

Managing Equipment for Emergency Obstetric Care in Rural Hospitals

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Abstract

In resource poor countries substantial sums of money, from governments and international donors, are used to purchase equipment for health facilities. WHO estimates that 50-80% of such equipment remains non-functional. This article is based on the experiences from various projects in developing countries in Asia and Africa. The key issues in the purchase, distribution, installation, management and maintenance of equipment for emergency obstetric care (EmOC) services are identified and discussed. Some positive examples are described to show how common equipment management problems are solved.

Key words: Equipment, Management, EmOC, Rural Hospitals

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1. Background

There is little published literature on equipment management in service sector - less so about management of hospital equipment. [1-5]. WHO has prepared some reports on equipment maintenance in the late 1980s [6-10] and a few papers have been published mainly in non-medical journals [11-16]. WHO report states that in most countries there is lack of adequate repair and maintenance facilities, infrastructure, professionally trained staff and logistics support resulting in wastage of limited resources and/or in their ineffective use [6]. Properly working essential equipment is equally important as the readiness of staff, physical facility and supplies in providing timely emergency obstetric care services (EmOC) [17].

Although many international projects provide equipment to improve the functioning of primary health centers and hospitals, not much attention is directed to the management of the equipment. A World Bank study showed that in a state in India, only 2-5% of district/town hospital budget was earmarked for “machinery and equipment”. While maintenance budget was next to nothing - a mere 0.02-0.06% of the hospitals annual budget. Rural secondary hospitals (at sub-district level) had no maintenance budget at all [18].

In this paper we present observations based on many field visits undertaken for the Averting Maternal Death and Disability (AMDD) programme of Columbia University supported projects and other consultancy assignments, research work as well as work with government health programs. The observations are based on work in two countries of Africa, three countries of South Asia and two countries of South-East Asia and one country of Central Asia. The experience is mainly from district and sub-district level hospitals run by governments and NGOs. The names of the countries, provinces and agencies are not disclosed as the paper tries to bring together common observations and lessons from various countries and does not discuss specific country case studies.

We first present common observations and then go into specific issues of equipment management. Even though this paper focuses on management of EmOC equipment, most countries have similar situation for all the equipment. The difference is that if equipment of EmOC is not working or not available then women cannot be provided this life saving service and may face the risk of immediate death. While in other non-emergency situation the risk and consequences of non-availability of services is not so great or immediate.

It was observed in almost all countries visited that there are no well worked out systems in place for management of equipment in rural hospitals. In many cases, the director and secretaries of health services, hospital directors, heads of the obstetric department and donor agency officers are involved in purchase or approval of donated equipment. Doctors and health managers, having no training in managing hospital equipment, are usually responsible for the equipment. And, they have little support from trained bio-medical engineers (or other technical experts) to

ensure continuous functioning equipment. Often this leads to disruptions of EmOC services and wastage of resources.

There is no good estimate of how much resources are wasted in non-functional equipment globally, but WHO estimated that in most developing countries will seldom have 50% of its equipment in usable condition, in some countries 80% of equipment will be inoperable [9]. In India, a national facility survey estimated that only 49% of rural sub-district hospital, 69% of FRUs had adequate equipments [19]. If even this equipment is not maintained/repared then the accessibility of EmOC services will be severely affected.

Equipment management is an integral part of the Health Technology Cycle. WHO has provided general guidance on equipment management in the past [6]. Equipment management includes selection and purchase, distribution and installation, use, repair, maintenance and disposal.

WHO has identified the usual factors contributing to wastage of resources due to lack of proper equipment management. WHO's estimate of wastage of resources due to each factor is given in the table below [6].

Table 1: Estimate of wastage of equipment resources due to various contributing factors

Contributing Factors	Estimate of wastage of resources
Purchase of sophisticated equipment which is under utilized or never used due to lack of operating staff, maintenance staff and medical expertise	20%-40% of equipment
Reduction in the useful lifetime of equipment due to inexperienced operators and lack of repair and maintenance.	30-80% reduction in useful life of equipment.
Additional purchase of accessories, extras, specialized spare parts etc due to improper, unplanned procurement systems.	10%-30% of value of equipment
Lack of standardization leading to increased spare parts costs and extra work load on limited maintenance staff	30-50% extra spare part cost
Excessive down time due to lack of spare parts, repair and absence of preventive maintenance	25-35% of equipment

This paper brings out the key issues in all these aspects from our field experience. The purpose of this paper is to discuss common problems observed in management of EmOC equipment and suggest simple methods of improving equipment management.

2. Selections and Procurement of Equipment

Equipment is long lasting and hence the selection of equipment and the purchase decisions have long-term implications affecting the capacity to deliver services and the cost of running the services. Some key observations and issues are discussed in the following sections.

2.1. Usefulness of the equipment

Sometimes equipment is purchased which is not of any proven value. For example in an Asian country, expensive imported hand washing machines were purchased instead of installing simple washbasins for the scrub area outside the Operating Theatre. We have also seen

instances where non-vital equipments are purchased for EmOC. For example purchase of ultrasound machines under a project focusing on EmOC. Ultra-sound is a useful tool but not vital for EmOC services. This type of problem is not very frequent for EmOC equipments but seen for other general equipments also.

2.2. Suitability of the equipment

Often, progress is equated by doctors and managers to the acquisition of the most sophisticated and the latest models of equipment, regardless of whether or not they are essential or could be maintained in the locations. Our observations showed that in several countries the selection and procurement of equipment were done at the national level, by the government or the donor agencies. Frequently equipment is selected and purchased without consideration to the location - needs and resources of the facility, where it will be installed and used. For example, some remote hospitals in Africa and Asia acquired very sophisticated anesthesia machines even though there were no systems in place for maintenance or repairs for such equipment. Even if an equipment is found suitable the level of technology acquired might not be appropriate at the level of service delivery due to lack of maintenance support. We also observed that sophisticated machines are two to four times more expensive than similar simple equipment. This type of problem is not uncommon. We have seen this in more than one project.

2.2. Staff and Training to operate the equipment

Sometimes very useful equipment is acquired but not used because there is no staff, who can use it or staff does not have the skills needed. The equipment should match with the skills of the staff. And, it may be necessary for the staff to receive training on the use and care of the new equipment before its arrival at the facility. An example of this occurred in one Asian country when very good quality imported vacuum extractors were acquired through an international program. Unfortunately, vacuum extraction no longer was taught in the medical colleges in that country and vacuum extraction was not practiced in the district hospitals regularly. In the same country high quality surgical equipment for Cesarean Section were given to many hospitals where there were no doctors trained to do this operation. We observed in three countries that neonatal resuscitation equipment remained unused due to lack of staff and training. In more than one country we have seen the situation that at some locations there are skilled staff but no or little equipment. Thus this problem of mismatch of equipment and skills is quite common. Hence the equipment remains unused, wasting the resources invested.

2.4. Standardization of equipment

We have seen that in some under developed countries in Africa and Asia, equipment comes as donations from various countries. It is common tendency that donor countries want to donate equipment made in their respective country. As a result, due to lack of standardization and norms, many different models of similar equipment from different suppliers arrive in a facility or in a district. This makes the operation and maintenance difficult, as each piece of equipment has different operating instructions and needs different spare parts. The classical example we have seen is of steam sterilizers (autoclaves) from at least four different companies of different countries in one hospital and most of them were unrepairable because of lack of spare parts. Other common examples seen are TO tables and OT lamps from various providers - many are unusable due to lack of spare bulbs. This is a common problem seen in most development

assistance. Equipment procured through tied grants in some instances might be entirely inappropriate. For example Hancock reports on supply of US refrigerators with 110 volt rather than the required 220 volt in African countries. [20] We have also seen donated anesthesia machines not working properly as they can take only one type of oxygen cylinders, which are not available in that African country.

It is recommended to purchase uniform equipment for all the facilities so that maintenance becomes easier. If there is donated sophisticated equipment, they then should be placed in large hospitals in cities, where maintenance is possible. And, the simpler rugged equipment installed in the remote and peripheral hospitals, where maintenance support is weak.

2.5. Inexpensive and poor quality equipment

Sometimes governments tend to buy the least expensive equipment in order to save money. This leads to the purchase of very poor quality equipment, which is unreliable and easily breaks. In one Asian country, stethoscopes of poor quality were purchased at a cost of only 40 US cents a-piece probably to save money. We have also seen labor tables with tops of regular steel instead of stainless steel. The stainless steel tables may cost more but they last longer and are easy to clean than the less expensive regular steel tables. The regular steel tables rust quickly and as a result harbor dirt, making cleaning very difficult. In the long run, inexpensive equipment can become costly, as they need to be replaced more often than that of better quality one. We have also seen in an Asian country surgical instrument of poor quality being purchased because they are cheap. They make surgery difficult and dangerous.

Lifetime purchase cost plus running and maintaining costs of the equipment should be estimated while deciding about equipment. It is better to spend somewhat more initially on the purchase of equipment, which is of higher quality (not necessarily more sophisticated), more durable and require minimal maintenance rather than purchasing the cheapest available equipment, which may need much more maintenance.

2.6. Centralized procurement

Centralized purchases have some advantages such as lower costs, uniformity, ease of procurement etc. However, centralized purchases can delay procurement by several months to years. Also, the supply of uniform sets of equipment from a central level can lead to duplication and wastage, as some of the equipment may already be present at the facilities. We have seen procurement being delayed by years in a large externally aided project in an Asian country. We have also seen delay in procurement due to donor agencies centralized procurement system. Many times maintenance agreements are not developed at the time of purchase and often present a problem later when the equipment needs servicing. We have seen this happen in more than one country in Africa and Asia. For example, we have seen that repair under warranty is not done because suppliers from national capital are unwilling or unable to provide that service in rural areas. Another drawback of central procurement is that the hospitals' staff or local managers do not feel the ownership of the equipment and hence sometimes are not interested to open, install and use the equipment. On the other hand, if the facility identified the need for a particular piece of equipment and purchased it locally, the equipment would be put to use immediately. In more than one country in Africa and Asia we have seen that centrally

purchased and distributed equipment kept lying in the stores of the hospitals for several months to years before it is installed or used. Some times it is never used at all.

2.7. Timing of equipment arrival and other inputs

Procurement planning should take into account lead-time required in the purchase process. It is important that when the equipment arrives at the facility, the other inputs such as training, infrastructure renovation (site preparation) etc. is completed. Equipment arriving much earlier or later than the other inputs can lead to non-provision of services and consequently wastage of resources. This problem we have seen in several countries and across projects. In one country in Asia equipment arrived more than 18 months after training. In other large project training never happened for certain category of staff who were to use the equipment. In one country in Africa equipment arrived more than one year after training.

It is recommended that project management techniques like PERT/CPM should be used by district and hospital managers to coordinate various inputs and processes. [21].

3. Distribution and installation of the equipment

After being procured the equipment has to be distributed, installed at several locations and proper documentation done. Based on our observations several important issues regarding the distribution and installation of equipment are discussed in the following sections.

3.1. Appropriate distribution of equipments

We observed that in some countries, the equipment is not well distributed in the districts. Some facilities have more equipment than others. Sometimes the type and amount of equipment does not correspond with the workload or staff or skills of staff in the facility. For example, in one Asian country, the sub-district hospitals with low numbers of deliveries per year received equipment for EmOC and neonatal care while the district hospitals with far more deliveries and complications were not given such equipment. In another project in the same country we observed that again equipment was distributed without taking into consideration the workload or the skills available among the staff. This was also observed in one country in Africa. In this country we saw many equipments in a hospital, which had almost no staff and in a not-so-far hospital there was staff but lack of equipment. Sometimes location of equipment is decided by politicians, bureaucrats or donors rather than technical managers who know the need or utility.

It is therefore recommended that for each district there should be mapping of the key equipment along with workload and staffing of the facilities in that district. This will help the district level managers identifying gaps and mis-matches, which lead to poor utilization of the facilities. District level managers should have freedom to transfer equipment to match the needs i.e. staff skills.

3.2. Proper installation of equipment

In many developing countries the electrical current has lot of fluctuations in voltage, which can easily damage the equipment. We observed in several hospitals in Africa and Asia that sensitive electrical equipments are not connected through voltage stabilizers to protect against voltage fluctuations. We have also observed that expensive equipment is damaged due to high voltage

in supply lines. Also, we have seen equipments installed in sub-optimal locations – e.g. neo-natal incubators in the labor room. Such installations cause obstruction to staff flow in those areas. Careful planning of facility space can reduce these situations. Proper earthing or grounding of sensitive electrical equipment is vital but neglected many a times, which can damage the equipment.

Experienced and qualified personnel should install all sensitive electrical instruments with proper protective devices such as voltage stabilizers depending upon local electric supply conditions. The location of equipment should be carefully decided depending on workflow and space available.

We have seen in many countries that there is substantial time lag between distribution of equipment and its installation. Sometimes equipment is never installed at all and kept lying in the stores. For instance, in one large externally aided project in Asian country much of the equipment remained in the store, uninstalled for years. Similarly in an African country we observed lot of uninstalled equipment in stores. Thus it is a common problem.

It is recommended that a system of installing the equipment immediately after its delivery should be developed. The regional and national managers as well as the hospital directors should keep a record of equipment delivered but not installed and follow up closely the reasons for the same. A visual display of such data in the regional manager's office would prompt faster action. We have not seen in any country such monitoring being done.

3.3. Good documentations

It is observed that generally, after the installation the user manuals of the equipment and information on maintenance warranties are not kept in an easily accessible but secure place. The availability and content of such manuals is not widely known to the staff and managers in the facility. Hence when the equipment needs servicing, the company responsible for the warranty and maintenance is not immediately contacted. In some instances, we have seen that even though equipment is under warranty due to lack of proper documentation the equipment is not repaired. The accompanying manuals are usually in English or French and the lower level staff, who, use the equipment may not be able to read them.

Developed countries have good documentation of the equipment. For example United Kingdom NHS has its own booklets on equipment management for providing guidelines to all the maintenance staff - eg Health Equipment Information (HEI) booklet titled “A code of practice for acceptance testing of Medical Electronic Equipment” and “ Management of Equipment” [7]. But we have not observed such practices in any developing country we visited.

Another important aspect of equipment management is keeping good records and inventories of equipment. In some facilities in Africa it was difficult to find a register or a permanent record of the equipment in each department and storage area. Sometimes there were records but were not readily accessible. Hardly any of the facilities visited had a system of periodic analysis of the equipment records and prompt action to repair or replace them.

It is recommended that each department keep a file of the user manuals of the equipment along with the copies of the service contracts and warranties. The key information of the service contract or warranty such as name, address, telephone numbers of the responsible company and date of validity of the contract should be written on a small card and pasted on the equipment at a prominent place so that everybody using the equipment knows about the maintenance arrangement.

Each department should keep a record of all the equipments in their department and this should periodically be verified and countersigned by the supervisor. In addition, the functional status of each piece of equipment should be indicated in equipment registers. The key points (Dos and Don'ts) of the user manual should be translated in the local language and pasted on the wall near the equipment so that the staff using the equipment can follow these instructions easily.

4. Use of equipment

Equipment, if used carefully and properly cared for, can last a long time. Proper care also includes cleaning and appropriate storage when not in use. Recently Skeet and Fear have written a book on care and safe use of hospital equipment, [22] which gives general principles for improving equipment use. But our observations show that there are many poor practices in equipment use that reduce their life and utility.

4.1. Proper care

In many instances, damage to equipment and medical furniture is due to rough and careless handling, improper cleaning, exposure to heat and dust etc. In some Asian facilities, the labour tables were rusted because they were not dried after washing in between deliveries. Instead, the moist surface of the labour table was covered with a piece of mackintosh, which trapped the moisture and increased the rate of rusting.

In many cases, equipment deteriorates because of improper use and lack of care. We have seen in several facilities rubber parts rendered unusable because of exposure to heat, rusting of legs of beds and other furniture due to careless wet mopping of the wards, cracking of ceramic wash basins because of heavy instruments being tossed into them, etc. Rural areas of many countries are very dusty. Dust can also damage sensitive equipment such as lab equipment, anesthesia machines etc.

It is recommended that each piece of equipment have instructions for its proper usage, cleaning and storage. Such instructions should be written in local language and pasted on the wall, so that the staff using and cleaning in the equipment know them and can follow proper procedures.

4.1.2 Regular calibration

Anesthesia machines, weighing machines, BP instruments and laboratory instruments need regular calibration. None of the hospitals we have seen in rural areas has a system of periodic calibration of the equipment. Hence the reliability of measurements taken by such equipment or test done by them could be suspect. We have seen oxygen flow meter on anesthesia machine showing obviously improper reading, which could be dangerous.

It is suggested to develop a system of regular calibration of measuring instruments. There should be fixed schedule of calibration of critical equipment such as gas flow meters, laboratory equipments, BP instruments etc. If skills or instruments of calibrations are not locally available, a district or state/province level team should come and do the calibrations periodically.

5. Repair and Maintenance of equipment and Disposal

Working equipment is vital for EmOC. For equipment to last and provide uninterrupted service, a proper system for repair and maintenance is vital. Unfortunately repair and maintenance (R&M) is one of the most neglected areas of hospital management in the developing world. Lack of R&M is very common and old problem in all public services. World Development Report 1994, observed, "inadequate maintenance has been an almost universal (and costly) failures of infrastructure providers for developing countries" [23]. WHO has published a book on maintenance and repair of lab and diagnostic equipment [24]. But unfortunately this problem is still not adequately addressed.

5.1. Planning for maintenance of equipment

Majority of the hospitals visited had no system of regular inspection, preventive maintenance or systematic repair of the equipment. In most places there are adhoc ways by which the hospital directors and other managers can get equipment repaired. But generally there is no regular system or budget for such maintenance. Sometimes very high-level permissions are required for sanctioning even small repair, which require only moderate expense about \$100-500. Many hospital directors we have talked to in Africa and Asia reported that they do not have any system of maintaining hospital equipment and also do not have adequate budget. For example in one hospital the ambulance was out of order for many months as it needed repair of about \$ 850 which had to be sanctioned from state capital. During these months of waiting the drivers were being paid \$200-300 of salary per month without any work.

The exception to these observations of lack of system for repair and maintenance is the system for maintenance for Cold Chain system for vaccines. Maintenance of Cold Chain is reasonably well planned and implemented with regular separate staff, clear guidelines and protocols. It also has uninterrupted supply of spare parts and there is close monitoring of this which includes donor agencies such as UNICEF. There is political will and priority for immunization. But sadly such things haven't been adopted for delivery of EmOC services and for maintenance of all equipments by the health system as a whole.

It is recommended that each level of facility should have proper maintenance plan with an adequate budget for the repair and maintenance of equipment. This budget should be decentralized and the rules should be simplified for its use.

5.2. New purchases versus repair of existing equipment

It is observed that many donor assisted-programs assume that various pieces of equipment are not available at the facilities and proceed to help in purchasing new equipment. Our observations show that in many instances this is not the case. Unfortunately donors and national government rarely invest time and resources in repairing the existing equipment or setting up systems for maintenance and repair. Improving maintenance systems does not have the same

visibility for politicians and donors as the purchase of new equipment. Even the hospital managers and doctors, many a times want new equipment rather than repairing existing one. This wastes lot of resources.

We have observed that in some of the countries there are small repair and maintenance units within the ministry of health. But they are only at a very high level (national or state), they are generally understaffed, under-funded, under-skilled, under-motivated and unmonitored. It was reported in one African country that due to an economic down turn such unit was disbanded. In an Asian country a state government had a large donor assisted equipment supply project. During the project period the suppliers had contracts to maintain the equipment, but after the project was over the government has not renewed the maintenance contracts for several months jeopardizing the functioning of the equipment.

It is recommended that all donors must insist on repairing the existing equipment before supporting purchase of new equipment. This would be much more cost effective strategy. Donors and governments should help set up repair and maintenance systems for the hospitals.

5.3. Spare parts

Other major problem is the lack of availability of spare parts for some of the imported equipment. For example we have observed in some countries that, many expensive OT lamps required specific bulbs, which were not easily available locally and there was no system to import them hence the expensive OT lamps were unusable. Hydraulically operated OT tables were not working due to non-availability of small parts for the hydraulic mechanisms. Electrical equipment such as cattery machines is usually non-functional also due to lack of spare parts. As a result, much of the past investments in equipment are unusable.

It is recommended that the rural facilities as well as the district hospitals should have adequate quantities of commonly used spare parts such as bulbs for OT lamps, heating elements for sterilizers, etc. Simple inventory management techniques should be used to ensure that critical spare parts are always in stock. In addition, the districts could keep some spare equipment so that when facility equipment is being serviced, similar equipment could be temporarily borrowed so that the EmOC services would not be disrupted.

5.4. Skilled technicians

We have observed in most of the countries visited that trained and well skilled bio-medical equipment repair technicians are not available. The repair of bio-medical equipment has not developed as a profession since there are no training programs available and there are no posts for such persons in hospitals.

It is recommended that a special unit for the repair and maintenance of medical equipment be established at the district or regional level. Furthermore, a facility would greatly benefit by establishing posts for technicians with support staff to specifically be responsible for the repair and maintenance of all the equipment. Some of the WHO documents have given optimal organization of such maintenance department [6].

5.5. Preventive maintenance

Due to lack of preventive maintenance such as routine cleaning, oiling and painting, many furniture items such as patients' beds, labour tables and examination tables are rusted or non-functional. Lack of policy, funds, priority and systems for R & M are the key reasons for such neglect of this important management function. World Bank observed, "Curbing capital spending is justified during periods of budgetary austerity, but reducing maintenance spending is false economy. Such cuts have to be compensated for later by much larger expenditures on rehabilitation or replacement." [23]

It is recommended that each hospital develop a schedule for the inspection and preventive maintenance of all the major equipment. The persons operating the equipment should be trained for simple maintenance such as cleaning, caring, oiling. Hospital furniture should be regularly repaired and painted so that it lasts longer. A good approach is to keep one fixed week, once in every year, when workload is relatively low, for carrying out such a drive for thorough cleaning, repair and disposal of old non-working equipment. In armed forces in many countries there are fixed inspection days every year before which each piece of equipment is cleaned, repaired and maintained. Such system should be started in health services.

5.6. Disposal of equipment

A common problem we have observed in hospitals in Asia and Africa is not disposing old and non-functioning equipment, broken furniture and even empty cartons and broken glass items. We have seen that these items are many times stored in some of the vital areas of the hospital such as operation theaters, labour rooms and wards. In government hospitals disposal of such items usually involves long and complicated procedures. And disposal is within no one's priority list, hence never gets done. The procedure for condemnation and disposal of the equipment should be simplified and each supervisor should know the procedure so that they can follow it expeditiously. The higher-level supervisors should make it a routine agenda during their review visits to check on removal and disposal of such old and unusable equipment.

We have observed in Asia and Africa that even broken glass items such as syringes and fluorescent tubes are stored for many months due to such stringent audit for disposal. Even the local supervisors (district and regional medical officers) generally do not expedite the removal of these non-functional items. What is surprising is the simple step of removing such equipment from vital and functional areas of the hospital, such as from the OT and labor rooms to a storage room or a garage, also is not commonly done. This is clearly due to poor management and perhaps due to non-realization of the threat such equipment poses to the health of the patients. As suggested above once a year there should be a special designated week for repair and disposal of non-useable items. Higher-level managers should monitor facilities for its disposal of old equipment. Disposal of hospital equipment should be done scientifically so that it does not cause any environmental damage.

6. Innovations and Positive Examples

There are several small innovations and good practices, which have been observed in the field, which could be quite instructive to hospital managers. Here we describe a few of them.

- 6.1. In Bugando Hospital, large hospital managed by church related organizations in Tanzania, there is small (3 staff) but active department of biomedical equipment maintenance. They repair most of the hospital equipment. In the same country there is R&M system run by NGO (church related) hospital maintenance association. Hospitals can become member of this association by paying a fee and then get R & M services for equipment. Similarly a Christian Hospital Association in Pakistan with 64 hospitals had electro-mechanical engineer on staff who visits various hospitals and provide maintenance services. Another hospital in Ethiopia, run with Italian help has an excellent equipment maintenance department managed by expatriate officer.
- 6.2 In a Netherlands government assisted large project of supply of hospital equipment to government hospitals in Gujarat state of India, there are efforts being made to improve capacity of the state government for equipment repair and maintenance. For the first five years of the project repair and maintenance was covered under a contract, a private bio-medical equipment manufacturing company. Under this project more than 260 types of equipments are monitored and maintained regularly in 65 facilities throughout the state.
- 6.3 In some of the hospitals we have seen there were a few staff who were taking interest in repairing and maintaining some of the simple equipment. We have seen some innovations done by staff to solve common problems of equipment. One very innovative example was in a hospital in Rajasthan state of India where an OT attendant (lowest level staff) replaced the holder of the OT lamp so that it can take regular household bulb of 200 watts. This eliminated the need for special bulbs, which were not available easily. In another hospital supported by AMDD and UNICEF project the staff suggested and fitted much larger and stronger wheels to the patient trolley. This solved the problem of repeated breakage of the original small wheels of the trolley due to the rough surface of the corridors connecting the scattered wards in this rural hospital. These two examples show how local simple modification can solve maintenance problems. These innovations show that even under most difficult circumstances equipment management can be improved with small expenditure.
- 6.4 In the state of Rajasthan in India, to overcome the long and bureaucratic procedure for getting furniture repaired, the AMDD and UNFPA supported project provided the idea and small amount of funds with which the chief medical officer put together a team of carpenter, welder and painter. This team was sent in a vehicle to far off rural hospital to repair all the furniture and simple medical equipment because such repair skills were not locally available. Within two months these teams covered most of the hospitals in the district, where they repaired and repainted much of the hospital equipments [25]. This repair and maintenance team costed a very small amount about \$ 1500 for about 7-10 sub-district hospitals. For more sophisticated equipment such as hydraulic OR tables, the Chief Medical Officer of the district contracted the staff of local mining companies which use hydraulic equipment, who repaired the OR tables at a very low cost.
- 6.5 AMDD program supported Women's Right to Life and Health project of UNICEF Bangladesh helped the country government to change the procedures of procurement so that good quality equipments are procured for large number of district and sub-district

hospitals; and the suppliers are required to distribute the equipment, install it and provide maintenance and after sales services for specified period of time as part of the single procurement contract. Thus avoiding many of the problems discussed earlier [26]. In Bangladesh, UNFPA and government had also made contracts with suppliers to maintain equipment provided to Maternal and Child Welfare Centers (MCWC). And such contracts are renewed periodically to ensure that equipment is well maintained.

- 6.6 In some government health centers in Tanzania, very systematic records of equipment were kept in each ward. To make the system of equipment record very transparent a copy of the list of equipment available in the ward was posted on the wall of the ward prominently. This copy was signed by the supervisor and had a date. This allowed easy identification of non-functioning or missing equipment. Such a system of transparency in equipment management could be considered as one of the best practices in this field.
- 6.7 Based on the simple design provided by the AMDD technical team a local hospital director in Africa prepared a low cost stand for water bucket with a tap and a metal sink below, which could be used for hand-washing in each of the ward and delivery room. This simple device fabricated by a local welder provided adequate running water for hand washing. This equipment saved the hospital lot of money, which would be otherwise required to set up running water system. This system is not only low cost and hardly requires any maintenance and is non-dependent on electricity. This again shows how locally fabricated simple equipment can serve the purpose in remote areas.

7. Conclusions

Availability of working equipment is vital for provision of EmOC. The essential equipment needed for EmOC is not very sophisticated. But, the proper management of equipment starting from selection, purchase, installation, use and maintenance are very important for ensuring ongoing readiness of the service facility. The problems described in this paper pertaining to EmOC equipment are also generic. Some of the root causes of such problems are lack of decentralized planning and inadequate management capacity. In addition within the meager health budget the proportion allotted for repair and maintenance is abysmally low which compounds the management problems. WHO had in the late 1980s suggested that a separate Health Care Technical Services (HCTS) to be created for effective handling of these problems [6]. WHO also formulated a Global Action Plan on management, maintenance and repair of health care equipment [10]. Our work shows that situation in equipment management in many countries is far from satisfactory.

Unfortunately, most of the health managers, doctors and nurses in developing countries are not familiar with the basic concepts of equipment management. Politically and administratively hardly any attention is paid to this area. As a result, there is wastage of precious resources in terms of non-functioning and not utilization of equipment in facilities. Non-functioning equipment has very serious consequences on EmOC services.

There is limited published literature on the topic of equipment management in rural hospitals. This paper highlighted some of the practical problems seen in the area of equipment

management in several countries in Asia and Africa. Even though the general picture is dismal the experiences in the field show successful innovations by local managers and doctors as solutions to the problems of maintenance. Various donor agencies and governments need to promote better equipment management rather than invest in the purchase of newer equipment when most facilities have usable and repairable equipment. Capacity development is required at district, regional and national level to manage equipment in the health system.



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References

- [1] Fitzsimmons JA., Fitzsimmons MJ. Service management for competitive advantage, McGraw-Hill Inc, Singapore, 1994.
- [2] Bateson John EG. Managing services marketing (III Ed.). Florida: Dryden Press, 1995.
- [3] On being in charge: A guide for middle level to management in primary health care. Second edition, Geneva: WHO, 1992. p. 160-170.
- [4] Management training modules for district level health officers. National Institute of Health and Family Welfare, New Delhi: 1990. p. 331-339.
- [5] Materials and equipment management. Module 12, National Institute of Health and Family Welfare, New Delhi: April 1992. p. 70-81.
- [6] Mallouppas, Andreas. WHO programme for support to countries in the field of maintenance and repair of hospital and medical equipment. Background Document. Geneva: WHO, 1986. (SHS/86.5 English only) (Website available at: http://whqlibdoc.who.int/hq/1985-86/SHS_86.5.pdf).
- [7] WHO. Report on workshop on management and maintenance of biomedical equipment in the South Pacific. Geneva: WHO, 1991. (Website available at: [http://whqlibdoc.who.int/wpro/-1993/RS_90_GE_03\(FIS\).pdf](http://whqlibdoc.who.int/wpro/-1993/RS_90_GE_03(FIS).pdf)).
- [8] Malloppas Andread, Porter David, Issakov Andrei. Guidelines for country situation analysis on management, maintenance and repair of health care equipment. Geneva: WHO, 1988. (Website available at: http://whqlibdoc.who.int/hq/1988/WHO_SHS_NHP_88.3.pdf).
- [9] WHO. Interregional meeting on the maintenance and repair of health care equipment. Geneva: WHO, 1986. (Website available at: http://whqlibdoc.who.int/hq/1987/WHO_SHS_NHP_87.5.pdf).
- [10] WHO. Global action plan on management, maintenance and repair of health care equipment. Geneva: WHO, 1987. (Website available at: http://whqlibdoc.who.int/hq/1987/WHO_SHS_NHP_87.8.pdf).
- [11] Lathwal OP, Banerjee A. Availability and utilization of major equipment at district hospital, Gurgaon, Haryana. J. of the Academy of Hospital Administration. July-Dec 2001; 13(2):23-28.
- [12] Hasper K, Centralised maintenance responsibilities: a case study. J of Clinical Engineering 1991; 16(3):191-206.

- [13] Stanley Chen JH, Contract management using cause-effect clues in service worksheets. J of Clinical Engineering 1996; 21(1):51-54.
- [14] Rainer W, Menegazzo E, Wiedmer A. Quality in management of bio-medical equipment. J of Clinical Engineering 1996; 21(2):108-113.
- [15] Lafrenaye RR, Pezzullo JC. Internally developed medical equipment management system: A viable alternative. J of Clinical Engineering 1991; 16(4):315-321.
- [16] Hill D. Evolving practice of medical equipment management following FDA inspections. J of Clinical Engineering 1992; 17(1):49-57.
- [17] Gill Zafarullah. Implementing emergency obstetric care in developing countries. Draft, Unpublished, AMDD Project, Columbia University, New York, December 20, 2000.
- [18] World Bank Report: India new directions in health sector development at the state level: an operational approach, population and human resource division. February 1997; p. 48-50.
- [19] IIPS. India facility survey phase-I under reproductive and child health project. International Institute of Population Sciences. Mumbai. 1999. p. 72 & 96.
- [20] Hancock Graham. Lords of Poverty. New York. The Atlantic Monthly Press, 1989. p. 11.
- [21] Mavalanakar D, Abrue E. Concepts and techniques for planning and implementing a program for renovation of an emergency obstetric care facility. Int J Gynecol Obstet, 2002;78;263-273.
- [22] Skeet M and Fear D. Care and Safe Use of Hospital Equipment. London: Voluntary Services Overseas Books, 1994.
- [23] World Development Report 1994: Infrastructure for development. World Bank, Oxford University Press, 1994. p. 27-29.
- [24] WHO. Maintenance and repair of laboratory, diagnostic imaging and hospital equipment. Geneva: WHO 1994.
- [25] UNFPA. Making safe motherhood a reality. Final Progress Report 2001-2003; Draft, Unpublished, UNFPA Integrated Population and Development Project, Rajasthan. p.8
- [26] Columbia University: Mailman School of Public health. The Averting Maternal Death and Disability Program Brochure. p. 12
