MAINTENANCE OF BIOMEDICAL EQUIPMENT AS MITIGATING FACTOR IN MAN-MADE DISASTERS IN THE EASTERN CARIBBEAN

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I. INTRODUCTION

A disaster can be defined as an incident or event, in most cases, of an unanticipated nature causing to the distressed habitat profound alterations, represented in the loss of health and life, the destruction or loss of the possessions of a community, and/or relentless damages to the environment.

Disasters can be originated by the manifestation of a natural phenomenon, induce by man or as a consequence of a technical deficiency in industrial or warfare systems.

In this work, we will address only man-made disasters including those that are the repercussion of technical malfunction, and to the possibility of extenuating its effect if we comply with and conform to an adequate program for the maintenance of biomedical equipment in our hospitals.

Man-made disasters can be conceived intentionally by men, or haphazardly by a technical break down, which could--at the same time--breed a series of errors that can precipitate a disaster of great magnitude.

Among the most common man-made disasters, the following warrant to be referred to:

EXPLOSIONS
FIRES
ACCIDENTS
POLLUTION

In a widespread manner, there is a variety of potential disasters of a technological character. Presently, seaports, airports, and urban centers bear high vulnerability to these type of phenomenon due to the high density of: industries, construction, and mass transportation for cargo and persons.

II. RELEVANCE AND FUNCTIONS OF HEALTH INSTITUTIONS

Most health services are composed of hospitals, polyclinics and health centers, operated by government and the private sector. Hospitals habitually offer emergency, secondary and tertiary medical care, meanwhile health centers and polyclinics deliver basic primary health care as well as first aid.

Hospitals command unique attention in connection to mitigation of risks fitting to its in-patient idiosyncrasy and to its crucial role at times of disaster. This role spans from the provision of services, distinctively--the diagnosis and treatment of--the injured and the sick, to managerial and technical support to all levels of the health care infrastructure.

In case of disaster, a hospital must carry on providing assistance to in-patients and also attend to and care for those distressed by the event that solicit services through the emergency room. Consequently, equipment must be maintained in peak operational order. Notwithstanding its implication, this has been neglected. This indifference is motive for great disquiet, chiefly in those locations where a hospital is the single in-patient health care provider.

The lack of regard and attention to maintenance issues, and the ever decreasing availability of resources is considered a world-wide problem, particularly in the developing countries. The following table shows the problematic in a schematic format.

In order to establish an operative system that is efficient and effective at all times--even in case of disaster--emphasis should be placed in the following components:

A comprehensive policy that identifies an approach to biomedical equipment maintenance.

A robust technical support structure and training program to ensure adequate development of professionals and technicians.

Adequate human resources and supplies to: (a) delay the aging of the equipment; (b) attend repairs in a timely fashion to avoid expensive -complicated repairs later; and (c) eliminate or reduce downtime.

An organizational system and planning process supported by a methodology to effectively manage maintenance activities.

SITUATION OF DEVELOPING COUNTRIES REGARDING HEALTH CARE EQUIPMENT

FACTORS CONTRIBUTING TO DOWN-TIME OF EQUIPMENT AND WASTAGE OF HEALTH RESOURCES	PERCENTAGE
Usable equipment at any given time	50%
X-ray equipment down at any given time	30%
Purchase of sophisticated equipment without technical backup a (underutilized or not used at all)	20-40% of all equipment
Decrease in useful life of equipment due to inexperience of operators and lack of maintenance	decreased by 30-80%
Additional purchases of accessories, parts and supplies due to lack of expertise in selecting appropriate systems	10-30% of value of equipment
Lack of standardization	30-50%
Excessive down-time of equipment	25-50% of equipment
Lack of liquidity in foreign exchange reserves	10-30%

Source: PAHO/WHO, UNIDO

An organized system for easy mobilization of personnel, equipment, and supplies within a sheltered environment is imperative to reply in an effective manner to a disaster demands. Emphasis should then be placed on the serious nature and inter-dependence of processes, equipment and infrastructure. Weaknesses and flaws in any of these components of a hospital operative system could prompt a crisis in the institution.

The latent demand produced by a natural or man-made disaster could concoct alterations in the functioning of health systems. This potential demand should be examined opposite to the prevailing supply of services, in order to estimate the demand-supply capacity in the event of a disaster.

III. PRIORITY AREAS

Experience demonstrates that--at the time of construction of a hospital--attention should be given to the design, with the purpose of safeguarding the integrity of the building pattern, with two main objectives in mind:

That the building and equipment withstand to be able to continue providing services with the least disruption,

and

that the gush of emergency patients can be sustained over that of the ambulatory patients.

The hospital as a whole is a significant realm, but when a disaster strike the most pivotal areas are:

Emergency Room
Operating Theatres
Intensive Care Units

These areas require sustenance from:

Radiology Department
Central Sterile Supplies Department
Laboratory Department
Medical Gases Station
In-patient Wards
Blood Bank
Out-Patient Department
Morgue

Among the most critical equipment in these departments are:

Life support systems (such as ventilators)
monitors and defibrillators
anesthesia machines
blood gas analyzers
x-ray equipment
autoclaves
electrosurgery
operating tables
surgery room lamps
oxygen cylinders with regulators

For equipment to function optimally in case of disaster, an assortment of activities need to be set in motion prior to it. That is, actions that need to become part of the standard operations of

the institution. Among these activities we highlight:

- Determine accessibility of and methodology for operationalizing transportation and evacuation procedures.

  This include, but are not limited to: ambulances, intensive care ambulances, helicopters, etc.

- Identify the state of the biomedical equipment installed.

- Maintain an inventory of human and physical resources.

- Determine the potential productive capacity of the institution.

  That is the maximum number of patients that could be served simultaneously, based on the operational capacity at the emergency room, operating theatres, and intensive care units. This analysis should be done assuming normal working conditions and assuming personnel reinforced conditions.

- Identify key functional areas as well as "overflow" areas, that will allow for increasing the diagnostic, treatment and in-patient capacity of the hospital.

- Create and adopt an organizational chart to respond to and become effective under an emergency state.

- Formulate a disaster plan.

  A disaster plan is an operational plan for hospital emergency situations. This plan will vary from institution to institution based on the relative complexity level, its capacity and role in the community, and the demand that can be generated after a disaster or emergency.

IV. RISK MITIGATION IN HOSPITALS

Risk is the result of relating the threat (hazard) and probability of occurrence of a given event to the vulnerability of the component and/or ingredients of an habitat or against the possible severity of the disaster over those elements.

Whatever is effected before an event, geared to reduce or prevent injury and damage can be called "risk mitigation".

Mitigation has no cost. In the long term it pays off. It pays off in actual savings and in lives saved.

The importance of maintaining medical equipment in optimal working conditions can also help to mitigate the repercussion of an internal disaster to the hospital. This cannot be stressed sufficient. Among the most recurrent accidents we can allude to:

Oxygen leaks
Electrical malfunctioning
Ventilators and anesthesia machines incorrectly calibrated
Sterilizers, ovens, and incubators with range settings incorrectly calibrated
Cobalt source leakages
Insufficient radiological protection
High frequency burns (physiotherapy equipment and surgical electrocautery)
Dialysis machines and infusion pumps without alarms and air bubbles detectors

All these examples as well as many more not mentioned here can be life threatening and, at best, cause temporary or permanent damage to patients and staff.

Nonetheless, all of these risks can be dramatically reduced by:

a) introducing a preventive maintenance program,

b) conducting training for personnel operating the equipment, to detect easily and on a timely manner any malfunctioning or variation from the parameters that the equipment should have.

V. DISASTER AND TOURISM

It is significant that in the Eastern Caribbean countries economies are tied more and more to the tourism industry. At the same time, current marketing research has established that there is a tendency among elderly-well-to-do tourists to select vacationing sites that have high quality health care services.

The reduction of resources, budget, and possibilities of financing due to structural adjustments programs have resulted in meaningful constraints that affect the health sector, specially areas such as maintenance and supplies, which presupposes an accelerated decline in the quality of health services provided.

Thus, it can be inferred that the availability of an adequate hospital infrastructure operating under optimal conditions could influence positively to increase tourism.

As a propaganda, in addition to marketing the natural beauties and hospitality, it is also appropriate to show that under any circumstances the country is capable of responding appropriately and in a timely manner. But not only in the case of accidents, sickness or disaster, but also it can be offered as a place for "Health Tourism", for those in need of medical treatment--for chronic conditions--while vacationing. For example "dialysis on vacation".

VI. CONCLUSIONS AND RECOMMENDATIONS

After analyzing the abovementioned areas, one can conclude that one of the most inexpensive ways of mitigating the effects of man-made disasters, is the maintaining of the hospital equipment at all times. For this we recommend:

1. Establish a preventive maintenance program for all medical equipment, emphasizing those belonging to critical/intensive areas and life support systems.

2. Conduct training programs for the personnel operating the equipment, to improve its efficiency and extend its useful life.

3. Search for sources of funding for these plans, among which could be:

a. International agencies such as the European Community and the Inter American Development Bank
b. Regional projects: disaster preparedness, Caribbean Cooperation in Health.
c. Technical Cooperation Among Countries: such as the Cuban project on biomedical maintenance or Taiwanese project on hospital maintenance.

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