FUNCTIONALITY OF THE ARCHITECTURAL PROGRAM IN THE REMODELING OF EXISTING HOSPITALS IN SEISMIC ZONES OF VENEZUELA

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SUMMARY

Functional collapse of hospitals (FCH) occurs when a medical complex, or part of it, although with neither structural nor significant nonstructural damage, is unable to provide required services for immediate attention to earthquake victims and for the recovery of the affected community. As it is known, FCH during and after an earthquake, is produced, not only by damage to nonstructural components, but by an inappropriate or deficient distribution of essential and supporting medical spaces. In July 1997, after de Cariaco earthquake the most important health complex in the Northern Eastern Region of Venezuela, although with no structural damage, was unable to attend victims and the regular service was not provided during the following two weeks. Evacuation of patients was traumatic; the location of Intensive Care and Surgery Units was inappropriate and patients had to be evacuated by inappropriate means. The purpose of this study is to provide a method for evaluating the functionality of the medical architectural program of hospitals for post-earthquake attention. This paper presents an analysis of the traditional architectural schemes for hospitals in Venezuela and some recommendations for the establishment of evaluation parameters for remodeling medical-architectural schemes of existing hospitals in seismic zones.

INTRODUCTION

Seismic hazard and urbanization in Venezuela.

It is estimated that almost 80% of Venezuela's population lives in active seismic areas; because the most populated areas in the country are located near by or in the mountainous system of the country. This tectonic belt, that generates most of the current seismic activity, is constituted by the system of faults of Boconó-San Sebastián (or Morón)-El Pilar. In the seismic map of Venezuela (FUNVISIS 1981) it is observed that almost all of the most important cities in the country are located in the areas with the greatest seismic hazard. Most of the hospital facilities are in these cities or very near them, what means that the great majority of these facilities are in of high and medium seismic hazard regions.

Seismic Vulnerability of Hospitals.

Health care facilities are complex institutions because the diversity of activities they are carried out during the 24 hours of all year round. This complexity implies variables difficult to manage, like the diversity of employees and users, with different characteristic and activities, who permanently visit the hospital. Hospitals have to be prepared to face massive emergencies caused by a sudden overload of victims affected by a great diversity of injuries.

In the last decades in different parts of the world, many hospitals have suffered serious damages, or they have arrived to the functional or structural collapse as consequence of the earthquakes. Not being able to respond to the emergency in spite of the fact that they had information to mitigate the seismic vulnerability in this construction type. As negative examples, many cases in San Fernando California's earthquake, in 1971, Mexico City in 1985, El Salvador in 1986, El Limon, Costa Rica in 1990, Northridge, California in 1994, Kobe, Japan in 1995, and Bahia of Caraquez, Ecuador in 1998.

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In February of 1996, in Mexico City took place the International Conference for Health Facilities Disaster Mitigation*. The Technical Commission, with health professionals, engineers, and architects, analyzed the design, construction and operational aspects, of both new health facilities and retrofitting existing ones, in terms of developing effective disaster mitigation measures. The recommendations aimed at the formulation of mitigation plans, understanding the hospital mitigation as those measures taken* ***before*** *a disaster occurs to reduce to a minimum the human and material losses, reducing the physical, organizational and functional vulnerability to ensure the hospital continues to function during and after a disaster*, (Pan-American Health Organization, PAHO/WHS, 1996, p. 21). As for the effective reduction of the functional vulnerability, this commission outlined that "*Functional and organizational aspects include: design of physical space (site selection, better distribution of the internal and external of space, etc.), and organization (emergency plans, drills, multidisciplinary teams, etc.).* In 1993, PAHO published a series of guidelines for the "Mitigation of Disasters in Health Facilities: Evaluation and Reduction of Physical and Functional Vulnerability" (Cardona, et al, 1993). In Vol. 3 of this series, *Architectural Issues*, some basic guidelines are presented for the design of hospital facilities in areas prone to disaster.

In Venezuela, most of the hospitals built during this century, have followed the design patterns used in England, Scandinavian countries and the USA, which do not included considerations for attending an extraordinary number of victims after an earthquake occurs. Some countries like Canada recently began to define concrete measures to guarantee that hospitals remain operational after an earthquake occurs. But, until now there is no knowledge of a method that allows the establishment of comparison patterns to carry out an evaluation of the physical plant and the functionality of hospitals to guarantee the availability of health care services during and after an earthquake.

In July of 1997, due to the earthquake in Cariaco, Venezuela, the Hospital Antonio Patricio Alcalá in Cumaná, the most important hospital in the region, even when it only suffered minor nonstructural damage, did not attend the victims of the earthquake. The functional collapse took place and it was only two weeks after the earthquake when the medical personnel and administrative staff returned to the building. A structural vulnerability assessment of that hospital was carried out during the two year previously to the earthquake, though a functional evaluation was not included.

At present in Venezuela, following the international tendencies, the model of health care facilities formulates that complex hospital buildings should offer specialized services and that the primary and preventive health care load has to be transferred to ambulatory facilities. This presents an opportunity for evaluating existing hospitals located in seismic areas and for making them functional for emergency situations.

The objective of the study:

To propose a method for establishing the parameters (performance variables) and their values for the diagnostic evaluation of the functional vulnerability of existing hospitals of medium and high complexity in the event of earthquakes . This method allows adjusting the evaluation instrument to the nature of each case. The evaluation results should allow the team of experts to establish which should be the design, the context, and the performance variables for upgrading the hospital, in order to have an efficient functional space arrangement to serve properly any post earthquake massive emergency.

Definitions of the technical concepts that have been used in this document:

<u>Indispensable space</u>: those physical spaces that house vital activities for the care of victims produced by earthquakes. <u>Complementary space</u>: spaces that can be used to achieve a better performing of the activities that are carried out in the indispensable spaces. <u>Functional area or service</u>: group of spaces interrelated by activities or functions that conform an homogeneous unit and make them to be different to other spaces or groups of spaces. <u>Hospital complex</u>: Group of buildings that bring integral medical care of primary, secondary and/or third level and are under the same administration. In this study, the term hospital will be used to identify either a unique hospital building or a hospital complex. <u>Massive Emergency</u>: Event of big proportions that requires special attention and celerity. <u>Functionality</u> capacity of being functional. <u>Functional</u>: Thatt in which the purposes for which buildings are to be used are the main considerations. <u>Hospital</u>: It comes from the Latin *hospes*, guest. Place where people are treated for, nursed through, their illness or injuries. Building that is dedicated to the medical attention of the collective. Public or private institution where the medical and surgical cares are made, as well as the childbirth (Plazola, A., 1997, p. 53). The Official Gazette of the Republic of Venezuela (1983) defines in its Cap. IV, Art. 9°: "The Hospitals have the following characteristic: 1) they lend integral medical attention of primary, secondary and tertiary level according to their category; 2) inside their organization, they will have observation beds and of hospitalization. <u>Medium and high complexity</u> hospitals in Venezuela: Until the 80s, the number of beds measured the complexity of the hospital. Today, it is measured by the resolution

capacity of health problems . They are of medium complexity, hospitals type II, and of high complexity, types III and IV (pp. 246-949). A system of health is an organization created to provide services dedicated to promote, prevent, recover or rehabilitate the damage in health, with the goal of facilitating the access to an attention of appropriate quality and a reasonable cost. The system is compound, among other, for facilities that are organized in levels of complexity, according to a defined model of medical care. These health facilities are related to each other through patient reference systems, conforming what is denominated a network of health care facilities. (Shell, M. and X. Aguilera, 1998, p. 1)

BACKGROUND

They are multiple factors that determine the direction of the advances of health care facilities architecture. Hospitals change with each innovation in the benefit of the health care. Since the end of last century, the changes have been very fast related to the medical care and in the type of service and the form of lending it, including the architectural and urban approaches. In Venezuela, the development of hospitals, so much from the equipment and functionality point of view, has been closely linked with the dominant outlines coming from developed countries. Following this dominant outlines, for each new orientation, there have been adopted equivalent changes. From the 50s, the most significant transformations have been within ten years-interval. There are three types of changes: a) the space conception, b) the labor-financial and c) the techniques of the medical practice.

Changes in the space conception:

The international advances in the medical technology and in the diverse branches of engineering, have transformed the space necessities of health care facilities. At the beginning of century the pattern of the "hospital cities" was imposed, centralizing in a single institution all the services. In the thirties, they incorporate the principles of functionality of modern architecture and the criteria "form follows function". In the fifties, the creation of the British National Health System and the diffusion of planning of the health services concepts for population's necessities, became one of the most innovative reforms in the western world: the hospital as a container of innovative expertise. In the mid 60s dominated the vertical hospital. This allowed the making of more efficient architectural medical outlines, for the centralization and better use of the diagnosis services and treatment. At the end of the seventies, with the advances of the medicine and the tendency to specialization, the demand of spaces with special functions surpasses the existent infrastructure. What was a simple and efficient structure becomes a complex of specialized areas. The vertical hospital allowed to concentrate the private area of hospitalization, surgery, obstetrics and intensive therapy in the tower and to take advantage of the low floors and the horizontal platforms for the public services: emergency, external consults, diagnosis and treatment and the administration areas and general services which grew to be able to manage these new emporiums. In the eighties the health care changed primarily because the high costs in construction and maintenance and the limited coverage. It changes the focus of the system of medical attention toward the ambulatory attention, quickly developing procedures to avoid the use of hospitalization bed as much as possible.

In the United States, this tendency is annually increasing, it is expected that for the year 2000 as much as 66% of the surgeries will be carried out in ambulatory facilities. It is thought with this new focus to enlarge the population coverage with smaller cost. Equally major change are expected that will make unnecessary the today's expensive laboratory facilities as we know it, with the miniaturization of devices that manage dry chemical reagent, which will allow that many of the routines of laboratory can be carried out, with enough precision, in a examination room or at home. The biggest advantage of this resides in the obtaining of results in short time and without the use of complex team that requires of special equipment and spaces.

Labor-financial changes:

The financial and business organization play an important roll in the functional architectural programming of health care. In Venezuela, there is the false believe that in order to improve the productivity of an inefficient hospital is by increasing resources. In last years, the frequent employees and workers strikes affected the productivity of health system, limiting services to emergencies. The administration of the financial resources was strongly distorted, which in turn affected other areas like the inputs, maintenance and technology. This situation is, partly, a product of the excessive size and complexity of the hospitals, originating that its operation and maintenance overcome the limits of administration control and capacity.

Because the great majority of the Venezuelan doctors specializes in the USA, they make their demands of functional program and equipment according to the patterns of that country, although Venezuela is quite different. The case of the hospitals type I during the last 3 decade has been the most dramatic: The functional programming took care of providing wide surgery suites and childbirth rooms with all the techniques for handling patient, asepsis, medical care and sophisticated equipment. When facing the inefficiency, however, it has been interpreted that their limited productivity, a lot smaller than the one that had been planned, had to do with the number of beds, without glimpsing that the lack of specialized personnel, especially in small cities, was the main cause for the services did not work. This wrong explanation made to look for the solution of enlarging the number of beds. Thus, in the 50s, 60s and 70s the hospital complexity was described by the number of beds.

At present, with the recent medical techniques and the growing massive emergencies due to social disasters, the approaches of space complexity, flexibility and relationships among spaces and among specialized areas are different from the past. Now, the level of hospital complexity is determined by what is or should be the type of attention given by the hospital, related with the range of sophistication of the technology that uses or should use.

Current and Future Situation: Technical Changes of the Medical Care.

The use of sophisticated techniques, through systems supported in communications networks, diagnosis systems based on 3-D images, of artificial intelligence, surgeries carried out in distant places by means of virtual reality, etc., indicate that they will transform the functional outlines of the hospitals. On the other hand, more sophisticated techniques are being developed every year, what is very convenient for each medical specialization. All these changes make now that all medical specialties no longer are grouped together in one big hospital, but each service is centralized in a single hospital. What today is seen as carried out in the hospital surgery rooms, it will become domain of the ambulatory environment. This focus implies the creation of an advanced system of health care facilities so that all interact to each other at local, regional and national level.

In Venezuela, the use of techniques of ambulatory care seems not to have still exercised enough weight in the health system in forcing its transformation of public hospitals. The growth of beds number has not been stopped, but rather it continues growing although maybe in smaller intensity that in previous years, more due to the economic crisis than due to a change in the system approach. On the other hand, the private facilities have already captured this message very well, they have developed ambulatory clinics that take charge of the surgeries and other procedures that were reserved, in other times, to the public hospitals.

THE HOSPITAL FUNCTIONALITY DIAGNOSTIC EVALUATION METHOD

The main and general twofold objectives of this method are:

a) *Related to the **evaluation process** in itself*: to provide an instrument that allows specialists to select, to establish and to formulate the parameters and their relevance for determining how, how much and/or how well an object (for example, a plan or an existing building) performs under certain circumstances.

b) *Related to the **object** to be evaluated*: to organize the formulation of parameters (performance variables)for valuing the eventual function of hospitals of medium and high complexity during and after an earthquake.

The specific objective of this method is to give an approach to help specialist to formulate the evaluation parameters and their ideal values. Once the evaluation is carried out and results are obtained, then a specialized team might determining the design variables that have to be modified in order to obtain a functional plan, efficient enough for performing properly under an extraordinary massive emergency due to an earthquake. The way of establishing of this parameters is by anticipating the properties, quality and efficiency of the services and functions that each service has to provide during and after an earthquake. According to the results of the evaluation, then decisions can be made regarding priorities in the remodeling of hospital under study.

Basic Steps and Some Dilemmas when Updating an Existing Hospital

When an existing hospital has to be functionally updated from the technological and architectural point of view, and it is located in a seismic region, it is convenient to follow some few main steps. None of these steps, though, is free from some dilemmas. It is important for the evaluators to know that the decision on *what* and *how* to modify, substitute, eliminate, include, etc., is not an easy but difficult task. The first thing to know is that, at the end, there is no guarantee on obtaining the “optimal solution” to the problem. There will always be some aspects which were not solved at all, or were not adequately solved. Updating an existing hospital is a *design problem*, which has a series a questions with no clear and secure answers. For instance: ¿what has to be updated? ¿Up to what point? ¿How to update? ¿What should finally be the updated hospital? In order to find the answer to these question, when the hospital is located in a very hazardous seismic region; then, the two basic knowledge situations have to be contrasted: first, a massive disaster might occur and the essential local health services should be available for post earthquake attention (a *deontic knowledge*); Sencondly, are the available essential local health services able, not only to resist the earthquake effects but, to efficiently keep all its full subsystems working for regular service and to adapt, very fast, to provide the required services for an extraordinary massive emergency? (a *factual knowledge*). The discrepancy between these two describes the problem to be solved.

What are those steps in the process to solve the problem? There are, at least, seven steps. They were grouped into two main categories: one, abstract or general to any hospital; and the other, concrete or particular for a specific hospital. The following figure shows these main steps.

Abstract-General	**Concrete:-Particular for Specific Hospital**					
1. Development of an Ideal Model for a Diagnostic Evaluation	2. Diagnostic Evaluation of the Hospital 'X'	3. Formulation of Discrepancy Between the "Is State" and the "Ought to Be State"	4. Determination of: Design Variables (d-v), Context Variables (c-v), and Performance Variables (p-v)	5. Generation of Alternative Solution, Selection of One, and Development of a Plan of Action.	6. Implementing the Plan.	7. Reopening of the Hospital, or of the Section Updated.
		Design Process				

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Figure 1. **Main Steps in the Updating Process of a Hospital in a Seismic Zone**

From these seven steps, only the first four are described, since the last three refer to regular design and implementing procedures. The *Ideal Model for the Diagnostic Evaluation* is developed more in detail, at the end.

ABSTRACT OR GENERIC ACTIVITY REGARDING ANY HOSPITAL:

Step 1: Development of an **Ideal Model** for a *diagnostic evaluation.*

The definition of the problem of updating a hospital deals with answering the following questions: Updating why, when and what for? In other words, is it the updating necessary? Why is it necessary and for whom? The ideal model consists then of two elements: a) the development of the *generic diagnostic evaluation procedure*, independent from any specific hospital; and b) the establishment of the criteria regarding the combination of "hospital functionality" and "seismic extraordinary massive emergency". Once these two elements are clearly stated, then the Ideal Model of diagnostic evaluation is constructed on the following bases: (a) Design of the process: *how* to carry out the diagnosis; and (b) establishment of *what* is necessary to know about hospitals in order to solve the problem. The diagnostic evaluation model is constructed through: (a) the establishment of ideal performance patterns, related to the services that has to be provided the hospital for the attention of a seismic massive emergency; (b) the establishment of priorities on the services that have to be evaluated accordingly to guarantee the efficient attention of seismic massive emergencies; and (c) the definition of the range in which each evaluation pattern ideally works: Establishment of the parameters values.

Concrete or particular activities for each hospital:

Step 2: Diagnostic Evaluation of Hospital 'X'.

The specific evaluation instrument is developed from the selection of parameters established in the Ideal Model and the characteristics of the studied hospital. The evaluation team has to agree then, on the parameters to be considered, as well as on the relative weights and values for each one. The final parameters and weights will depend on two aspects: a) the contextual conditions in which it is assumed the hospital will perform; and b) the client's and the evaluation team's desires and expectations regarding the performance of the hospital. Once the final evaluation instrument has been developed (a very difficult activity), then the surveyors, will carry out the proper evaluation process of the hospital. The evaluation process includes the reviewing of the medical-architectural program and the interior and exterior functional spatial organization through: a) the inspection of the physical state of the building; b) blue-prints and reports on the functionality of the facility; c) the determination of the regular activities of the Emergency Room and of the Critical Medicine Department; and d) the identification of the location, characteristics of the rooms, and installations of the indispensable activities. From this reviewing, other indispensable services and new parameters can be incorporated to the evaluation instrument, adjusting the Ideal Model to the specific case study. Another complementary source of factual knowledge about the specific hospital is the interview to hospital staff . The development of questionnaires allow to obtain information from the different levels of the medical and administrative . An analysis of the diagnostic evaluation results (values obtained by the studied hospital) is carried out and its results are compared with the ideal pre-established patterns (Step 1) in order to establish the actual situation of the evaluated facility.

Finally, conclusions and recommendations are formulated for improving those aspects that were found deficient. A "Final Report" is presented with all information organized in such a way that the following steps might be approached easily. All these evaluative considerations should be applied taking in consideration that this particular diagnosis is about a hospital located in a specific place with a specific program for satisfying a specific population. Thus, the evaluation is carried out within a very specific **context**, which should be described. In the case of seismic regions, the main context variable to be considered is the seismic hazard of the hospital. The main aspects that should be taken into account are: a) the local seismic activity, soil dynamic properties, zone's historic seismicity and seismology, and other necessary aspects to determine the seismic hazard; and b) the hospital's influence area, population to be attended, existing urban infrastructure and structure of the inter-hospitals emergency service network, within other relevant aspects.

The Design Process

Step 3: Problem Formulation of the Updating of Hospital 'X': the Discrepancy Between the "Is State" and the "Ought to Be State". From steps 1 and 2 the"formulation of the updating hospital 'X' design problem" is developed. Any design problem, the formulation and reformulation process is constant through the whole design process. Different pictures of the problem are built and some reflect better the wishes of the people involved in the process (decision-makers, clients, evaluators, etc.) One way of starting the process is to take both, the Ideal Model and the results of the diagnostic evaluation as initial references for developing updating issues and discrepancies. The diagnosis evaluation will reveal some *factual knowledge* about the "Is State." The Ideal Model might suggest to the design team very useful "objectives" to reach, *deontic knowledge* for the "Ought to Be State". The formulation of both states are done simultaneously, interacting between them, so that some of the ought to be formulation might originate the need to gather new information about the hospital 'X', and, in the other way around, some factual knowledge might trigger in the design team some new objectives.

Step 4: Determination of the problem variables: design variables (*d-v*), context variables (*c-v*), and performance variables (*p-v*).of the updating of Hospital 'X'. One very difficult task is to determine which variables are to be considered. If something should be done and it might be carried out changing, adding, eliminating or just modifying part or the whole section of the hospital to be updated, then the aspects to be manipulated and the way to carried it out, become **design variables** (*d-v*). But, if something cannot be change by any reason, and the upgrading has to be designed considering this as a "constraint", then it becomes a **context variable** (*c-v*). The objectives, goals, desires and duties become the **performance variables** (*p-v*). As stated by Guevara, Jones-Parra, Cardona (1996,) all these three types of variables have to be organized and, when generating the variety of solutions, related to each other in such a way that any potential solution is thought and proposed having in mind that it will *perform* sufficiently well under the set of assumed set of *limitations*.

Next figure shows the sequence of the different design situations, that are to be considered in the design process, and the relationship between them. The design process is not viewed as a linear process, but as a process where the activities occur going forward and backward, constantly adjusting and revising previous decisions and ideas.

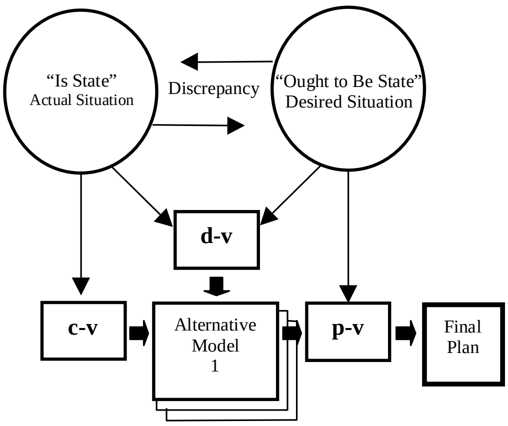

Figure 2. A General View of the Design Process Main Situations

The discrepancy between the *is* and the *ought to be* states, might be developed from the diagnostic evaluation of hospital 'X' (*factual* knowledge) and the ideal model (*deontic* knowledge). However, each state formulation is refined in relation to the other. Once there is an agreement in their formulations, the discrepancy arise more clearly. The discrepancy has to be clearly explained by the evaluators. There might be a variety of explanations. Each one, emphasizing on different causes, that will aim towards the generation of solutions in different ways. The selection of each *d-v, c-v* and *p-v*, as well as their respective values, will depend upon the *causal explanation* that finally is given to the discrepancy.

Once the variables are set and the values for each established, then a variety of alternative possible solutions is generated. From these variety of possible solutions, those that seem to be the best for solving the problem, are selected and developed as “alternative models”. Each model is evaluated, and all are compared to each other. A decision is to be made in order to select one, and then develop it as the “Final Plan” (Step 5).

1.1.1 Steps 6 and 7: The implementing of the Plan and the Reopening of the Upgraded Service.

These two steps follow traditional schemes of remodeling and upgrading buildings and finally reopening the renewed service. It is recommended, though, that a process of continuous evaluation and monitoring follows up.

DEVELOPMENT OF AN IDEAL MODEL

The parameters or performance variables proposed for the Ideal Model illustrated in the following paragraphs, is based in the method presented by Guevara, Jones-Parra and Cardona (1996). That method establishes that the Overall Performance of the evaluated object, in this case a hospital, is the addition or aggregation of partial value judgments of each of the different parameters that represent parts of the object. In this study, the overall performance is the *Functionality of a hospital for post-earthquake attention*. The items that identify “functionality” for each case, can be formulated from two sources: (a) a theory on functionality of hospitals, from which the parameters to be evaluated are derived taxonomically; (b) The specific characteristics of the studied hospital: its history, location, type of service that provides, specific problems and institutional dynamic.

BRIEF DESCRIPTION OF BASIC PARAMETERS IN THE EVALUATION TREE

The selected parameters can be analyzed from different degrees of detail depending of the disaggregation process applied to each one. At the end, the “parameter tree” is obtained. In this specific case, three parameters are recommended for the first subdivision: (1) *Hospital Functionality in Relation with its Environment;* (2) *Hospital Internal Functionality*; and (3) *Efficiency of Contingency Plan and Evacuation Process*. Some of the following branches are presented, just to illustrate part of the developed evaluation tree.

0. *Functionality of a hospital for post-earthquake attention*: Refers to the overall performance of the studied hospital. It is obtained from the addition of the values of the following partial parameters.

1. *Hospital Functionality in Relation with its Environment*. The proposed parameters evaluate the hospital’s capability of relating to its context, as a whole system.

1.1 Relationship with Urban Lifeline Utility Infrastructure.

1.2 Accesses functionality: Heliport availability; Distance and vulnerability of roads to nearest airports; Flow and parking of vehicles; Pedestrians accessibility, etc.

1.3 Seismic Vulnerability of Neighboring Structures: Adjacent Buildings; Lifelines Superficial Structures; Bridges; etc.

1.4 Efficiency of Procedures for connecting to the Local and Regional Emergency Network.

2. *Internal Functionality*: This group of proposed parameters, evaluates each of the different parts of the hospital that are considered indispensable and their complementary, for obtaining an efficient attention service for an earthquake eventuality. The following list illustrates the classification of services: **Indispensable Services (IS):** Emergency Care; Intensive Care Unit; Surgery and Obstetrics Unit. **Complementary Services (CS):** X-rays; Laboratories; Blood Bank; Patient Medical Records; Pharmacy. **Complementary General Services (CGS)**: Telecommunications; Laundry; Morgue; Kitchen; Oxygen Sevice; Water Storage Tanks; Backup Power Generator; Sewage Disposal System; etc.

2.1 Accomplishment of Basic Indispensable and Complementary Services proposed in the Ideal Model of the Medical-Architectural Program.

2.2 Relationship between Indispensable Services and their Required Complementary Services.

2.3 Flexibility for temporary transformation in Indispensable Services and their Complementary Services

3. *Efficiency of Contingency Plan and Evacuation Process*. These parameters evaluate: The efficiency of internal circulation layout; the physical characteristics of evacuation ways and emergency exits; location of emergency exits; maximum distance from any place to the closest emergency exit; efficiency of interior and exterior signposting for emergency evacuation.

CONCLUSIONS AND RECOMMENDATIONS

In Venezuela, architectural schemes of hospitals apply traditional schemes followed by England, Scandinavian countries and the USA, that do not consider functionality of the medical-architectural scheme during and after an earthquake.

The massive emergency produce by an earthquake, implying great number of victims and an usual variety of injuries, deserves an especial functional architectural scheme, that facilitates an efficient attention service.

Traditional medical-architectural guidelines recommend the location of the ICU, Obstetric Unit and SU in the highest floors of the hospital, far from public areas, in order to guarantee privacy. In seismic regions it is recommended that these units are relocated in lower floors and, if possible, in an independent low building or platform, in order to either facilitate the evacuation process or to keep these services operative in case of earthquake while the safety of the rest of the building or complex is evaluated. It is necessary to carefully study the new use assigned to those spaces left in the upper floors where relocated essential services were.

Relationship between essential (ES) and supporting services (SS) should follow a special scheme. Budget for relocation of ES and the corresponding SS has to be carefully studied since these spaces require of special installations and equipment.

Usually a functional collapse in a hospital occurs when the facility is unable to attend an extraordinary massive emergency, however, hospitals cannot maintain idle spaces for housing essential and supporting services, waiting for such extraordinary situation. There should be a scheme of transformation of the regular functional architectural scheme of the facility into a safe facility for the attention of an extraordinary emergency.

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