the country (e.g. Diamedica-Glostavent, for resource-limited countries), with an uninterrupted oxygen and nitrous oxide supply, is the most essential item of equipment for the anaesthetist. Reserve cylinders for both oxygen and nitrous oxide should always be available. If nitrous oxide is not available, the patient can be maintained on ether or halothane, but the level of anaesthesia has to be deep, requiring more intensive post-operative monitoring.
- The suction machine (which should have both electrical and manual functions, in case of electrical failure) should be periodically emptied and cleaned with antiseptic solution after every individual patient. It must be constantly checked.
- A fumigation machine is essential for the sterilisation of the OT.
- Anaesthetic equipment and supplies (see Section 1.22 for a list of essentials).
- All emergency drugs (e.g. lignocaine, adrenaline, atropine, sodium bicarbonate, 25% dextrose, morphine, etc.), with syringes, should be readily available in the OT (see Section 1.22).
- A boiler is essential for sterilisation if an autoclaving facility is not available. A heater of some kind is also essential for warming up crystalloid infusions to be used during surgery to prevent hypothermia.
- Monitoring equipment (see Section 1.22 for a list of essentials).
- Room heaters are essential, especially for surgery on infants. The OT temperature should be in the range 28–32°C to prevent hypothermia in babies. Hot-water bottles can provide heat for infants and are inexpensive, but it is essential to be vigilant about safety. Radiant warmers, incubators and electric blankets are helpful if they are available. Equally, air conditioning is also required in hot countries to ensure appropriate working temperatures for patient and OT staff.
- A cautery machine is useful for reducing blood loss.