The Design and Construction of Hospitals in Developing Countries

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1. Introduction

The Alma Ata Conference in 1978 identified the approach of Primary Health Car (PHC) to be the key to health for all. Though curative and rehabilitative services have explicitly been included in this concept hospitals and similar health care facilities have been neglected in many countries introducing PHC. Only in recent years the important role of hospitals has been rediscovered, in particular its supporting function for PHC. This mainly includes:-

- technical support such as training and supervision, treatment of referral cases and research;
- administrative support such as supplies and organisation of referral system; and
- health education (hygiene, nutrition, child care, AIDS, Family planning etc).

The levels of care to be dealt with include the first health facility up to the second or third referral level according to the models supported by WHO:-

Higher Referral Levels
Third Referral Level (National)
Second Referral Level (Provincial)
First Referral Level (District)
First Health Facility (Subdistrict)
Community Health Activity
Family and Home

The Department of Health, Nutrition and Population Development of GTZ the official German agency for technical co-operation with developing countries for which I work, shares the opinion of many experts that hospitals exceeding 300 beds cannot be economically operated in most developing countries. For this reason and because of the apparent urgency of meeting the needs of the rural areas, this paper will only deal with health facilities below national level.

Before proceeding to the physical requirements of such health facilities, it should be remembered that circumstances with regard to technical capabilities of health staff in developing countries are far from satisfactory. When designing and equipping health facilities this fact must be taken into account.

The aforesaid is the primary reason why we have to think of hospitals in terms of a system, in which elements such as construction, energy supply, equipment and its operation and management to name only a few are intricately interrelated. Thus, planning, design and construction of health facilities cannot be regarded merely as a sequence of separate activities, but as an integrated task for a team.

2. Historical Review

In most developing countries traditional healing methods had been repressed or even demolished by external factors such as the increasing world wide contact through trade and colonisation. As a result of this process, health facilities as we understand them had been established in particular by the turn of the century.

The buildings were mainly hybrids between European standards and traditional designs and in this way captured advantages of both systems. In the years after independence, the inherited health structures were taken over without major changes and in the first instance new hospitals were established accordingly by governments and (religious) charity organisations. Between and after the world wars new demanding designs of great sophistication were introduced. Multistorey buildings with huge capacities and complicated technology were transplanted into desert, bush and jungle. Local construction techniques and ways of utilising material appropriate for the climate were abandoned and replaced by unsuitable and unsightly concrete boxes. Even development agencies of industrialised countries initially took part in this, until they realised that such facilities were doomed under the extreme conditions in most developing countries.

3. Construction and Equipment

3.1 Tasks of a Hospital in Developing Countries

In order to illustrate typical features of appropriate design and appliances, the most common hospital type, ie a 100-bed district hospital, will serve us as example. The major tasks of this type of referral facility include:-

- gynaecology, obstetrics;
- primary surgery;

LA PLANIFICATION ET LA CONSTRUCTION DES HOPITAUX DANS LES PAYS EN VOIE DE DEVELOPPEMENT

La conférence d'Alma Ata en 1978 a reconnue l'approche des Soins de Santé Primaires (SSP) comme la voie pour arriver à la santé pour tous. Bien que les services curatives et de réhabilitation ont été explicitement inclus dans ce concept, les hôpitaux et services de santé semblables ont été négligés dans beaucoup de pays qui ont introduits les SSP. Ce n'est que dans les années passées que le rôle important des hôpitaux a été redécouvert, particulierement dans sa fonction de support pour les SSP.

En accord avec les modèles préconisés par l'OMS on comprend comme les niveaux de service a prendre en charge de service de santé de base jusqu'au échelon, ainsi que le troisième échelon (de référence):-

Echelons de référence superieurs
Troisième échelon de référence (niveau national)
Deuxieme échelon de référence (niveau provincial)
Premier échelon de référence (niveau de district)
Service de santé de base
Activité de santé communautaire
Famille et ménage

Le Département Santé, Nutrition et Développement Démographique de la GTZ, l'office allemand de cooperation technique avec les pays en voie de développement, partage l'opinion de nombreux experts que des hôpitaux de plus de 300 lits ne peuvent être gérés de facon economique dans la plupart des pays en voie de développement. C'est en fonction de cela et de l'urgence apparente de satisfaire aux besoins des régions rurales, que ce texte ne vise que les services de santé en dessous du niveau national.

- emergency cases;
- equipment related diagnosis including laboratory and basic x-ray services;
- equipment related therapy;
- distribution of drugs;
- health education;
- staff training;
- maintenance of subordinate facilities;
- transport of patients and material; and
- administration and supervision of district, communication.

3.2 General Construction Features and Hospital Plants

Provided certain specific requirements and conditions are considered, the principles of hospital design in industrialised countries can also be applied in developing countries. Conditions in the majority of third world countries are characterised by extreme elimatic and topographic conditions. High temperatures and/or high humidity lead to rapid deterioration and unsuitable environmental conditions for patients and staff, unless buildings and equipment are designed accordingly. Factors to be considered are:-

- building orientation (eg east-west alignment to avoid excess of solar heat radiation);
- building shape (eg single storey buildings to avoid lifts).
- solar radiation (eg wall shading by generous roof overhang);
- ventilation (eg forced cross-ventilation);
- terrain features (eg trees for shading); and
- pests (eg protection of electrical wiring against rodents).

Remoteness accounts for difficulties in building maintenance, in energy supply, logistics etc. Utilisation of imported or scarce building material contribute heavily to maintenance and improvement problems. Also cultural and social factors determine the requirements of health facilities, for example the necessity to separate sanitary facilities according to sex or certain hygienic habits (not many people in developing countries use toilet paper!).

Some special requirements and features of hospital departments and units are described below.

Outpatient

As a rule, hospitals in developing countries have to care for a great number of outpatients. An average district hospital covers approximately 3,000m^2 of floor space. For the outpatient department between 15 and 25% of this space is required, of which the waiting, registering and circulation area should be 0.5m^2 per patient. The waiting area should be suited for health education activities. Only in smaller hospitals the emergency section may be part of the outpatient department.

Surgery

The size of theatres and its support units varies widely and depends on the specific conditions of a country. A typical size of a surgery ward for an African 100-bed hospital for example would be in the region of 300 to 500m^2. Space requirements for plaster room and theatre staff are mostly not considered. Separation of sterile and non-sterile areas is mostly not observed to the required extent. This is due to organisational and design deficiencies.

The theatre itself should be completely tiled except for the ceiling. Though sterility may not be maintained completely, a floor gully should be installed for easier cleaning. Air conditioning in hot and humid climates is mandatory. In arid areas dust poses special design problems.

Obstetrics and Gynaecology

In general, hospitals in developing countries have difficulties coping with a great number of deliveries. Efforts of health authorities to divert normal pregnancies to peripheral health facilities have not yet succeeded in facilitating this condition. This circumstance, and the tradition that pregnant women (and patients in general) are accompanied by several family members have to be accounted for when space requirements are estimated.

Laboratory

For most hospitals a laboratory space of 0.5m^2 per bed should be sufficient. Tiling up to 180cm and floor gullies are recommended. For microbiological labs various sterilising and incubating equipment may require additional ventilation of the room.

Pharmacy

For a typical district hospital which has also to back up peripheral health facilities too, 100 to 150m^2 are considered to be sufficient. In case long term storage of drugs and particularly vaccines is required, a separate cold room is recommended.

Radiology

50m^2 of space for the radiology department is considered adequate for district hospitals using the WHO-standard x-ray (Basic Radiological System, BRS). In order to meet basic safety requirements for radiation protection, solid brick or concrete walls must be provided. Wooden wall constructions and doors have to be lined with a minimum of 0.5mm lead sheeting. Separate and solid operator cabins are essential. Separate rooms for developing x-ray films are required and must be very well ventilated.

Orthopaedics and Physiotherapy

The role of workshops for production and fitting of orthopaedic appliances is often underrated. Basic rehabilitation facilities belong generally to rural hospitals as well. Most patients in this area are treated as out-patients. Again, sufficient space for these and accompanying relatives should be provided.

Wards

Wards should not have more than eight beds per room. Few smaller, separate rooms can serve as infection units. Since many patients are attended to by at least one relative even over night, appropriate space must be provided, eg extra beds which can be stored under the patient beds during day time. For easier cleaning, walls should be treated with oil or plastic paint. At least two hand basins should be installed. Forced cross ventilation provides, in most cases, sufficient ventilation. In many areas, due to religious or habitual reasons, sanitary facilities cannot be tolerated in close proximity to the ward itself or on a floor above. The single-storey pavilion type of arranging wards and hospital departments easily allows an acceptable partition of sanitary units.

It must not be forgotten that under conditions of most developing countries, a psychiatric ward is necessary too.

Mortuary, Air Conditioning and Cooling

This area is one of the technically most critical areas in third world hospitals. Poor design and management frequently leads to overload and in consequence to frequent break downs. Though split units are basically more economical to operate and more comfortable to use (noise!) single units should be preferred, since the eventual failure of one of these units does not paralyse the air conditioning of the hospital as a whole. In addition, maintenance and exchange of these units are easier and can be managed by local resources.

Cold rooms are very often established after the completion of a hospital under technically unsatisfactory conditions. Heat insulation is insufficient, problems with dampness due to condensation.

Refrigerators constitute a particular weak spot. Whether used in laboratories, blood banks, pharmacies etc or for kitchen purposes, various problems occur again and again. Two types are in use: Electrically operated compressor units

and absorption units which are operated with kerosene or liquid gas. The compressor type is more reliable, provided the power supply is stable enough (< +/− 15%). Absorption units, on the other hand, can be operated under difficult energy conditions, but are rather sensitive to inadequate handling of the burner. Both refrigerator types need thorough ventilation and should therefore, but also to avoid premature corrosion, be placed on pallets.

Energy Supply

In many cases there is no external power supply or this is unreliable (unstable, power cuts, high frequency contamination). Sensitive equipment therefore need protective and stabilising devices. In-house power sources are mostly limited to (diesel) generators. Most problems with these stem from inadequate maintenance, overload and often from too sophisticated control circuits (automatic triggering etc!). Renewable energy sources are usually too expensive to buy and difficult to operate at medium- to large-scale. Small-scale applications such as solar thermic water heating, small photovoltaic units to run single equipment etc seem to be more feasible.

Water, Sanitation

External water supply is scarce and unreliable, too. Supply from the hospitals' own wells, cisterns etc tend to be insufficient or of poor quality (mineral contents, corrosive, bacteriologically unfit for consumption). Water towers should be preferred to booster pump systems. Water treatment is mostly neglected, even when a plant exists.

Fittings and sanitary installations should be available in the country to allow for easy replacement and repair. Special armatures for clinical use should be avoided. PVC tubing should not be used underground, since certain rodents take great interest in these. Waste water disposal, for ecological reasons, deserves much more attention than it is usually the case.

Sanitary installations are very problematic. A thorough analysis of local habits and designs is strongly recommended during the planning phase of a hospital.

Medical Gases

Except for countries which provide a well established technical infra-structure, central medical gas supply should not be considered. Decentralised supply with gas cylinders is much easier to maintain. Oxygen may be provided for many applications by using oxygen concentrators.

Waste Disposal

Too often the problem of disposal of hospital waste, specifically infectious waste, is neglected or not adapted to local conditions. Hospitals in third world countries do not usually possess any means to dispose of waste other than to bury or to burn refuse on the hospital grounds. Incinerators are rare and where they exist, they mostly turn out to be too complicated or expensive to run, or to be a source of heavy pollution.

Sterilisation

This area is one of the most critical in hospitals in developing countries. The failure of autoclaves, in particular if only a single central one is available, cripples hospitals frequently. Simple and sturdy design and provision of several (smaller) units in one hospital are recommended. In many cases sterilisers operated with a power source other than electricity may be preferable.

Kitchen

Many examples of hospitals which use traditional kitchen equipment such as charcoal stoves instead of the 'comfortable and efficient' machinery provided, prove that modern catering technology is prone to become unusable after a short time. It should be remembered that employing labour can be much more economic and efficient in developing countries than using fancy equipment, as for example automatic potato peelers. In some countries, kitchens are not needed, because patients are fed by relatives.

Laundry

Like kitchens, laundries are a permanent source of trouble for basically the same reasons. It is observed that old (>20 years), semi-automatic equipment does often still serve its purpose, whereas modern progammable washing robots cease to operate within a short period.

Staff Quarters

Staff quarters, though essential in most developing countries, are often not considered in the planning process, especially when foreign donors 'import' their own concepts.

Maintenance Workshop

Though mostly ignored, maintenance services are supported to play a central role within the technical management of health facilities. For the standard district hospital a minimum space of 100m^2 must be allocated, excluding an adequate open space for welding and spraying. The workshop should at least have separate working rooms for medical equipment (precision mechanics, electronics etc), hospital plants (plumbing, electrical installations etc) and carpentry. Adequate stores for tools and material and for the equipment to be serviced must be provided too. A small office should be available for the inevitable paperwork. The workshop should be equipped for two technicians and four artisans (standard staff requirement for a 100-bed hospital in developing countries).

4. Medical Equipment

This issue is too broad to give specific recommendations in this paper. The equipment situation in most developing countries is disastrous. Inoperable devices clog valuable hospital and storage space, replacement provided by donors soon give in to the unfavourable conditions. Three principal reasons are responsible:-

- operators of medical equipment are insufficiently qualified;
- after-sales-service, maintenance and repair are barely existent, equipment management not well understood; and
- equipment is insufficiently adapted to levels of care and is of inadequate quality.

Training of operators (medical doctors, nurses etc) mostly does not include technical subjects such as first line maintenance, handling and safety precautions. Equipment management is thought to be something mysterious, exclusively handled by technicians with the help of a few tools. Donors pump a tremendous variety of hospital equipment into third world countries, without much consideration for their suitability. However, it should be noted that the introduction of 'appropriate equipment' will remain a fiction even in the long run. Apart from a few exceptions, industry is not interested in investing in the development of special technology for a comparatively small market. Only standardisation and a coherent political will of the receiving governments will eventually contribute to an acceptable solution.

Selection of equipment for a specific hospital should at least be based on the following aspects:-

- country-specific data with special regard to vital statistics, epidemiological information such as prevalances and incident rates of the most important diseases, special risks of certain diseases to patients and community etc;
- staff situation, job descriptions, workload, competence, possibilities for further training etc;
- health policy related information such as catchment

areas, size of population serviced, level of health care, standards etc.
- economic situation, size of budget, budgetary control, characteristics of local currency in view of imports;
- local equipment market, maintenance provided by private sector, availability of spare parts;
- equipment management related information, role of administration maintenance and repair capacity of the institution etc; and
- data on the technical environment such as characteristics of power and water supply, availability of steam, climatic data etc.

Finally I would like to warn of overrating the impact of a 'good technology and architecture' on the quality of health services: technical solutions cannot compensate for lack of motivation and competence and for ineffective management. In other words, if health policies, administrative action and personnel resources are not tuned towards improving a health care *system*, the best and most appropriate piece of equipment will not serve its purpose.

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