3. CONSIDERATIONS IN EQUIPMENT PROCUREMENT AND IMMOBILIZATION OF PATIENTS

Equipment used for pediatric radiology needs to be well designed and suited for the purpose. This is best ensured by having a good procurement policythat includes rigorous specification of what is required and verification that this iswhat the supplier delivers (see Section 3.1). In addition, a quality assurance program is required to ensure that the equipment continues to be both functional and safe throughout its service life (see Section 3.2). This underlines the need to include medical physicists and quality assurance teams in procurement.

These considerations are important in pediatric radiology, where special steps are often necessary to ensure that exposure factors will be 'child-sized'. Where the same equipment is also used for adults, this can be a major problem. However, it can also be problematic even where equipment is solely for pediatric use. Equipment supplied with general purpose exposure protocols willinevitably and systematically overexpose children. Care in procurement also applies to ancillary items, for example, shielding for patients, lead aprons or protective screens. Special arrangements to facilitate immobilization of children are considered in Section 3.3.

3.1. EQUIPMENT PROCUREMENT

Radiological equipment can be very expensive. For this reason and to ensure safety, the procurement process followed has to be formalized [49]. It needs to specify the functions that the equipment is expected to perform. It is alsoimportant to ensure that equipment complies with appropriate international technical standards, such as those developed by the International Electrotechnical Commission (IEC) [50–54]. The safety standards of the IAEA will apply [2–4]. Such standards establish requirements for the levels of safety and of performance to be achieved. Taken together with manufacturers' specifications, these will ensure that the equipment purchased is appropriate, achieves the performance expected and is safe.

More attention needs to be given to the development of technical standards specifically for equipment intended for pediatric use. Examples of where this area has been neglected include automatic exposure control (AEC) systems in radiology and fluoroscopy, and the scanning protocols in CT. However, there are recent encouraging signs that both the industry and technical standards organizations recognize this and are open to suggestions for corrective actions. In

Europe, additional requirements are expected for all equipment, whether old or new, to meet minimum criteria of acceptability for use with patients [5, 49].

Once installed, equipment needs to be acceptance tested so that its supply, performance and safety are verified prior to commissioning for clinical use [49]. This is consistent with practice in some countries, where an agent (other than the supplier) who acts for the end user and/or the hospital has to sign off acceptance tests [5, 49]. Even where this is not legally required, it is important that it is done and properly documented. On installation, 'child-sized' exposure factors and protocols have to be established and communicated to all relevant staff as part of user training. This is particularly important with angiographic and CT systems [2, 49, 53–57].

The stages involved in the procurement process are listed in Table 5. All of these stages are important, regardless of the organizational framework in which they occur. Neglecting them almost inevitably leads to problems. The advice and support of an experienced procurement officer is invaluable. When estimating costs, the list in Table 6 may be considered. Where possible, these items need to be included in the main contract for provision of the equipment. Otherwise, many will be neglected and they are difficult to resource once the equipment has been delivered and paid for.

When second-hand equipment is considered, it needs to maintain the original manufacturer's specifications and meet the local minimum criteria for acceptability. Proof of compliance with these requirements has to be obtained. If an original feature is no longer functional but the equipment still meets the criteria for acceptability, this has to be clearly indicated in the documentation provided by the donor and/or seller [58].

In addition to the technical considerations, other operational, training and maintenance requirements have to be met. Satisfactory operator training is essential for all systems but particularly for CT, fluoroscopy and digital systems.

TABLE 5. STAGES OF THE PROCUREMENT PROCESS

Analysis of equipment requirements (clinical and technical)
Development of equipment specifications
Invitations to tender to appropriate suppliers
Analysis of tenders
Agreement of contract
Installation of equipment
Acceptance testing, commissioning and acceptability testing
On-site application training

TABLE 6. ITEMS TO BE INCLUDED IN THE COSTS OF A RADIOLOGY FACILITY

Purchase and installation of the radiology equipment
Building costs, including structural shielding
Provision of alternative services during refitting (where relevant)
Radiation protection devices, including the operator's protective lead screen, ceiling suspended lead screens, lead screens at the tableside, lead aprons, etc.
Ancillary equipment and/or accessories, including film processors, laser imagers, printers, cassettes, etc.
Test equipment for quality assurance
Ongoing running, maintenance, acceptance testing and quality control costs
Operator training and continuing education

The absence of such machine specific application training leads to systematic overdosing of patients and unnecessary exposure of staff over prolonged periods, sometimes several years. It is also important to budget for acceptance testing and ongoing quality control testing, particularly if this is to be carried out by third parties.

3.2. QUALITY ASSURANCE OF EQUIPMENT

A quality assurance program in diagnostic imaging ensures qualityduring all phases of the operation of the service. One aspect of such programsfocuses on the operation of equipment. Quality assurance is required by the BSS,by many governments and the EC, and is recommended by numerous professional bodies [2, 49, 57, 59–61]. A quality assurance program may be seen as part of clinical audit and part of the optimization process. It is important to ensure that equipment is working properly, is delivering the exposures expected and is compliant with good standards of installation and design.

Examples of relevant tests with a general radiography unit include checking whether the X ray beam is coincident with the light beam localization system, what its output is and whether the correct filters are present. Accurate, well adjusted collimation is essential in pediatric radiology because of the small size and close proximity of a child's organs. It is essential that the results from quality control assessments be integrated into the work of the management of the department, so that the findings are noted and acted on. A wide range of published guidelines are available for quality assurance [59–61].

3.3. CONSIDERATIONS IN IMMOBILIZATION

Immobilization is required with many children when performing radiographic studies. This is required so that:

— The beam can be correctly centered.
— Correct collimation can be obtained.
— Blurring and motion artefacts are reduced.
— The non-examined parts of the body are properly shielded.

Devices, such as sponges, sandbags or polymethyl-methacrylate plates, may be used with very small infants. In young children, it may be useful to take advantage of the period when the infant is calm or asleep after being fed to perform the radiological examination. With longer or more complex examinations, some sedation may prove valuable or necessary.

When assistance of a person is required for immobilization of or comforting a patient, this is, generally, not to be done by radiological or hospital staff. If, exceptionally, hospital personnel help in this way, the exposure they receive is considered an occupational exposure [2] and care has to be taken to ensure that the same staff members are not repeatedly exposed.

It is preferable that the patient be comforted or restrained by parents or relatives. In this case, the doses received are classified as doses to carers and comforters, and are dealt with as outlined in Section 2.4. This is the more appropriate route to follow as it avoids repeated exposure of the same hospital staff. It requires that the duties involved be undertaken by people who know the risks and that appropriate provision be made for informing them and protecting them (e.g. use of lead aprons). Those for whom pregnancy cannot be excluded will not be allowed to act as carers and comforters.

Even for young children, the time allocation for the examination has to include the time necessary to explain the procedure, not just to the accompanying parent or person but also to the child. Information specifically adapted for the parent and the child can be forwarded to the family in advance of the study. Video recordings or illustrated books and materials provided for viewing by children in the department in advance of the studies can also be helpful. Time taken to explain to a child and the parents what will happen is time well spent in obtainingoptimal cooperation and securing a good examination [61].