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2017
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HOSPITAL ENVIRONMENT FOR PATIENT AND WORKER SAFETY

August 27th to 31th

Rio de Janeiro Brazil

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Associação Brasileira para o Desenvolvimento do Edifício Hospitalar

IFHE
International Federation of Hospital Engineering

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International Seminar:
HOSPITAL ENVIRONMENT FOR
PATIENT AND WORKER SAFETY

IFHE
RIO DE JANEIRO, BRAZIL
2017

IFHE INTERNATIONAL SEMINAR
RIO 2017

PROCEEDINGS

Organized by:
Claudia Queiroz Miguez
Antonio Pedro Alves de Carvalho

Collaborators:
Fábio Oliveira Bitencourt Filho
Elza Alves Costeira

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FOREWORDS

August 2017, Rio de Janeiro City had the opportunity to promote the most important international event to discuss aspects related to architecture and engineering buildings for healthcare along the year. The **IFHE Rio 2017 International Seminar** on promotion of the International Federation of Hospital Engineering (IFHE) and the Brazilian Association for Hospital Building Development (ABDEH) was the first IFHE event in Brazil.

The IFHE is a global membership body supporting national member associations of architecture and engineering to promote safe, efficient, effective and environmentally sustainable concept, design and facilities management in the healthcare and hospital context.

At same time happened the Meeting of healthcare architecture and engineering associations of all continents, the Council Meeting. More than fifty countries from all five continents and their representatives discussing the future of the buildings, facilities and environments for healthcare.

A Meeting with the most important experts in planning, design, construction and healthcare environments management on new concepts of hospital buildings, presentation of technological innovations that allow new insights for the future of health architecture and engineering.

Here we present some contributions concerning the theme of the event **Hospital Environment for Patient and Worker Safety**, providing the opportunity to bring new contributions to security and risk reduction in healthcare environments through innovation, evaluation and critique of the flows and paths established for healthcare buildings. And in addition, to all contemporary issues, also presenting and discussing solutions for the future of hospitals.

The different solutions, experiences and ideas presented in the IFHE RIO 2017 represent a distinct mosaic of compliant solutions, each of which can teach us a new lesson. A great opportunity to assess the ways that architecture and engineering perform the healthcare activities with the best quality, comfort and safety for patients and health workers.

Fábio Bitencourt
IFHE RIO 2017 President
IFHE Executive Committee Member

In this year 2017 I am especially happy to have participated in the organization of this great meeting, the **IFHE RIO 2017 International Seminar**, which offered opportunity for the exchange of information and knowledge among professionals working on the design and maintenance of health environments in the world.

The Seminar organized by the Brazilian Association for the Development of the Hospital Building (ABDEH) with the support of the International Federation of Hospital Engineering (IFHE), a world-renowned and recognized institution, discussed safety for patients and healthcare professionals in the hospital environment.

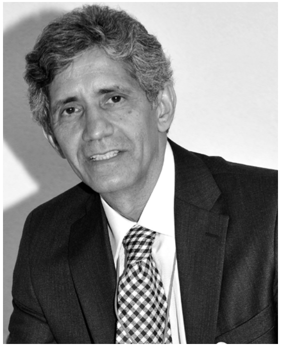
We had the presence of 19 important international speakers, architects and hospital engineers, representing all five continents. The realities of different countries and their experiences reveal new paths to be followed. New technologies and different forms of healthcare delivery and organization require a broader view of security.

The recognition of the importance of the environment in reducing both physical and psychological damage to patients, health professionals and visitors in hospital environments and the need to create increasingly safer systems drives the field of architecture and engineering for research in the areas of design and maintenance of the necessary infrastructure.

The production of this book records some of the important issues addressed in the Seminar and disseminates in our field new experiences contributing to the construction of healthier and safer health buildings.

Claudia Queiroz Miguez
IFHE Rio 2017
Scientific Committee President

OPENING SESSION



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ARCHITECTURE AND ERGONOMIC IN HEALTHCARE BUILDINGS: HUMAN COMFORT AND SAFETY FOR USERS

Defined as one of the priorities of the International Federation of Hospital Engineering (IFHE) Working Groups during the 24th IFHE World Congress held in April 2016 in The Hague, the Netherlands, patient safety has a priority role to be achieved through *"Efforts to reduce risk, to treat and reduce incidents and accidents that may adversely affect health service users"* in the broadest sense, according to the World Health Organization (WHO, 2013).

Research on the human comfort aspects has shown that unfavourable environmental conditions such as excess or lack of heat, relative air humidity, ventilation and renewal of air, intense and constant noise, inadequate lighting conditions, may represent an important source of tension In the development of work activities. Therefore, some of these aspects may also be related to the risks to health care safety.

Ergonomics can contribute fundamentally to the prevention of errors, improving the human conditions for the best performance in the work activities. In the designs of more complex systems, such as an operational control center for magnetic resonance imaging, hemodynamic equipment, nursing posts, ergonomics emerges as one of the most important factors in reducing errors in human activities and, consequently, as a factor to reduce accidents. Human error is a specific research topic of psychology and cognitive ergonomics and is a central approach to the most recent ergonomic tests.

Relevant research and scientific work on human error has also been recurrent approach in ergonomics by the World Health Organization (WHO), as well as by practitioners and researchers from around the world (KOHN, 2000; WHO, 2013).

With the purpose of formalizing and standardizing ergonomic measures to reduce errors and accidents, technical manuals have been developed, as well as official laws and regulations in various regions of the world. In order to encourage its application by the ISO (International Organization for Standardization), the European standards of CEN (European Committee for Standardization), ANSI (American National Standards Institute - USA) and BSI (British Standards Institution - UK) work intensively on these approaches. In Brazil, there are specific ergonomic norms that are already used for health care facilities, as well as for companies and industries since 1978 with the publication of the Norma Regulamentadora 17 - Ergonomia, of the Ministry of Labor and Employment (MTE).

Other expressive contributions are those resulting from the investigations of the International Ergonomics Association (IEA) and the Brazilian Ergonomics Association (ABERGO), an institution created in 2004 and *"whose objective is the study, practice and diffusion of people's interactions with technology, organization and environment, taking into account their needs, capabilities and limitations"* (ABERGO, 2017).

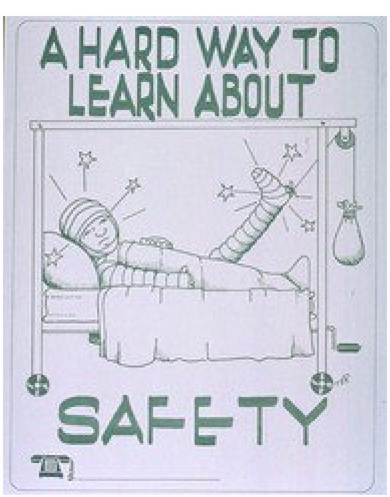

Figure 1 - Campaign for Safety of the Department of Health and Environment, Kansas, USA (19--): "A hard Way to Learn about Safety". **Source:** U.S. National Library of Medicine, 2017.

Patient safety is one of the goals inherent in the quality of health care, according to the World Health Organization (WHO, 2013) and has been the subject of frequent campaigns to reduce its harmful impacts (Figure 1). Directly or indirectly, the professionals' performance in care activities may be seriously compromised and, consequently, the effectiveness of health care.

In the *"How to safeguard health facilities"*, orientations for planning and preparation to protect health facilities by World Health Organization (WHO) are presented some specific recommendations for Location, Design and Construction that would can result in comfort and safe for all users (WHO, 2013, p. 2).

*"**Location:** A well-chosen site allows health facilities to keep functioning in emergencies. When choosing a site:*

- *Choose locations for hospitals that are not exposed to the elements or are less prone to known hazards;*
- *Build away from chemical and other hazardous industrial plants that may contaminate the facility;*
- *Do not build near high-risk coastal areas, in flood plains or other low-lying locations that are prone to damage from hurricanes, floods or water surges, including rising sea-levels associated with climate change;*
- *Do not choose sites that are prone to landslide or on ground that amplifies ground-shaking from seismic activity;*
- *Ensure that the health facility has good access for pedestrians and vehicles, and that entrance and exit routes are protected from hazards.*

***Design and construction:** These structural techniques will help health facilities withstand hazards and operate in emergencies:*

- *Build on high ground to avoid flood damage, or elevate floor levels by using multi-storey designs and piles or stilts;*
- *Design to provide resistance and stability against hazards known to threaten the area;*
- *Adhere to local building codes;*
- *Use building techniques such as "base isolation technology" by which a building is isolated from the ground oscillations in earthquakes;*
- *Use natural ventilation in order to provide air change that decreases the transmission of communicable diseases*

within low-cost health care facilities;

- *Construct the building's external envelope, such as walls, doors, and roof coverings, according to regulations and standards to protect, for example, against strong winds;*
- *Design health facilities so all aspects of the building, from its various wards to medicine cabinets, are well integrated. Symmetrical designs can help health facilities withstand earthquakes and strong winds;*
- *Apply designs to allow staff to expand critical health services, such as intensive care and surgery, in order to manage the surge of patients in an emergency;*
- *Have independent consultants review the health facility's design and construction;*
- *Design health facilities for all major hazards they are exposed to. Designs should not be done separately for earthquakes and hurricanes; they should be done for both".*

On the other hand, for each of the environmental variables (light, climate, noise, smells...) there are specific characteristics that are more or less determinant to the comfort or discomfort of each person. How more complex the actions performed by the individual, greater the responsibility of the risks involved, while more attention is needed for comfort in health care buildings.

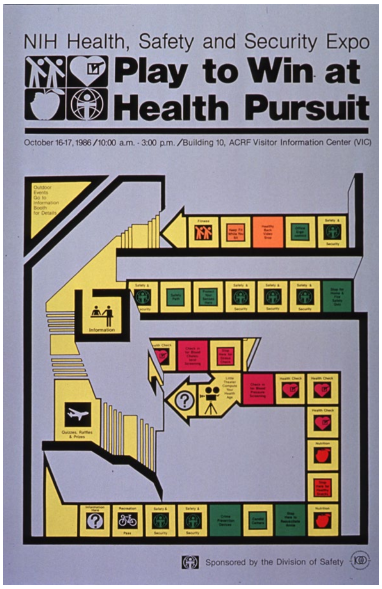

Figure 2 - Public Health Safety Campaign: "Play to Win at Health Pursuit", Safety Division of the US National Institutes of Health.
Source: U.S. National Library of Medicine, A024744, 2017.

The fundamental needs related to the architectural and ergonomic variables that can provide patient comfort and safety in health care environments are interrelated and is the main objective of the present study.

In a relevant official contribution, the Brazilian Ministry of Health published the Standard RDC Nr. 36, in July 25, 2013, which *"establishes actions for the safety of patients in health services and other measures"*. Among other aspects, patient safety is presented as *"minimizing the risk of unnecessary harm associated with health care."* This Standard establishes the obligation to implement the Patient Safety Core (NSP) in all hospitals in the country and establishes as a priority *"the promotion of the safe environment"* (BRASIL, 2014, p. 3).

In the search for the 'safe hospital', the guarantee of safety in the environment and in the work processes is indispensable from the solution established in the architectural design. In the same way, the hospital design concept must consider the architectural approaches that allow human comfort: visual, acoustic, higrothermal, olfactory and ergonomic.

In the planning guidelines for a safe environment in health buildings, multidisciplinary actions are recommended, with emphasis on the work of several professionals that include more than the performance of architects and engineers. However, administrators, physicians and nurses, among others, must act in full with the planning of the environments at all stages from the design of the project to the management of the building and the care services. In the article about Hospital insurance against disasters: a reflection on biosafety and architecture, the authors point out that *"WHO formulated three fundamental criteria to guide this planning: protection of life, investments and function, that is, To stand up, with minimal damage to the impacts of destructive phenomena and to continue operating, maintaining its production of health services as part of the network to which it belongs"* (SABA, 2012, p 177)

Figure 3 - Public Health Safety Campaign: "At the gates: our safety depends upon official vigilance".
Source: U.S. National Library of Medicine, 2017.

In health care buildings, where critical and stressful situations involving interpersonal relationships and people with some degree of physical and/or psychic suffering are frequent, environmental factors that define comfort conditions (acoustic, visual, higrothermal and ergonomic) plays a significant role.

Patients, health workers and visitors have different conditions and psychophysiological characteristics and each one also require specific environments. Thus, this is the great challenge, finding the balance between the demands of the various users of the health environments and their respective different demand. On the other hand, combining the formal determinations of technical regulations and standards with environmental, social and cultural diversity is the main objective to be achieved in the planning of buildings where health services are performed.

In a complementary way, ergonomics can also contribute to the prevention of errors and accidents by increasing the protection and safety in health services. The study and planning of the ergonomic contribution applied in projects of health environments allow the understanding of the interactions between human beings and other systemic elements.

REFERENCES

ABERGO. Manual Normativo sobre apuração de Responsabilidade Ética e/ou Civil no âmbito da ABERGO - Associação Brasileira de Ergonomia, Dez, 2005. Visited in: http://www.abergo.org.br/revista/index.php/ae. Access: 19 feb 2017.

ABNT - ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. Acessibilidade a edificações, mobiliário, espaços e equipamentos urbanos; NBR 9050. 3ª edição 11.09.2015, Rio de Janeiro, 2015. 162 p.il.

Brasil. Ministério da Saúde. Documento de referência para o Programa Nacional de Segurança do Paciente/ Ministério da Saúde; Fundação Oswaldo Cruz; Agência Nacional de Vigilância Sanitária.

Brasília: Ministério da Saúde, 2014, 40 p.: il. Visited in: http://bvsms.saude.gov.br/bvs/publicacoes/documento_referencia_programa_nacional_seguranca.pdf. Access: 18 feb 2017.

Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária - ANVISA Este texto não substitui o(s) publicado(s) em Diário Oficial da União RESOLUÇÃO DE DIRETORIA COLEGIADA - RDC Nº36, DE 25 DE JULHO DE 2013. Brasília: Ministério da Saúde, 2014, 40 p.: il. Visited in: http://portal.anvisa.gov.br/documents/10181/2871504/RDC_36_2013_COMP.pdf/36d809a4--e5ed-4835-a375-3b3e93d74d5e. Access: 11 jan 2017.

Brasil. Ministério do Trabalho e Emprego. Normas Regulamentadoras NR 17 - Ergonomia. Visited in:: http://www.trt02.gov.br/geral/tribunal2/LEGIS/CLT/NRs/NR_17.html. Access: 14 mar 2017.i

BITENCOURT, Fábio et COSTEIRA, Elza. Arquitetura e Engenharia Hospitalar: planejamento, projetos e perspectivas. Rio de Janeiro: Editora Rio Books, 2014, 410 p. Il.

BITENCOURT, Fábio (Red.). BRASIL. Agência Nacional de Vigilância Sanitária. Conforto Ambiental em Estabelecimentos Assistenciais de Saúde/Agência Nacional de Vigilância Sanitária. Brasília: Anvisa - Agência Nacional de Vigilância Sanitária, 2014, 165 p. Il.: Color.

BITENCOURT, Fábio. Conforto acústico em ambientes de saúde: música, paisagismo e materiais de revestimento como soluções humanizadoras. In: Revista IPH Edição Especial 60 Anos IPH, ISSN 2359-3630, São Paulo, maio, 2014, p. 27-60. Visited in: file:///C:/Users/Fabio/Downloads/Revista%20IPH%20Edicao%20Especial%2060%20Anos%20IPH-pt_br.pdf. Access: 15 jun 2014.

BITENCOURT, Fábio, org. Ergonomia e conforto humano: uma visão da arquitetura, engenharia e design de interiores. Editora Rio Books, Rio de Janeiro, 2011, 195 p.: il. Color.

BITENCOURT, Fábio. Espaço e Promoção de Saúde: a contribuição da arquitetura ao conforto dos ambientes de saúde. Saúde em Foco/Informe epidemiológico em Saúde Coletiva. Secretaria Municipal de Saúde da Prefeitura da Cidade do Rio de Janeiro. Nº 23 issn 1519-5600. Rio de Janeiro, Julho, 2002. p. 35 a 46.

BITENCOURT, Fábio. Arquitetura: hospitais precisam se adequar às regras de acessibilidade. In: Revista Hospitais Brasil, edição 58, nov.-dez, São Paulo, p. 81. Visited in:http://issuu.com/publimededitora/docs/rhb_58_site/81 . Access: 06 fev 2014

FGI - The Facility Guidelines Institute. PHAMA - Patient Handling and Movement Assessments: A White Paper. Prepared by the 2010 Health Guidelines Revision Committee Specialty Subcommittee on Patient Movement. 2010, Dallas, TX, USA, Abril 2010, 140 p.

KOHN, Linda T., CORRIGAN, Janet M. et DONALDSON, Molla S. To Err is Human: Building a Safer Health System. Institute of Medicine (US) Committee on Quality of Health Care in America; Kohn LT, Corrigan JM, Donaldson MS, editors. Washington (DC): National Academies Press (US); 2000.

JOSEPH, Anjali et all. Designing for Patient Safety: Developing Methods to Integrate Patient Safety Concerns in the Design Process. Concord, CA, USA, The Center for Health Design, 2012, 117 p. Visited in: 28 fevereiro 2013, Acesso em: http://www.healthdesign.org/chd/research/designing-patient-safety-developing-methods-integrate-patient-safety-concerns-design-pr. Access: 17 jul 2017.

NELSON, H. E., SHIBE, A. I. System for Fire Safety Evaluation of Health Care Facilities. NBSIR 78-1555-1; 150 p. May 1980. Visited in: http://fire.nist.gov/bfrlpubs/. Access: 25 Jun 2016.

NORD, Romano Del. Hospital Planning and Building: new ideas in Hospital planning and building flexibility, quality and energy efficiency. 32nd UIA - PHG International Seminar on Public Healthcare Facilities. Proceedings, Oslo Congress Centre, Norway 22-24 march 2012. Tesis, Florence, Italia, 2013, 222 p.; il.

SABA, L. C. de P.; CARDOSO, T. A.; NAVARRO, N. M. B. A. Hospital seguro frente aos desastres: uma reflexão sobre biossegurança e arquitetura. Rev Panam Salud Publica 31 (2), 2012, p. 176-180.

STERNBERG, Esther M. Healing Spaces: the science of place and wellbeing. The Belknap Press of Harvard University Press. London, England, 2009, 343 p.

TOSI, Francesca. Progetattazzione Ergonomica: Metodi, strumenti, riferimenti técnico normativi e criteri di intervento. Il Sole 24 Ore. Milano, Itália, 2001. 381 p.; il.

WHO – World Health Organization. Ethical issues in Patient Safety Research: Interpreting Geneva, Switzerland, May, 2013. http://www.who.int/patientsafety/activities/technical/vincristine_learning-from-error.pdf, Access: 23 mar 2016.

WHO – World Health Organization. How to safeguard health facilities WORLD HEALTH DAY 2009: BACKGROUND. Geneva, Switzerland. May, 2013. Visitado em: http://www.who.int/world-health-day/2009/safeguard_health_facilities/en/. Visited in: 14 jan 2017.

WHO – World Health Organization. PATIENT SAFETY WORKSHOP: LEARNING FROM ERROR. Geneva, Switzerland. May, 2013. Visited in: http://www.who.int/patientsafety/activities/technical/vincristine_learning-from-error.pdf. Acces: 14 Jul 2017.

WHO – World Health Organization. Comprehensive Safe Hospital Framework. Safe Hospital Initiative. Geneva, Switzerland,2015. Visited in: http://www.who.int/hac/techguidance/safehospitals/en/. Access: 10 Jul 2017.

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WATER AND ENERGY SECURITY IN HEALTH FACILITIES

Safety in the health facilities operation constitutes an essential strategy in a society. For a community to feel supported, it needs the confidence that its institutions guarantee the survival of those who are affected by accidents or diseases. There are systems in a health building that can not be overlooked, since they depend on the provision of services with the least quality.

In this theme, we highlight the hydrosanitary and electrical installations, which supply the essential inputs for health buildings operation. The water and energy supply can not be interrupted or rationed in these buildings, constituting a safety condition related to the rescue of human lives. The water and energy security of Healthcare Facilities (HF) has technical specificities that must be known, and this is the main objective of this work. To do so, norms and references were consulted regarding the subject, in addition to visits and interviews with maintenance professionals of this type of building.

WATER SAFETY

Quality and Quantitative Sufficiency

Quality and sufficiency in the potable water supply is a basic condition for the health building operation. The main procedure for controlling infection in health facilities is hand washing. In order for this activity to be carried out properly, it is necessary adequate sinks location and the potable water availability. The water quality analysis should be daily, since any small variation may cause negative changes in the debilitated patients health status.

The health environments cleaning procedures are constant and with intensive use of water. Some hospital sectors, in particular, use large volumes, such as in laundry, sterilized material center, kitchen, laboratories and steam and air conditioning facilities.

Health facilities, in general, consume a lot of water. Such consumption changes according to the type, size, location, complexity, installed equipment, among other aspects. A management, that aims the rational use of water, needs to preserve, control waste, reduce consumption and improve building performance in its life cycle.

Gomes, Bittar and Fernandes (2016) indicate that the water consumption in a hospital, most of the time is due to hygiene and cleaning, air conditioning, medical equipment, laundry, kitchen, sterilized material center and hemodialysis. To detect water conservation and saving opportunities, it is necessary to measure and share data. These data can be evaluated by indicators of intensity of use by constructed area (m^3/m^2), intensity of use by number of beds (m^3/number of operational beds) or other parameter that seems more appropriate. Monitoring water consumption helps set targets by sector and encourages economic actions. Correct water management is essential so that the maintaining cost of the health facility is compatible with its budget and its storage capacity. This care also assists in the early detection of leaks and waste of this important resource. It is common the lack of care by the managers of HCF with the water consumption, causing product scarcity. (GOMES; BITTAR; FERNANDES, 2016).

The need to generate steam can be listed as one of the greatest water consumption main points, due to the loss caused. Steam is essential for sterilizing materials, washing clothes, cooking food and cleaning procedures. The steam installation is particularly necessary in laundries, whose machines must reach temperatures and pressures compatible with the disinfection process. As boilers for steam generation are elements of high risk and difficult maintenance, the existence of this installation must be correctly evaluated in costs and benefits terms.

The health care establishments managers have the responsibility to identify and apply water saving solutions compatible with the institution financial reality, appropriate to the size, complexity and facilities.

Reuse

Reuse is the best way for saving water in health facilities. Reuse can be done in many forms, taking advantage of raw sewage water, air conditioning steam condensate and sewage treatment.

The wastewater utilization can be considered the easier reuse procedure, since it can be accomplished by directing the wash water from sinks and baths to special tanks. This type of water can be simply colored and used in activities such as garden watering, floors and vehicles washings.

Oliveira and Almeida (n.d.) indicate that, with the water consumption analysis in sectors of a hospital where the reuse and treatment system can be implemented, it is possible to generate great savings, both in financial resources (increasing the viability of the project) and in natural resources. In general, the best use of reuse water is in less noble activities:

> The reuse of non-potable water can be done in order to supply the demand in places that usually use potable water with different application needs. Among them are:
> - fire protection reserve;
> - aquatic decorative systems, such as fountains, water mirrors;
> - public toilet flushes [...]
> - irrigation of gardens [...];
> - cooling towers;
> - boilers [...]. (COSTA; BARROS JÚNIOR, 2005, p.93-94) [our translation]

The reused water can be used in other activities, depending on the level of quality achieved by the treatment. The construction of new special facilities for it, however, is not always feasible in establishments already built.

To implement a reuse system, it is necessary to do a site study, check the supply system, which sectors would provide the water with the quality needed to be reused, as well as the hospital budget, due to the need for investment (OLIVEIRA; ALMEIDA, n.d.).

Storage

Another important point in guaranteeing the health facility water resource supply is stocking. The existence of reservoirs that guarantee a minimum supply of three days is a safety measure, regarding this important resource availability, mainly in supply interruption emergency cases. In locations where there is a frequent lack of water, such storage should be compatible with the most serious cases, statistically determined.

The water storage must be carried out in distributed form in reservoirs at ground level and elevated, with volume and number of cameras that guarantee the integral supply, even in periodic cleaning and disinfection cases. The reservoirs cleaning must be determined according to the water qualitative analysis results, including the solid particle content control. As a general guideline, should not extend the intervals between reservoirs washes and disinfection beyond six months.

Treatment

The water treatment in health units is mandatory procedure in hemodialysis use cases, laboratories and when catching raw water. In the hemodialysis, the water should be free of certain chemical elements, such as aluminum, which requires even the potable water treatment. In laboratories it is common to have distilled or deionized water, which implies the treatment devices adoption.

In some hospitals, reverse osmosis is already done as a water treatment method for safe reuse in the hemodialysis sector. According to Silva and Teixeira (2011, p. 43, our translation), "[...] water used for hemodialysis has a primary function, since 95% of any solution that cleans the blood consists of water." Oliveira and Almeida (n.d.) observed the possibility of using water from the hospital laundry for reverse osmosis treatment and following reuse in the hemodialysis sector.

In the reverse osmosis treatment sector, the water passes through a sand filter, which removes the dirt solid particles; a reaerating filter, which removes calcium, magnesium and finer soils; a charcoal filter, that removes chlorine and microorganisms, and a polypropylene filter, to remove coal residues (OLIVEIRA; ALMEIDA, n.d.).

The treated water is stored in a lung tank and distributed to the hemodialysis machines and to the capillary reuse room. Even with reuse, up to two-thirds of the water that passes through the process becomes waste, going to the sewage system (OLIVEIRA; ALMEIDA, s.d.). In order to avoid this waste, Silva and Teixeira (2011) verified that saline water from the reverse osmosis waste is also reusable. In the case studied in a medium-sized hospital in the interior of São Paulo, 40% of the reverse osmosis water consumed and rejected has enough quality to be reused in toilet flushes.

Rainfall harvesting is the most economical raw water. Depending on the consumption type, its treatment can be summarized at decanting and filtering or adoption more complex procedures, such as flocculation and chlorination. In some localities, the raw sewage treatment is already done, with steps of railing, prolonged aeration, decantation, sand filter and chlorination. After this treatment, the effluent is pathogenicity free and can be pumped to reservoirs and reused (COSTA; BARROS JÚNIOR, 2005, p. 96).

Costa and Barros Júnior (2005) point out that the water quality acquired for treatment must be consistent with the reuse purpose, because the greater the quality difference of the water to be treated to the water to be reused, the greater the process difficulties. It is not always possible to destroy all pathogens present in the water and it is important to identify the necessary quality for the treated water destination, in order to establish the purity to be reached by the treatment and to guarantee the users' health.

In the hospital laundry, the clothes are separated by light or heavy dirt, which happens when there is contact with body fluids. Pure water, free of iron, magnesium and calcium, between 80 and 90 degrees Celsius (aiding in sterilization), as well as various chemical products suitable for sanitizing and disinfecting clothes, are used for washing.

Certain health buildings effluents collected also needs to have special attention, regarding the need for separation and treatment. There should be a separation process, for example, in sewers from plaster rooms, kitchen, laundry, laboratories, examination rooms, insulation and others that represent risks to public health or maintenance of the external network. The effluents final destination, in the same way, must be monitored, so that they do not cause water resources contamination.

Sewage from certain hospital units has treatment mandatory. Laundry water, for example, has a large amount of fabric flukes, which can lead to clogging or water sources pollution. Laboratory wastewater, in the same way, should be monitored, so that it does not lead to spread of diseases. The laboratories and restrooms of nuclear medicine units must have their wastewater monitored, so that they are not carried with any radioactivity. The sanitary sewage of food preparation services must have fat and filtering boxes, which do not allow the fatty or solid debris contribution in the channeling of the unit or surroundings.

The large consumption of water by hospitals is an obstacle to its sustainability, and it is essential for the hospital safety to implement economic strategies, optimized management, measurement and consumption identification, treatment, reuse and alternative collection. Despite the reduced application of these measures in Brazil, should be highlighted that they can generate, in addition to saving water, a reduction of expenses, making possible the continuation of the consumption rationalization.

ENERGY SECURITY

Reserve generation

Health units are characterized by being large consumers of electricity. The 24-hour operation and air conditioning intensive use are frequent conditions, which impose a high energy demand. Medical equipment, such as in the diagnosis and imaging area – radiology, tomography, resonance – are great energy consumers.

Energy security in health facilities requires that, in particularly sensitive units, such as surgical center, ICU, blood and medicines storage, there is a reserve supply, with the availability of generators and batteries. Alternative voltage supply is advisable in large hospital cases, as way to minimize the supply disruption risk. This safety feature puts health facilities as ideal establishments for the use of energy generation and storage multimodal forms.

The installations and equipment safety is an utmost importance issue in project management. Each facility has its set of standards that specifically cite the health buildings. The electrical installations need, as a priority matter, to guarantee the energy uninterrupted supply and, to that end, must be correctly dimensioned and have alternative supply.

The lighting has characteristics that must be observed, such as the need for outbreaks for patient examination in clinics, examination rooms, dressings and dormitories (SANTANA, 1999). In these environments, the need for safety lighting should not be overlooked. In the operating rooms, the bulbs are essential elements, having several peculiarities, such as the need for minimum dimensions and connection with energy accumulators, which guarantee its operation without interruption. This care should be extended to all life-support equipment and monitoring for vital signs (LAMHA NETO, 1995). Another important factor is the grounding and shielding of equipment against interference, whose faults can lead to serious accidents. The main standards in Brazil with specific recommendations for electrical installations for health facilities are RDC 50/2002 (BRAZIL, 2004) and NBR-13534 (ABNT, 2008).

Economy

The debate about energy saving is necessary, due to energy high cost, problems of equipment maintenance, environmental impact and emission of greenhouse gases caused by the generation forms of electric energy. An energy-saving culture benefits the institution and the urban context in which it operates, as well as serving as an example for other institutions. The energy supply must be safe, reliable and efficient, as it supports equipment that saves and maintains lives (CARVALHO; UCHÔA, 2014). Therefore, it is necessary to optimize, reduce and comply with environmental requirements and legislation.

In the face of the continuing crisis in the supply of electricity and the scarcity of resources, the HCF large consumers, with tight budgets, may implement a management program to reduce expenditures. Such program can range from simple, low-cost actions, such as awareness campaigns, to complex solutions, involving larger investments and long-term returns, such as the installation of a cogeneration system. The energy management program should be designed without impairing the quality of the environment and the services provided, nor compromising the safety of patients and employees (ROSA; MÜHLEN, 2002).

The strategic placement, in hospitals, of energy transformers close to the high consumption places, as a center of diagnosis and treatment, central air conditioning, laundry and kitchen, can represent great savings on cabling and power consumption costs.

In relation to glass and window frames, there is a wide range of types that let light penetrate with the control of the maintenance of heat in the environment, which helps in the air conditioning.

The use of vegetation as a barrier to solar heating in ceilings and facades constitutes a proven procedure. Roof gardens have several advantages besides the shading of roofs, such as the possibility of collecting rainwater and creating places for leisure and rest.

The main responsible for energy consumption in hospitals is usually the air conditioning system, followed by lighting and water heating, and these areas should be the major focal points of an energy management program. According to Rosa and Mühlen (2002), this program should cover all forms of energy used in the establishment, such as electric, gas and fuel oil.

Danella et al. (2016) point out that the main obstacle encountered in the implementation of an energy saving program is to obtain the commitment and support of the hospital community, which can be achieved by presenting a prior assessment of the economy perspective. This perspective can be based on an expected percentage measure, which can be overcome after installation, depending on its management.

In order to provide a basis for the program elaboration, it is necessary to analyze the electricity bills of recent years, extracting data on consumption, cost components and details of provider contract clauses, in order to identify the characteristic demand profile of the hospital, as well as abnormalities, to aid the projection for years to come. It is necessary to make a survey about the periods and units characteristics of operation, equipment and systems of greater expenditure, in order to identify rationalizations possibilities. It is also important to have adequate electrical installations design and maintenance, due to security and also energy conservation, avoiding the losses that occur in poorly designed or installations without maintenance (ROSA; MÜHLEN, 2002).

Air conditioning

Responsible for the greater energy consumption, usually the health facilities air conditioning do not obey standardization, which is usually due to undersized central systems, which does not offer conditioning to the whole complex. According to Carvalho and Uchôa (2014), in these cases, it is necessary to complement the central system, using the most diverse solutions, such as window and split units, sometimes combined in the same environment, significantly increasing consumption power.

As air conditioning can represent up to 60% of the health unit energy consumption, the various economical alternatives, such as the thermal accumulation and the optimization programs, must be considered. An intelligent system, which uses sensors to determine the occupation of certain spaces, such as waiting and service places, can represent great savings on the facility energy consumption.

Water resulting from air conditioning installations condensation can be efficiently harnessed if properly planned. The heat exchanger characteristic of air conditioning systems may represent an opportunity to use heated water during the generation of heat in the compressors.

Rosa and Mühlen (2002) indicate actions aimed at optimizing consumption, such as:

- The use of air conditioning systems with better relation between power consumed and produced, properly sized;
- Maintenance, cleaning and periodic repairs of equipment;
- Ensuring the proper conditioned environments insulation by keeping doors, windows and other air passageways closed, avoiding heat exchanges with other areas, to reduce the workload of the equipment and
- The installation of automation systems to control the appropriate environment temperature levels and the system automatic shutdown.

In an indirect way, the application of solar control films on windows, thermal insulation on walls, sun blockers and shutters on facades are methods of reducing the sun direct incidence and optimizing the air conditioning (CARVALHO; UCHÔA, 2014).

Lighting

In relation to lighting, the economy strategies must be executed in an integrated way with the other building projects. If there is correct use of natural lighting, the lighting design can make the hospital maintenance costs considerably reduced by the circuits placement separated by zones related to the natural illumination index.

Systems for conducting natural light through mirrors (solar tube type) can present great savings in large health units, which cannot always have open windows in all compartments.

The electric energy consumption with lighting becomes lower with the maintenance and modernization of luminaires. In order to save energy in this sector, it is advisable to survey the luminaires and lamps types, quantities and powers installed in order to replace those used by more efficient lamps that allow to improve the illumination level with a lower consumption.

Another efficient procedure is the lighting circuits division into sectors, allowing each environment shutdown separately. In this way it will be possible to use presence sensors, timers and photo sensors to control lighting levels; adjust lighting levels according to standards; to perform lamps maintenance and cleaning and to change the luminaires arrangement, increasing the use of natural light (ROSA; MÜHLEN, 2002).

A new lighting system can maintain or improve the illuminance level, using a smaller number of more efficient lamps and with greater reflection power and, nevertheless, save energy (DANELLA et al, 2006). The lack of lamps standardization and the absence of luminaires independent controls are prevalent problems related to the energy management consumption with illumination in health units (CARVALHO; UCHÔA, 2014).

Water Heating

Heating water by inefficient means can be an obstacle to energy savings. Natural gas boiler systems for heating are more efficient, being a better alternative in relation to the electric showers, which consume a lot of energy. Diesel oil boilers should be avoided and maintenance should be performed on a regular basis. A solution that requires a bigger investment, but brings greater benefits to the environment, is the installation of solar panels for water preheating (CARVALHO; UCHÔA, 2014). According to Rosa and Mühlen (2002):

> [...] Solar water heaters and cogeneration systems represent a good opportunity for energy conservation in large hospitals. In addition to these systems, one can also mention gas water heaters and different types of steam boilers that operate with cheaper fuels than electric energy. (ROSA; MÜHLEN, 2002, p. 5) [our translation]

The steam production facility, however, must be preceded by an accurate cost study, which takes into account the problems of equipment maintenance.

Alternative Generation

The sizing of generators for complete supply of certain areas of the hospital can be considered a safety and economy strategy. The withdrawal of part of the building from the public supply at peak times, with the input of the generators, can be considered a viable economic and functional provision, depending on the fuel price. In this case, cogeneration would also be indicated:

> The cogeneration systems can be very interesting economically, since they have high energy efficiency due to generate electric energy with thermal energy, that would be lost in the process used for heating water or other works. But while attractive, the implementation of a cogeneration system requires a high investment and may be infeasible for small hospitals. (ROSA; MÜHLEN, 2002, p. 5) [our translation]

Solar water preheating is an advantageous alternative in the case of buildings in tropical areas. This can be particularly useful in supplying electric showers and as an aid in the steam generation.

Depending on the locality, geothermal energy can represent a sensible economy in the cooling or environmental heating functions.

Large hospitals, that have large parking areas and access roads, can efficiently utilize a battery system charged with solar panels as the external lighting source.

Conclusions

Despite the scarcity of actions aimed at water and energy security in Brazilian hospitals, there are alternatives available, with different degrees of complexity and investment to be implemented, mainly requiring the managers and community commitment, as well as investment valuation in the area.

In the present work, some highlights of this theme were presented. Regarding water security, quality, quantitative sufficiency, reuse strategies, storage and water treatment were pointed out as essential factors. In relation to energy security, the need for reserve generation, economy, air conditioning, lighting, water heating and alternative generation were highlighted as more relevant items.

Security issues should not be disregarded, as well as the medium or long-term environmental and economic benefits for institutions. It is imperative to raise the managers and employees awareness and seek environmental consulting and certification to assist in taking safety and energy-saving measures to bring the benefits to the environment to patients and employees.

REFERENCES

ABNT. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 13534: 2008**. Instalações elétricas em estabelecimentos assistenciais de saúde. Rio de Janeiro, 2008.

BRASIL. Agência Nacional de Vigilância Sanitária. **RDC 50/2002**. Normas para projetos físicos de estabelecimentos assistenciais de saúde. 2. ed., Brasília, 2004

CARVALHO, Antonio P. A. de; UCHÔA, Patrícia F. Strategies for energy optimization. **IFHE Digest**. V. 2014, p. 96 - 98.

DANELLA et al. Projeto de Eficiência Energética no Hospital de Clínicas da UNICAMP. In: XVII SEMINÁRIO NACIONAL DE DISTRIBUIÇÃO DE ENERGIA ELÉTRICA, 2006. **Anais...** Belo Horizonte, 2006. Visited in: http://www.fem.unicamp.br/~jannuzzi/documents/hc_unicamp_sendi_v6.pdf. Access: maio/2017.

ROSA, J.; MÜHLEN, S. **Gerenciamento de Energia Elétrica no Ambiente Hospitalar**. UNICAMP: São Paulo, 2002. Visited in: http://www.bioingenieria.edu.ar/grupos/geic/biblioteca/Trabypres/T02TCBr12.pdf. Access: maio/2017.

COSTA, Djeson M. A. da; BARROS JÚNIOR, Antônio C. de. Avaliação da necessidade do reúso de águas residuais. **Holos**, Ano 21, set. 2005, p. 81-101. Visited in: http://www2.ifrn.edu.br/ojs/index.php/HOLOS/article/viewFile/74/80. Access: junho/2017.

GOMES, A. M.; BITTAR, O. J. N. V.; FERNANDES, A. D. Sustentabilidade na saúde: água e seu consumo. **Revista de Gestão em Serviços de Saúde - RGSS**, vol.5, n.1, jan./jun. 2016. p 76 - 85. Visited in: http://www.revistargss.org.br/ojs/index.php/rgss/article/view/238/178. Access: junho/2017.

LAMHA NETO, Salim. **Instalações prediais ordinárias e especiais**. Textos de apoio à programação física dos estabelecimentos assistenciais de saúde. Brasília: Ministério da Saúde, 1995.

OLIVEIRA, Simone G.; ALMEIDA, Rogéria M. A. **Reuso da água hospitalar**: uma fonte de economia e sustentabilidade. Baurú, s.n., s.d. Visited in: http://www.fatecbauru.edu.br/mtg/source/Reuso%20da%20%C3%81gua%20Hospitalar%20uma%20fonte%20de%20economia%20e%20sustentabilidade%20(1).pdf. Access: junho/2017.

SANTANA, Crismara J. R. **Instalações Elétricas Hospitalares**. 2ª. Ed. Porto Alegre: EDIPUCRS, 1999.

SILVA, Patrícia B. da; TEIXEIRA, Elisabeth P. Reuso da água do rejeito de um tratamento de osmose reversa de uma unidade de hemodiálise hospitalar: estudo de caso. **Revista Brasileira de Inovação Tecnológica em Saúde**. 2011, p. 42-51. Visited in: file:///C:/Users/La%C3%ADs/Desktop/1496-4627-1-PB.pdf. Access: junho/2017.

LECTURES SUMMARIES

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LEVERAGING A RISK-BASED APPROACH FOR SAFETY AND SUSTAINABILITY IN HEALTHCARE SETTINGS

Introduction

Every day hospital administrators and facility leaders make major decisions that affect community and environmental health, patient and staff lives, and their organization's bottom line. Safety must always be paramount, yet there is risk inherent to the medical field of practice and to the operation of facilities. Increasingly, hospital decision makers are tasked with addressing not only the immediate safety issues, but also the longer-term concerns of resiliency and environmental threats. They must simultaneously address safety and sustainability of their staff, patients, and the greater community their organization serves. Consider a hospital that has just had the water tested. The testing company reports that legionella, the bacteria that causes legionellosis, was discovered in the water supply. They recommend dosing the building water supply with chlorine and starting a daily water testing regime until there is no legionella detected in the water system. They further recommend transporting all immunocompromised patients to another facility until tests show no legionella is present in the facility. What should hospital decision makers do when facing such risks?

In these complex spaces, where daily decisions affect safety and the ability to provide critical service, effective models for decision making are needed. A risk management approach can be leveraged to facilitate decision making and improve both safety and sustainability for healthcare facilities. Risks have costs that may include financial, environmental, societal, and safety outcomes. Every organization faces some level and amount of risk; managing it proactively and effectively can lead to increased compliance, increased likelihood of achieving organizational targets, streamlined decision making, operational efficiencies, and improved transparency and reporting. For issues like ventilation rates and water system design and maintenance, sustainability and infection control can seem to be opposing interests. With air ventilation systems, there is a direct relationship between the time and speed at which they run and the amount of energy they consume. However, there is no evidence that the relationship between infection rates and ventilation rates are similarly related above a minimum threshold. People who are highly concerned about sustainability are often accused of being zealous, encouraging lower than acceptable rates, at the expense of patient safety. Those who are highly concerned with infection control may be accused of utilizing higher than necessary rates, that have no obvious or quantifiable impact on patient safety, but lead to less sustainable systems and wasted resources.

RISK MANAGEMENT APPROACH

Overview

The risk management approach involves developing an understanding of the level of risk of particular conditions, and then matching appropriate actions with each risk level, so that the risk is either completely mitigated or acceptable. In this approach, a system is created that comprehensively and continually manages risk. Managing risk is an iterative process, and should involve regular evaluation, as influencing factors change over time. If an adverse event threatens to occur or does occur, the framework and knowledge developed from this experience are used to make the system stronger.

Methodology

The first step in a risk management approach is to organize a multidisciplinary team of stakeholders, with clearly identified roles, to collectively assess the potential threats. Without an appropriate team of dedicated experts and a risk manager to lead the effort, it would not be advisable for an organization to take this approach. Some roles may be filled by individuals outside the organization (i.e. consultants as necessary). The workgroup is tasked with: 1) identifying the risk and risk criteria (i.e. acceptable and unacceptable levels of risk); 2) determining the response strategy (i.e. policy and procedure) for high and low risk situations; 3) implementing and monitoring said strategy; and 4) validating outcomes and reevaluating risk on a regular basis. Risks come in the form of internal or external factors. Assessments begin at a high level (i.e. with geographic or community factors) and move towards more granular factors (i.e. operational processes). Considerations may include probability of occurrence, severity of risk, and level of mitigation or intervention to decrease risk. The team should look at the system and identify the areas of the system that are most susceptible to an adverse event. Next, the team should review the system and note the areas that could be potentially most impacted by an adverse event. In the case of hospitals, this is usually where your most vulnerable patients are. When embarking on this path, it is helpful to utilize a visual tool, such as maps of buildings or processes, or one-line diagrams. More information on risk management can be found at www.iso.org/iso-31000-risk-management.html.

FIELD APPLICATIONS

Applying a Risk Approach to Water Management

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 188 is a standard developed to deal with the risk of legionellosis from building water systems. Legionellosis, a term referring to both Legionnaires' disease and Pontiac fever, occurs when the bacterium Legionella causes either severe pneumonia (Legionaires' disease) or a less severe influenza-like illness (Pontiac fever). Legionellosis is acquired predominantly from exposure to legionella associated with building water systems. ASHRAE 188 was developed for all non-residential buildings (as well as certain multi-family residential buildings) and sets the standard for dealing with legionellosis in building water systems.

The development of this standard for water management is helpful to consider here, because it highlights how healthcare environments can benefit from a risk based approach. ASHRAE has considered developing a standard to battle legionellosis for some time and has produced other precursor guidance documents. There was an original ASHRAE committee formed to do the important work of creating an adoptable standard, but they envisioned a similar process for all building types. The healthcare community did not approve of this approach because it ignored the fact that certain healthcare facilities have onsite resources, such as infection prevention programs and risk managers, to effectively manage risk. The original standard dealt with one waterborne pathogen, whereas hospitals have hundreds of pathogens and other risks that they routinely manage. What is of major concern to other building types was one of a host of concerns for hospitals. In other words, hospitals have different resources and a different risk horizon than other organizations, and therefore wanted an alternate way to comply with the standard. The committee was reformed and hospitals that met certain criteria could use normative annex A as an alternate compliance path to meet the requirements of ASHRAE 188. This highlights an important point as we consider using a risk management approach to improve sustainability and safety; in making decisions, it is necessary to fully consider the context of those decisions.

How it Works

Legionellosis typically spreads to humans when water that contains legionella is aerosolized in respirable droplets. Legionella will enter a water system. If the conditions are right, the legionella bacteria will grow in biofilms in the water. It exits the water system via water fixtures and features (e.g. showers or ice machines). If the water becomes aerosolized, then it can enter the respiratory tract. If that person is susceptible to the bacteria, they will develop legionellosis. The presence of legionella bacteria in a building water system is not sufficient to cause legionellosis. Moreover, drinking water with legionella bacteria is not believed to cause legionellosis; instead, it must be inhaled. Thus, the bacteria must grow, become aerosolized and enter an infected host. If any portion of the chain of infection is disrupted, legionellosis cannot be transmitted. A risk management approach allows for consideration of efficient ways to disrupt this chain, by identifying, mapping, and managing critical points to understand, manage, and reduce risk.

In order to ensure this is done effectively, ASHRAE 188 requires hospitals to do the following: 1) establish a designated team; 2) develop a building water flow diagram; 3) identify at-risk populations; 4) identify the areas, equipment and systems at risk; 5) develop strategies to mitigate the risks; 6) assign responsibility to implement risk mitigating strategies; 7) establish a program to monitor the strategy parameters; 8) develop actions to be taken when monitoring results are outside of established parameters; 9) document all activities; and 10) periodically review the water management program. The dedicated team ensures there are people with the requisite areas of knowledge to write a water management program and oversee its implementation. The roles necessary to do this include a hospital executive who can make command decisions about the water management program, a facility manager who is familiar with the building water system and has the ability or authority to provide maintenance resources, and an infection preventionist who knows the facility's protocol and methods for reducing infections. It is also advisable to include representatives who work in areas with higher infection risk.

The team develops and reviews a building water flow diagram and uses this map to evaluate the physical and chemical conditions of each step in the water flow system to evaluate areas where hazards may occur. Conditions that favor legionella growth include water temperatures of 77 to 108 degrees Fahrenheit, stagnation, scale, sediment, and biofilms. Different sections of the water system present varying levels of risk. The team also identifies areas with patients at higher rates of susceptibility (e.g. compromised immune systems). Once the water flow diagram and patient risk areas are mapped, the team identifies locations with a control measure to ensure that parameters stay within control limits. A fluctuation from normal operations may be a first indicator that there is a change in risk for waterborne pathogens. For example, at the point water enters the system, the team may want to indicate that the water should be less than 70 degrees Fahrenheit to ensure it is outside of the legionella ideal growth temperature range. The plan would then consider how to monitor this location (e.g. measure the temperature weekly), and respond if a characteristic is outside the tolerance range (e.g. measure the chlorine residual). All actions in the water risk management plan must be assigned to a responsible party. Wherever elevated risk is identified, the plan should indicate the appropriate procedures to follow. More detailed information on ASHRAE 188 can be found at www.ashe.org/management_monographs/mg2017platt_et_al.shtml.

Applying a Risk Approach to Ventilation Rates

After ASHRAE 188 was established, the committee and ASHRAE members realized they had developed a powerful approach to deal with risk in healthcare, and that it could present an opportunity to enhance sustainability within hospitals while maintaining safety. In hospitals, reductions in ventilation rates represent a major opportunity for energy conservation. There is a general sense that hospitals are overventilated at great energy cost, but without associated benefits in infection reduction. The problem is the lack of definitive evidence to support the established rate standards. This has prevented reduction of required ventilation rates in healthcare for some time, and likely wasted a large amount of resources. However, with the advent of the risk management approach used in ASHRAE 188, many recognized an approach that could also work for hospital ventilation rates. Designated teams of experts could decide which areas within their hospitals were deemed too risky for changes in ventilation rates and those that were safe enough for reductions, based on an assessment of risk and appropriately determined and monitored policies and procedures. Thus, the idea for ASHRAE 170 Addendum O was born.[1]

Infection control and prevention identifies and segregates people who are especially vulnerable and affords them greater than normal protection in a healthcare setting. It also identifies and segregates threats so that they cannot pose a risk to building occupants. This segregation and protection can be done through engineering controls, but it can also be accomplished through operational controls. Moreover, the trained infection control and prevention professionals on staff at most hospitals can take community-levels of risk into account in assessing their particular situations, as opposed to more generalized concerns. For those healthcare providers that have the expertise to analyze, implement, and document their specific ventilation requirements, this proposed addendum provides a risk-based approach to establish alternate ventilation rates for spaces required in the ASHRAE 170 Standard. In some cases, a lower ventilation rate is proposed, leading to sustainability benefits in conserved resources. In other cases, a higher ventilation is proposed, leading to safety benefits of mitigated risk.

Addendum O calls for an airborne hazard risk management plan, which includes a designated team, air system space plan, ineligible spaces (to which the plan does not apply), high risk spaces (as identified through the risk assessment), design requirements, building monitoring procedures, response procedures, and a continuous review process. The appendix offers a sample airborne hazard risk management plan.

CONCLUSION

At first glance, the adoption of a standard like ASHRAE 188 hinders sustainability initiatives, while ASHRAE 170 Addendum O appears to neglect safety. In reality, they both implore a method of calculating risk, considering a wide variety of criteria and impacts, and selecting the appropriate actions for optimized safety and sustainability outcomes. Sustainability may generally call for a reduction in water use and ventilation rates, while safety may call for the opposite. There is a perceived conflict between the two; however, a more reflective review

[1]Addendum O has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada). This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website, www.ashrae.org. The appearance of any technical data or editorial material in this public review document does not constitute endorsement, warranty, or guaranty by ASHRAE of any product, service, process, procedure, or design, and ASHRAE expressly disclaims such.

helps us understand that they do not need to compromise one another. While it is true that sustainability is concerned about the future, it is also concerned about the present. The idea of sustainability is to preserve both the present and the future. In that sense, strategies that are attentive to the need for safety today, while also considering the effects of today's actions on the future are the most sustainable.

The thought that reducing water use may increase the risk of legionella growth in the water system may cause a hospital decision maker to reject the idea of reducing water use entirely. The risk management approach acknowledges that reduced flow rates may increase the risk of legionella growth in certain areas, but it provides an avenue through which the actual risk can be assessed. Where sustainability measures make sense, and are no riskier, they can be implemented. Where they are riskier, they will not be implemented. As opposed to completely rejecting sustainability, a more nuanced approach is the result, which helps effectively balance sustainability and safety. The healthcare facility that has implemented water and airborne hazard risk management plans is well served.

There is a rush around the world to follow US standards in building design, but in many cases, a lack of adequate data to fully support them. Resources are often wasted by attempts to be overly cautious. Building standards operate based on hypotheses about causation, as opposed to the real, particularized data that is continually collected through a risk management approach. Building code offers a one time, 'one-size-fits-all' solution, whereas the risk-based approach provides customized solutions and an iterative process of 'plan, do, check, act'. One of the challenges for the healthcare industry lies in the sustainability extremists, who believe in 'going green' at all costs; they can give sustainability a negative view in healthcare decision makers' eyes and prevent progress in environmental, social, financial, and public health outcomes. The extremists on the infection prevention side see sustainability as something that will compromise safety no matter what. Having a dedicated team of experts who can see past this dichotomy and devote the time necessary to the practice of risk management is a challenge, but when done in a responsible, intelligent way, safety and sustainability benefits can both be realized.

Because it forces assembly of people with the knowledge and authority to make these effective decisions, the formation of a designated team itself likely reduces risk. Moreover, because this approach requires an evaluation of where risk is coming from, it focuses resources on the most critical areas. This can lead to more efficient use of resources and more effective outcomes. A hospital's resources are focused at the decisive point instead of being generally focused everywhere. If done effectively, the risk management approach can reduce the resource need for effectively managing the water or ventilation system. As compared to not monitoring, it saves the cost of dealing with future problems in the system or with high incidence of hospitals acquired infections. Not only is this protecting building occupants, but these conserved resources could be used to advance more safety and sustainability initiatives. Importantly, the risk management approach highlighted here provides an opportunity for the gathering of evidence-based intelligence that can be used by the industry to make even more effective, data-driven decisions.

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DISASTER RESILIENCE IN HOSPITAL ENGINEERING AND ARCHITECTURE

Introduction

Ashikaga Red Cross Hospital received 1st Prize at the IFHE International Building Awards in 2016, which was a newly established awards scheme created in 2016. As a designer, we wish to contribute to the IFHE's current seminar by participating in this session. The BCP (Business Continuity Plan) in Japan is focused on countermeasures against earthquakes. I am an Architect who works for the largest design office in Japan, Nikken Sekkei, and I am responsible for the section specializing in hospitals. A hospital must continue to provide medical care even after a major earthquake, therefore various ideas are important during the design stage.

In recent years, several earthquakes have hit Japan, including the Southern Hyogo Prefecture Earthquake on 17th January 1995, the Great East Japan Earthquake on 11th March 2011, and the Kumamoto Earthquake on 16th April 2016. As they caused damaged to the hospitals designed by Nikken Sekkei, we have learned lessons for designing resilient hospital buildings and services, and applied them to new projects.

This presentation will be made on the design lessons learnt from the earthquakes in 2011 and 2016, based on our experience of the hospitals performance during and after the earthquakes.

First, the following situations after the earthquakes will be described:

- What kind of damage was caused to the hospital buildings and services;
- How the hospital functions were quickly recovered from the damage; and
- How the hospitals played key roles as disaster centers.

In conclusion, the following lessons will be presented: as 3 case studies.

- **Case study-1**: After the Great East Japan Earthquake, how JAPANESE RED CROSS ISHINOMAKI HOSPITAL could follow BCP and keep its function as the only operational health care facility in the city after the disaster caused by both an earthquake and a tsunami.
- **Case study-2**: After the Kumamoto Earthquake, how ASO MEDICAL CENTER could follow BCP and keep its function as the only operational health care facility in the city after the earthquake.
- **Case study-3**: How hospital buildings and services can be made resilient against earthquakes in the future, in order to support 'the hospital environment for patient and worker safety'.

Case study-1:
JAPANESE RED CROSS ISHINOMAKI HOSPITAL
This core hospital, providing regional acute care, is located in Ishinomaki City, the area that sustained the highest number of deaths and missing persons of all the regions devastated by the Great East Japan Earthquake of March 11, 2011. Due to its high altitude above the water line and seismically isolated structure, the hospital escaped major damage in the earthquake and subsequent tsunami <Fig-1>. With medical facilities in coastal areas sustaining tremendous damage and countless numbers of patients converging on the hospital, it continued to carry out disaster-related medical activities. Normally used as a waiting area for patients, the hospital's entrance lobby was immediately transformed into a triage station, and by putting into practice drills that had been practiced on an everyday basis, it was possible for the hospital to take in huge numbers of additional patients <Fig-4,5>.
The video of the earthquake and subsequent emergency planning and implementation can be viewed in the following link. (audio is Japanese only).
https://www.youtube.com/watch?v=Pc1ZO7YwcWc

Furthermore, because of the large eaves above the entrance, it was also possible to perform medical activities outside under the eaves, enabling a broadening of medical activities<Fig-7,8>. With the purpose of utilizing this experience and providing knowledge down to future generations as well as enhancing the hospital's functioning as a regional acute care hospital, in 2015 the hospital was extended to include a new hospital building, training center, and nursing school. The new facilities also include expanded water supply equipment and other improvements, making the building stronger against future disasters based on the valuable experiences provided by the March 11, 2011, earthquake.

• What kind of damage was caused to the hospital buildings and services

- Earthquake occurred around 14:46 on March 11, 2011
- By the 3rd day, as a disaster base Hospital, 1,251 affected patients were treated.
- Since the building was not heavily damaged, medical treatment continued.
- Power outage for 2 days, water outage for 5 days, gas supply stopped for 30 days
- The maximum displacement of the base isolation was about 26 cm.
- The structure received little damage.
- Partial subsidence of the ground (10~15 cm), caused external cracking.
- Expansion joints, doors, etc, received some damage.

• How the hospital functions were quickly recovered from the damage

- Power outage for 2 days, however the emergency generators provided sufficient power
- After 9 days, the line from the substation was restored.
- The generator capacity was about 60% of the contract maximum power, but there was no shortage.
- The fuel reserve was for 3 days, and 30% of this was used.
- The water outage was five days from March 11th to 16th, and one day on April 8th.
- Although the hospital ran out of water in one day they continued the water supply with two fire-fighting 10 t water supply cars, enabling medical treatment to continue.

- As a measure of water saving, the hospital banned showering, and posted notices to conserve water around the hospital.
- Since the public sewer system was undamaged, there was no need to use the emergency drainage tank.

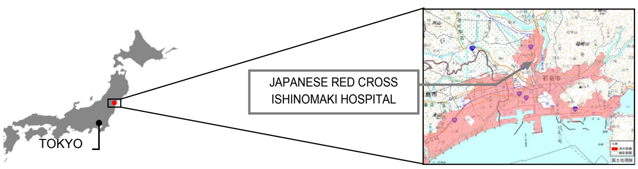


Figure 1: Inundation area due to tsunami (red area in the figure)

Figure 2: Hospital before disaster
At the time of designing, the site was set aside 3 m in consideration of the history of the past damage, so it escaped flood damage.

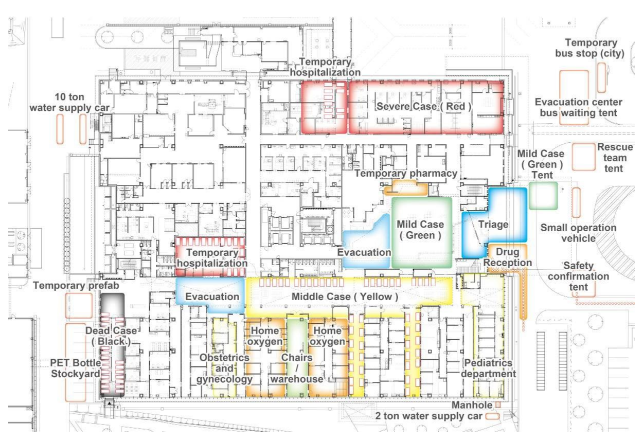


Figure 3: The first floor was temporarily used for triage after the disaster. The daily training carried out by the hospital for this situation was critical in the successful implementation of the BCP.

Figure 4: Entrance Lobby under normal circumstances

Figure 5: Entrance Lobby when in use as a triage station

Figure 6: Two heliports are required for large-scale disasters

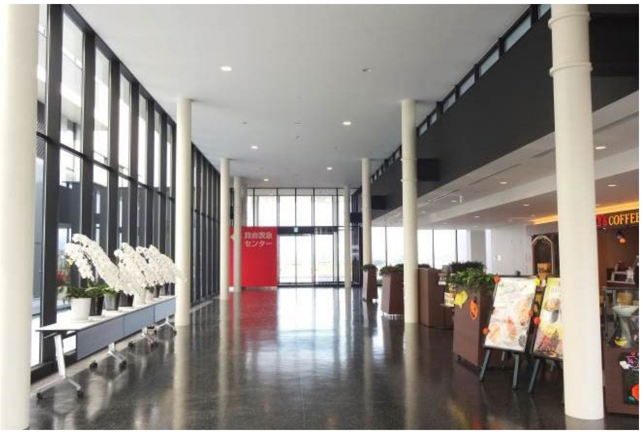
Figure 7: Rescue vehicle used when performing minor surgeries

Figure 8: Medical activities under the hospital's eaves

The outline of the extended Acute Care Hospital of JAPAN RED CROSS ISHINOMAKI HOSPITAL

The newly extended building includes an emergency and critical care section that has been enlarged to several times its previous size as well as an ICU, equipping the hospital to respond to rising regional needs for acute medical care. These new facilities are linked to the original hospital building via a walkway in a design facilitating easy coordination. Furthermore, connecting these emergency medical facilities and the Training Center via a Medical Mall makes it possible to enhance disaster medical training. Not only has a new rooftop heliport been installed, but a second heliport has also been built on the newly constructed car park, enhancing transportation activities in times of disaster.

The extended Acute Care Hospital



Medical Mall in the extended section

Overall view of the facility with new extensions

Miyagi, JAPAN - 2015

2012 - Selected The Special Prize of Japan Society of seismic isolation and more...

17,319 m2 GL+33 m

53,405 m2 452Beds

Case study-2:

ASO MEDICAL CENTER

Aso Medical Centre is a core hospital in the area responsible for acute care and disaster functions located at the foot of Mt. Aso, a symbol of the town where the volcanic activity is continuous. It is a newly constructed hospital just opened in 2014, but experienced the Kumamoto Earthquake in 2016.

With on-site takeoff and landing areas, medical gases were set up at outpatient waiting areas and auditoriums, in conjunction with stockpiling warehouses. In an emergency situation such as the earthquake, it is a facility capable of accommodating many patients.

As a result of considering the construction cost, the central medical clinic and wards were constructed as a seismic isolation structure, and the outpatient building was constructed as an earthquake-resistant structure <Fig-9>. The boundary expansion joint was assumed to be destroyed when the swing width of the earthquake reached its maximum. The building experienced swaying of 46 cm on one side and 90 cm in reciprocation, and as a result the expansion joint was destroyed. First of all, there was a blackout after the earthquake, the emergency generators started to work and provided sufficient electric power instantly. 40 hours after the power generation car which the power supply company sent arrived and restored the power. The water outage was temporary. All surrounding medical facilities were unable to function, only Aso Medical Center was operational. The hospital became the base of DMAT, Disaster Medical Assistance Team, after the earthquake. Since the heliport was also planned on the ground near the emergency department, it was able to accept patients transported by helicopter. The elevator stopped for 4 days.

Figure 10: Damage from the Kumamoto Earthquake

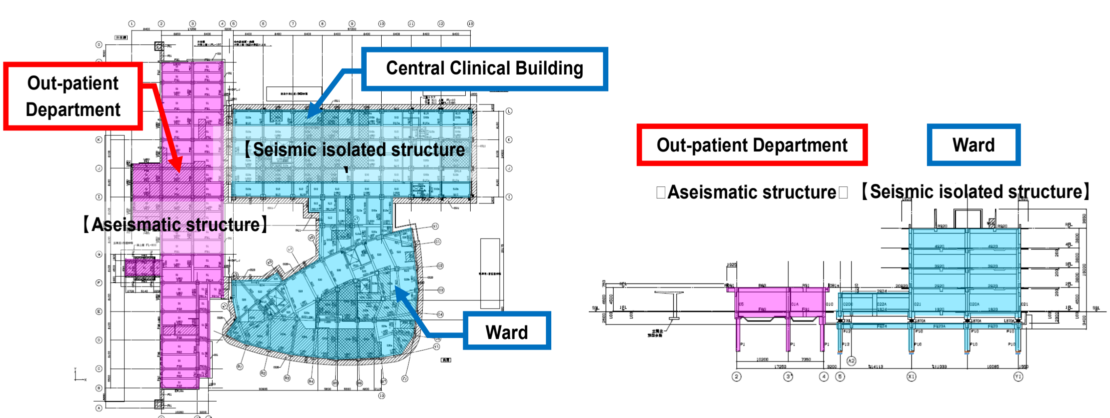


Figure 9: The structure of Aso Medical center

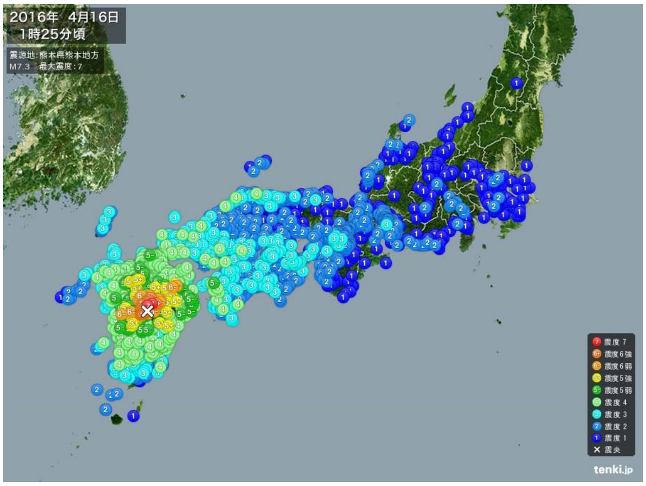
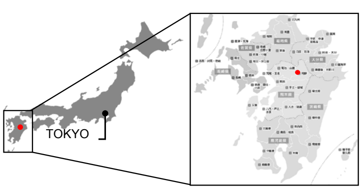


Figure 11: The hypocenter of the Kumamoto Earthquake

The outline of ASO MEDICAL CENTER

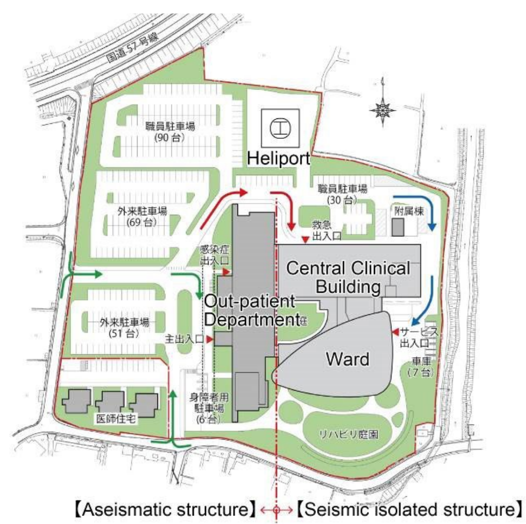


The outpatient wing, central medical clinic building, and wards are divided into 3 buildings. The outpatient and inspection functions are consolidated on the first floor. It is an easy layout for visitors to understand. Also the arrangement allows the hospital staff to collaborate between departments easily.

From the courtyard and top-lights with clear sunlight, it was planned as a bright and comfortable hospital.

Taking advantage of the majestic landscape of the mountains of Aso, each hospital room was arranged to take in the panorama. The central part of the ward was made the staff station, making it a ward building that is easy to manage for nursing staff and providing a sense of security for patients.

Using curved lines and natural colors, the appearance was harmonized with the scenic natural environment.



Kumamoto, JAPAN - 2014

26,335 m2 GL+20m

11,336 m2 124Beds

Case study-3:

SAKU CENTRAL HOSPITAL ADVANCED CARE CENTER

Saku Medical Center is a hospital responsible for emergency and advanced medical care. Saku-city, Nagano Prefecture is located 200 kilometers from Tokyo, and has rarely experienced major earthquakes. Therefore, when a major earthquake occurs in Tokyo, it is built assuming that the patients will be carried to the hospital by helicopter. In case of a power outage, medical care can be self-reliant with power supplied by an emergency generator. If the elevator is stopped, it cannot be resumed unless qualified inspection personnel inspect it to ensure safety. Assuming such a case, in this hospital the functions of supporting acute care are coordinated horizontally on the 2nd floor so that ambulances can also access the second floor with a sloped ramp. In other words, even if the elevator stops, emergency medical care can still be continued <Fig-13>.

This arrangement ensures that the hospital can act as an emergency disaster centre during an earthquake.

Figure 12: Overall view of the building showing patient ward and therapy wings standing side-by side

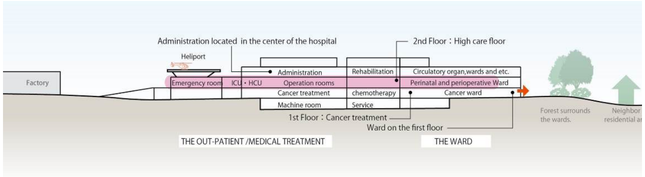


Figure 13: The cross-sectional structure enables horizontal coordination of functions across related section

In order to soften the sense of high tension of an acute care hospital, locally produced "platy andesite stone", Japanese Larch wood, architectural exposed concrete cast in cedar formworks, and other invitingly textured materials have been utilized <Fig-14,15>. Inside, not only have large windows been installed in open-ended corridors, but also natural light streams in through light gardens and top lights throughout the facility, creating an internal hospital space with a warm atmosphere enveloped in gentle light <Fig-14-17>. As a "High Care Floor", the 2nd Floor supporting acute care has a layout that emphasizes functionality, enabling horizontal movement on the one floor amongst facilities including the Emergency and Critical Care Center, operating theaters, angiography rooms, ICU, Perinatal Care Section, and Perioperative Care Ward. Ambulances drive up a slope exclusively for their use to the 2nd Floor, and the helicopter ambulances land on and take off from the top of the Emergency and Critical Care Center. In the ICU, care has been given to ensuring that staff can watch over patients easily, with the Staff Hall surrounded with glass-walled private rooms. The design enables visitors to enter patients' room from the corridor on the exterior side of the rooms, completely separating the lines of flow of staff and patients' families <Fig-18>.

Figure 14: The Entrance Hall features beautiful natural light and greenery

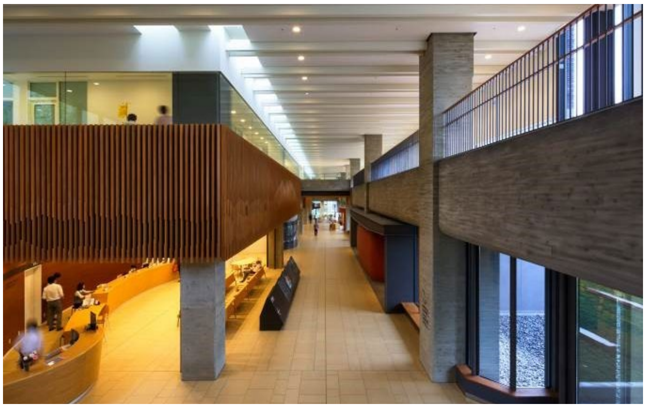


Figure 15: The Entrance Hall features beautiful natural light and greenery

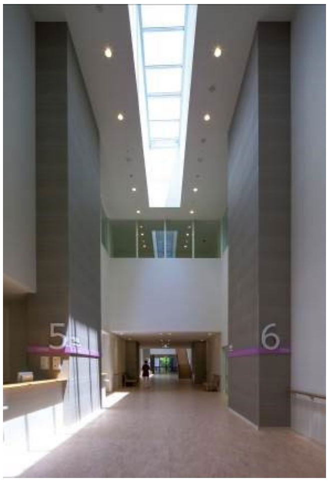
Figure 16: Façade incorporating locally produced Teppeiseki stone

Figure 17: The light court of Out-patient Department

The outline of of SAKU CENTRAL HOSPITAL ADVANCED CARE CENTER

Patient wards can be clearly viewed from the staff station

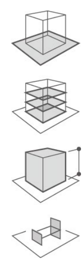
Leading advanced and emergency medical care for the local community, the 450-bed Advanced Care Center takes advantage of the characteristics of the facility's expansive, abundantly green site to create a low-lying 3-floor building that spreads out horizontally, with separate ward and diagnosis & treatment standing side-by side. The 1st Floor is the "Cancer Treatment Floor"; the 2nd Floor is the "High Care Floor", and the 3rd Floor is the "Rehabilitation Floor"; each of these floors are laid out so that the functions of closely related patient wards and therapy wings can be coordinated simply and easily through movement around each of the floors. Beginning with the 1st Floor, the ward has a high sense of connection with the ground, creating an atmosphere of being in the middle of a forest.



Testing Hall, where patients can see where to go at a glance

Figure 18: ICU providing clear lines of vision

Nagano, JAPAN - 2014



129,066 m2

49,843 m2

GL+20 m

450Beds

Ambulance parking spaces within the Emergency section

Heliport and helicopter ambulance hanger

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RESILIENCE IN ENGINEERING AND ARCHITECTURE - "CATASTROPHES AND DISASTERS" Experience from Colombia

I. INTRODUCTION

Communities in Latin America and the Caribbean are often affected by adverse events of great magnitude and intensity, with direct consequences on the life and health and adverse effects on essential services such as health services.

To reduce risk[4] and ensure adequate and timely response to damage it is essential that the health sector has plans and processes for the organization and coordination, structured and implemented in advance, involving the institutions of the sector, seeking the best use of resources and the complementarity of the medical services provided by the institution.

Within health systems, hospitals play an essential role in disaster situations, since they are the articulators of both primary and secondary response[5] being also the place where the population seeks attention to their immediate health needs.

A safe hospital is that health facility whose services remain accessible and operating at its maximum installed capacity and on its own infrastructure immediately after a highly destructive phenomenon of natural origin.[6]

Therefore, it is necessary for hospitals to have comprehensive plans to identify the risks inherent in its geographical location, structural, non-structural and functional components in order to reduce them and deal with emergencies and disasters. These hospital plans must be integrated into the sectoral and communal plans in the areas of the region where the institution is located, with their corresponding level of coverage and complexity.
Both an emergency and a disaster produce alterations or damages of various kinds (to health, goods, the environ-

[4]Risk: Extent of the likely losses in the event of a natural disaster. The level of risk is intimately associated with the level of protection incorporated into the structure. Source: PAHO/WHO
[5]Primary response: involves all actions taken during the first twelve hours after impact. The secondary response: corresponds to the activities developed after the first twelve hours of the event until seventy-two hours.
[6]PAHO/WHO Concept of Safe Hospital

ment, etc.) that demand immediate response from the affected community. Disasters have been popularly attributed to "bad fortune". In this view, disasters are often attributed to the punishment of the gods or the participation of external forces. However, emergencies and disasters are socially constructed over time, generating conditions of vulnerability that make communities susceptible to be damaged/impacted before the materialization of threats.[7]

Decision makers often have to deal with impacts of low - or medium-intensity disasters - and less frequently disasters - which are the result of natural or manmade threats. It is very likely that climate change and climatic conditions increase the population's exposure to extreme risks and events. Although less obvious, normal developmental activities can also generate major environmental changes that contribute to increased risk, if they're not taken into account and aren't dealt with accordingly.

II. TERMINOLOGY

Answer: Actions taken in the event of damage or when imminent, with the aim of saving lives, reducing suffering and reducing losses.

Mitigation: A set of actions to reduce possible negative effects during disasters and emergencies. In this case, the objective is to minimize possible damages

Preparation: A set of measures and actions to minimize loss of human lives and other damages, timely and appropriately organizing the response and rehabilitation to ensure continuity of services. The preparation is all actions that will facilitate the response to emergency and disaster situations

Prevention: Set of actions to prevent the occurrence of damages as consequence of an adverse event, for which the threat, the vulnerability, or both, are intervened until the risk is eliminated. The ideal of prevention is to eliminate the threat and/or vulnerability or at least reduce the probability of it. Once the risk analysis has been completed, plans should be written and measures implemented to eliminate or reduce it. One of the key actions in risk prevention in hospitals is to avoid their construction in risk areas

Rehabilitation: Restoration in the shortest possible time of the continuity of the health services that were interrupted during the acute phase of the emergency or disaster

Risk analysis: Set of actions tending to make an assessment of risk components (threats and vulnerability). To perform a complete risk analysis the different results of the related technical studies should be taken into account to accompany this evaluation process.

Hospital Safety Index (HSI): It is an instrument that allows for a general and approximate estimate of the safety situation of the establishment, taking into account its environment and the network of health services it belongs to. In comparative terms, it is like taking a "blurred photograph" of the hospital, but one which provides the basic elements to identify the characteristics of the establishment and confirm or rule out the presence of imminent risks.[8]

Determining the HSI is a new way of managing risk in the health sector that allows the continuous monitoring of the safety level of health establishments. Safety is no longer considered as a "yes-or-no" or an "all-or--nothing" situation, but rather as an intermediate state that can be improved gradually. In this way, the HSI can be used to identify those aspects involved in the proper functioning of a hospital during and after the impact of the threats. For this reason, it is a useful, easy to apply and low-cost tool that allows the assessment of hospital vulnerability to disaster.

What is Calculated?

There are a number of steps to calculate the HSI. It starts with applying a standardized verification[9] list to evaluate a set of indicators (structural, non-structural and functional) and their levels of security where by means of a rating system a numerical value is assigned to each aspect according to its relative importance to contributing to the capacity of a hospital to withstand

[7]Threat: External risk factor represented by the potential occurrence of a phenomenon or event of natural origin, generated by human activity or the combination of both, which can manifest itself in a specific place with a certain intensity and duration

[8]Taken and adapted: PAHO/WHO Evaluator's Guide

[9]PAHO/WHO Tool - This is a checklist that contains aspects that are evaluated, applying safety standards and assigning relative weights to each evaluated aspect; it is applied by professionals trained in the structural, non-structural and functional components of the hospital.

a disaster and to follow operating at maximum capacity, with the same structure, immediately after a natural disaster. Within the HSI, three vulnerability components are evaluated:

-Functional: The functional capacity reflects the level of preparation of the hospital staff for mass emergencies and disasters, as well as the degree of implementation of the hospital plan for emergencies and disasters. This component refers to the organization, plans, preparations and training of the human group to deal with the impact of identified threats.

In addition, it includes the elements that interact in the daily operation of a hospital. This concept refers, among other things, to the distribution and relationship between architectural spaces and medical and support services within hospitals, as well as to the administrative processes (contracting, acquisitions, maintenance routines, etc.) and the relations of physical and functional dependence between the different areas of a hospital and basic services.

- Structural elements - all those essential elements that determine the overall safety of the system, such as beams, columns, slabs, load-bearing walls, braces, or foundations. Structural elements comprise a building's resistance system.

- Non-Structural elements: all those other elements that, without forming part of the resistance systems, ultimately enable the facility to operate. They include architectural elements (non-load-bearing walls, floor coverings, ceilings, and other coverings or finishes); equipment and contents (electromechanical systems, medical and laboratory equipment, furnishings), and services or lifelines. In the case of hospitals, nearly 80 percent of the total cost of the facility is due to non-structural components.[10]

[10]Source: Learned Lessons in Latin America from Disaster Mitigation in Health Facilities. PAHO/WHO cost-effectiveness aspects.

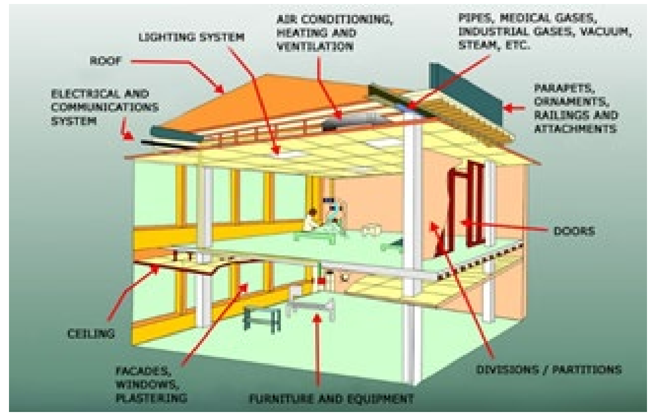

Figure 1: PAHO/WHO disaster mitigation in health facilities

The sum of the weighted results of the three components results in the total level of hospital safety expressed as a percentage of probability of functioning in a disaster.

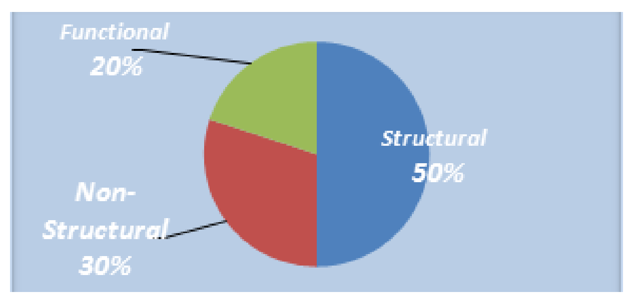

Figure 2: Incidence of participation of each component in the HSI

The final result of the HSI shows results that allow hospitals to be located within three security ranges in order to recommend the necessary actions and the term in which they must be implemented in order to improve the security status of the evaluated health establishment.

Safety Index	Classification	What Measures Should Be Taken?
0 - 0.35	C	Urgent action is urgently needed as current levels of safety of the establishment are not sufficient to protect the lives of patients and staff during and after a disaster.
0.36 - 0.65	B	Necessary measures are required in the short term as levels security features of the establishment can potentially endanger the lives of patients and staff during and after a disaster.
0.66 - 1	A	Although it is likely that the hospital will continue to function in the event of disaster is recommended to continue with measures to improve response capacity and to carry out preventive measures in the and long-term to improve the level of security against disasters.

Table 1: Classification of health establishments. Source: PAHO/WHO safe hospitals in disasters

What is Resilience, Then?

Societies have evolved by adapting and adopting elements of resistance, reinventing themselves in order to survive periods where emergencies, catastrophes and disasters occurred and the strategies developed for response, learning, innovation and adaptation, self-organization and self-sufficiency, are responsible for setting the path to reduce vulnerability to these unfavorable scenarios; this is known as Resilience.

It is thus that resilience and recovery capacity from the impacts that any hospital institution suffers is something that can be achieved by anticipating the problem, repairing it and giving an effective response where continuity of basic services is ensured, regardless of the circumstances.

The risk of disaster will always be less the more resilience against an exposed vulnerability we have.

$$\frac{\text{Threat X Vulnerability X Exposure} \qquad \text{Risk of disaster}}{\text{Resilience}}$$

The resilience of infrastructure is a probabilistic result, we cannot assure in advance that a system is resilient, but we can increase its probability of resilience. The indicators proposed are: First, the infrastructure must have sufficient coverage, with an acceptable level of service. Second, infrastructure must be resilient and reliable. When infrastructure systems fail, disadvantaged sectors suffer the most. Whether infrastructure services can be sustained and quickly recovered, vulnerable sectors will have fewer negative impacts from materialization of risks.[11]

The functioning of infrastructure systems is measured in terms of their level of service, so that these systems have a good level of service require attention: First, all infrastructure systems are subject to natural deterioration; Over time, these systems will start to fail if they do not have maintenance, which allows them to reach their expected useful life. Second place, the operation of the infrastructure may also be affected by natural destructive events or anthropogenic, such as accidents, deliberate attacks, hurricanes or earthquakes. Basically, infrastructure resilience refers to the capacity of a system to support extraordinary events (destructive events - natural and anthropogenic) that cause at least part of the system to fail. The resilience manifests itself in the infrastructure when it maintains a minimum level of functionality in the face of an adverse situation and recovers in a short time and with a reasonable cost.

Commonly, there are four characteristics of resilient systems, called Four "R" (Bruneau et al., 2003).

Rapidity: The rate at which the functionality of the system is recovered.

Redundancy: The system has enough redundancy to prevent bottlenecks or elements from failing to cause complete failure of the system.

Resourcefulness: Refers not only to have resources to meet an emergency, such as spare parts and personnel, but also to improvise temporary solutions that support the operation of the system.

Robustness: The ability of a system to not completely collapse before a fault, but to keep a minimum. Before this impossibility, an alternative is that the system is prepared to withstand interruptions and recover quickly

Figure 34R

Resilient infrastructure shows additional benefits; with the case study carried out in Colombia, it was found that systems that have been more resilient tend to be more sustainable, although this is not necessarily in the short and Medium-term, instead refers to coordinated and coherent actions based on the master recovery plan. In addition, maintaining a high likelihood of resilience in a system, forces for more efficient management and better conservation.

There are several ways to increase resilience in the infrastructure, I'm going to mention some, improving the characteristics in terms of the four "Rs": Robustness, Redundancy, Resourcefulness, and Rapidity[12]. Knowing the risks and the threats, taking into account learned lessons from other countries that have endured floods, earthquakes, volcanic eruptions such as Colombia.

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[11]Extracted and adapted from "How to Develop More Resilient Cities A Handbook for Local Government Leaders. A contribution to the 2010-2015 World Campaign Developing resilient cities - My city is getting ready! Geneva, March 2012"

[12]Extracted and adapted from "Resilient Infrastructure: performance in an ever-changing world Leon Francisco Gay Alanís *2016 Approved: 10/31/2016

III. DEVELOPMENT OF THE STUDY

There´s a case study carried out in Colombia, where the results of the HSI surveyed in twenty-five (25) institutions of the country during the last 3 years were analyzed and to which I participated as evaluator of the Nonstructural Component.

Based on the evidence from these evaluations, we have real examples that can serve and contribute to the planning, construction and operation of institutions and provide the necessary information to prioritize investments in more resilient infrastructure systems and where it is emphasized that the best moment to implement resilience in the face of a natural disaster is before this is faced.

The analysis was based on the evaluation of the structural, non-structural and functional components, synthesizing the responsiveness and its effect in case of materialization of an adverse event.

Thus, it is concluded that making health facilities safe in emergency, catastrophe and disaster situations, it is a collective effort and involves the participation and knowledge of each of the actors who develop, design, construct and supervise this infrastructure, as well as administrative and care staff, and visitors who occupy it later on.

The evaluated hospitals are located in urban areas, in 13 departments and 22 cities.

The classification and selection was made according to the resolution capacity, its function within the hospital network, the support services it offers and its level of complexity that is set as follows:

Hospital of high complexity: They provide coverage to the entire population for high complexity services, according to the portfolio of services defined by the network manager. They can be self-managed and offer several specialties according to their function.

Hospital of medium complexity: These are centers of reference that provide coverage to population part of its jurisdiction. Their management depends on the health service to which they belong.

Of the 25 hospitals, 10 correspond to hospitals of high complexity (40%) and 15 correspond to hospitals of medium complexity (60%).

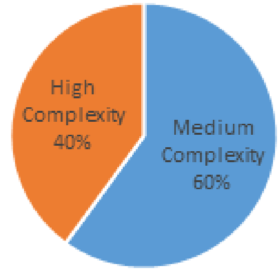


Figure 4: Percentage of evaluated hospitals

In order to preserve the confidentiality of the hospitals studied, they are numbered from one (1) to twenty-five (25) after the letter H (Hospital) and said code is stablished as identifier.

Thus, the 25 institutions are plotted from highest to lowest HSI and shows its classification in A, B or C

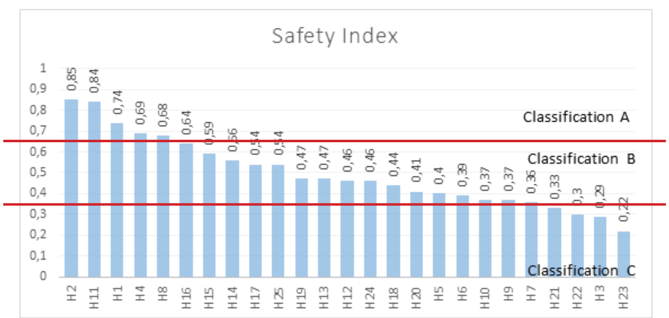


Figure 5: HSI of 25 Hospitals in Colombia

IV. RESULTS

Of the 25 hospitals evaluated, it is stated that: 5 are in A, 16 in Classification in B and 4 in C:

Classification	Amount	Percentage
A	5	20%
B	16	64%
C	4	16%
Totals	25	100%

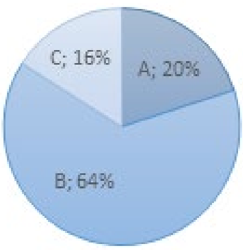


Table 2/ Figure 6:
Comparative classification of Hospitals according to their level of safety

Also, several crosses of information were carried out independent of its level of complexity and from which the two most relevant are presented:

Major Component Vulnerability by Rating:

Classification	Number of Hospitals			
	Structural Medium and Low	No Structural Medium and Low	Functional Medium and Low	Total
A	0	1	4	5
B	5	3	8	16
C	2	0	2	4

Table 3:
Greater vulnerability per component study of 25 hospitals in Colombia

- Interpretation: The most vulnerable component for Hospitals with classification A and B is the Functional, for C Structural and Functional in equal parts.

Figure 7: Colapsing structure, supported with bamboo

Figure 8: Biological waste storage at maximum capacity

Figure 9: Dirt floor/lacking structural foundation

Figure 10: Blocked emergency exit

[13]

Safer Component by Rating:

Classification	Structural	Non-Structural	Functional
A	1	2	3
B	2	1	3
C	2	1	3

Table 4: More insurance component study 25 hospitals in Colombia

Rating: 1. It is safer, 2 moderately safe, 3 less secure

- Interpretation; For A class, the safest component is the structural, and for B and C the non-structural.

Weighted Most Vulnerable Component

Regardless of its classification (A, B or C), the most vulnerable component is the functional, followed by the structural and finally the non-structural.

[13]Personal photos archive, HSI 25 hospitals in Colombia

COMPONENT	QUANTITY	PERCENTAGE
Structural	7	28%
Non-Structural	4	16%
Functional	14	56%

Table 5: High ranges in low and medium scores by component

- Interpretation: it is conclusive that for the 25 evaluated hospitals the most vulnerable component is the functional.

V. CONCLUSIONS

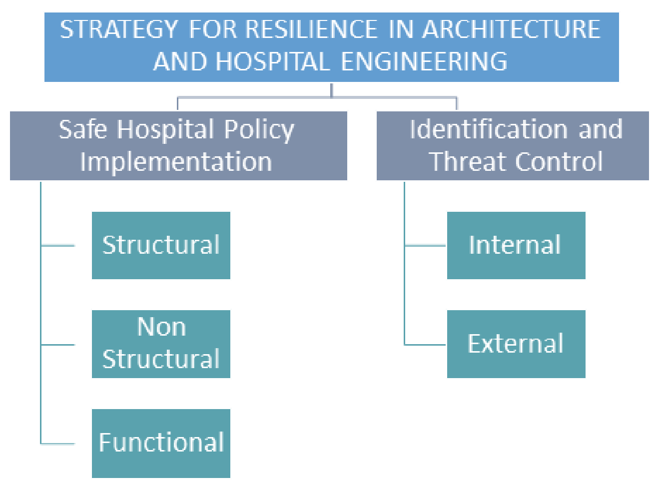
- Opportunities for improvement were identified in 25 hospitals in the country, strengthening the capacity of response in the structural components, Non-structural and functional.
- The analyzes and results have supported budget requests for investment for the execution of plans and activities to reduce vulnerability
- When it was detected that the institutions located in areas with high seismic risk are the most vulnerable, the government entity was motivated to expedite priority investments and total reconstruction of these infrastructures.
- It was evident that structural reinforcement is not only a priority, that it must be articulated with the non-structural component.
- It was evident the importance that a good architectonic-structural design with concepts of Safe Hospital, it showed that it reduces considerably the cost of implementing subsequent measures, and we would no longer be talking about vulnerability reduction but of Safe Hospital
- Reduction of functional vulnerability despite being the least cost is the one that the most percentage is representing, so that, I prioritize to conduct dissemination and training meetings for technical staff in charge of hospital emergencies, in other words, strengthen the hospital emergency committee.
- The main reasons for damage, collapse and deterioration of infrastructure in hospitals are: the fact that these are built without taking into account, in most cases natural hazards; there´s no compliance with building codes and standards; and the lack of implementing of maintenance plans.[14]

VI. PROPOSALS

In order to achieve the fundamental objective of moving from reducing vulnerability to a Safe Hospital where resilience in architecture and engineering exceeds any emergency and/or disaster and in order to cover the three levels of protection: Protect life of the patients, visits and staff of the institution; Protect investment in equipment and facilities and Protect the function of the health facility in cases of disaster.[15]

It proposes:

1. Consolidate the resilient hospital infrastructure with the following structure:



2. Undertake physical functional rearrangement studies, to redefine the physical plant, since over the years it has undergone mutations, changes of use and function. The evolution of medical science, technology, variation of the epidemiological profile, new diseases, type and composition of served population, climate change, the orientation of health and care policies and the rela-

[14]Within the database of the 25 hospitals it was found that independent of its year of construction in some cases natural hazards were not taken into account, in others although they were designed under actual building codes during construction failed to comply with some of them, or simply Safe Hospital concepts were not taken into account. In the vast majority of them, lack of investment in physical plant maintenance accelerates the deterioration of it.

[15]Taken and adapted from the PAHO/WHO Safe Hospital Policy

tionship with patient; have imposed situations that generate transformations in the different aspects of health care delivery and in the management model, requiring changes in both physical and organizational structures, that demand review and adjustment in conventional designs. This is why you must identify the critical points of physical infrastructure and establish the possibilities of development by formulating feasible solution alternatives through Physical-Functional Master Plans in order to build the physical plants in an integral way; which in turn correspond to the reduction of vulnerability and to the identification and control of threats by preparing the institution to be a Resilient hospital including the 4Rs (Resilience, Redundancy, Resources and Rapidity)

3. Implement Concepts of safe Hospital within the design, construction and supervision processes, with a prospective management where measures and actions are adopted, which definitely avoid the materialization of future risks, in other words, be designed with the premise that is designed and built to "not yet existing" risks.

4. Follow the recommendations made by PAHO/WHO after the HSI, namely:

- Draw up an intervention plan, setting out actions to be carried out at short, medium and long term

- Incorporate in the preventive maintenance plan of the health facility, actions to reduce vulnerability.
  Non-structural collapse is most often the main effect of a disaster, rather than structural collapse. The solution to this problem is found in preventive maintenance programs of the facilities. Maintenance, as a planned activity, not only reduces deterioration but also ensures an adequate behavior of public services (water, gas, electricity) and non-structural components (Finishes, ceilings, openings, etc.), in case of disaster and, is not onerous if it is considered as a cost more than the normal operating budget of a building. The importance of maintenance as an adjusting measure to pre-established levels of vulnerability, allowing the incorporation of prevention measures, must be highlighted.

- Plan the allocation of resources for these actions

5. Continuous and ongoing training for staff in terms of management of emergencies and disasters, empowerment of the Hospital Policy

6. Insurance by the Hospital Emergency Committee

IV. REFERENCES

- Entre-textos (enero 16/marzo17 año 8 numero 24) infraestructura resiliente: desempeño sostenido en un mundo siempre cambiante resilient infrastructure: sustained performance in an ever-changing world león francisco gay alanís

- Infraestructura resiliente bajo un enfoque de reducción del riesgo de desastres y adaptación al cambio climático marco Conceptual la paz Bolivia (2017)

- NACIONES UNIDAS (2012) Cómo desarrollar ciudades más resilientes Un Manual para líderes de los gobiernos locales Una contribución a la Campaña Mundial 2010-2015 Desarrollando ciudades resilientes - ¡Mi ciudad se está preparando! Ginebra, marzo de 2012

- OPS (2008) – Catalogación en la fuente Organización Panamericana de la Salud "Índice de seguridad hospitalaria: Guía del evaluador de hospitales seguros" Washington, D.C.: OPS,114 p.-- (Serie Hospitales seguros frente a desastres, 1) ISBN 978-92-75-33256-6

- OPS (2008) – Catalogación en la fuente Organización Panamericana de la Salud "Índice de seguridad hospitalaria: Formularios para evaluación de hospitales seguros" Washington, D.C.: OPS, 34 p. - (Serie Hospitales seguros frente a desastres, 2) ISBN 978-92-75-33257-3

- OPS (1999) Organización Panamericana de la Salud Fundamentos para la mitigación de desastres en establecimientos de salud Washington, D.C.: OPS, 153 p. - (Serie Mitigación de Desastres) ISBN 92 75 32304 6

- UNISDR (2015). Marco de Sendai para la Reducción del Riesgo de Desastres 2015-2030.

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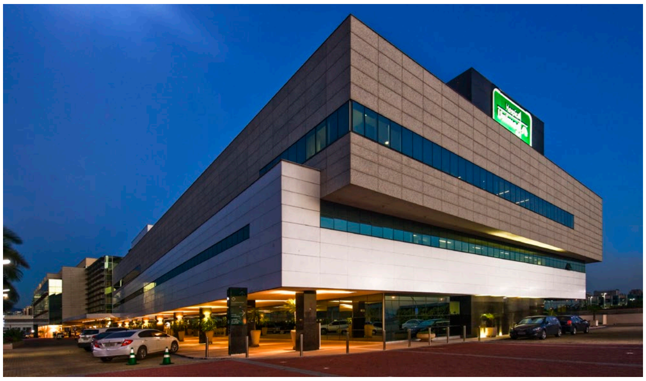
HOSPITAL ARCHITECTURE – GOOD DESIGN

Here, at the IFHE RIO 2017 Congress, our main objective is to present some of the work RAF Architecture has been developing in the field of hospital architecture. We will be showing which restrictions lead us to choose certain volumetric design approaches and how the projects benefit from them as regards their characteristics and advantages.

The facades, for instance, usually follow a design that derives from the internal functions of each building, as it could not be otherwise.

We decided to focus on two different high complexity hospitals and we chose the ones that will be visited during the event. With that, we understand that our talk and the visits will complement each other and provide a clearer understanding of what is seen.

The hospitals chosen are Unimed Hospital in Barra da Tijuca, situated in the western area of Rio de Janeiro and Copa Star Hospital, in Copacabana, located in the southern area of Rio.



Unimed Hospital

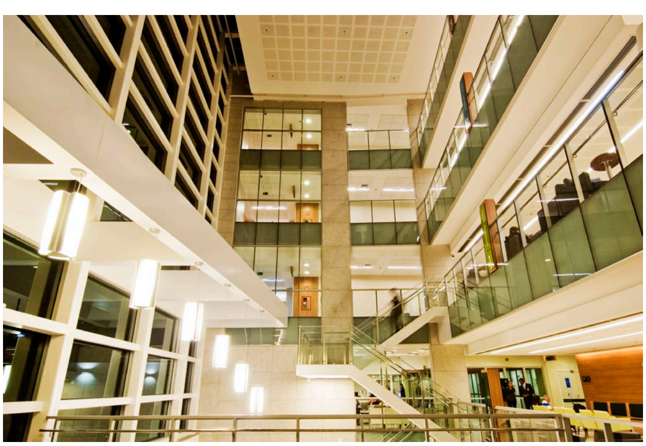
Copa Star Hospital

The concepts for the architectural design approach of both hospitals were gradually defined in accordance with the urban context and the specific legislative restrictions of each area.

The Unimed project was designed for an elongated piece of land, in an area where the legislation requires a horizontal typology, which led us to create a building with an architectural design approach that divides the hospital into two separate blocks. The two blocks are connected by a large central atrium, which guarantees an easy understanding of the hospital's sectors and circulation.

On one side, we find the high complexity scientific block, with pure, slightly uneven volumes, and different types of cladding to mark the different services provided here. On the Ground Floor, the Emergency Room and the Image Centre are lined with transparent glass walls that welcome the clients. The other two floors house the ICU and the Surgical Centre. Different functions intertwine, just like the architectural volumes.

The rooms and the social and support areas are located on the other side. Here, we find the rhythm of the hospitality buildings. In the atrium – a wide integrated space with several connections – the vertical circulations and the primary horizontal circulations converge, unveiling the entrance to the main areas in a clear manner.



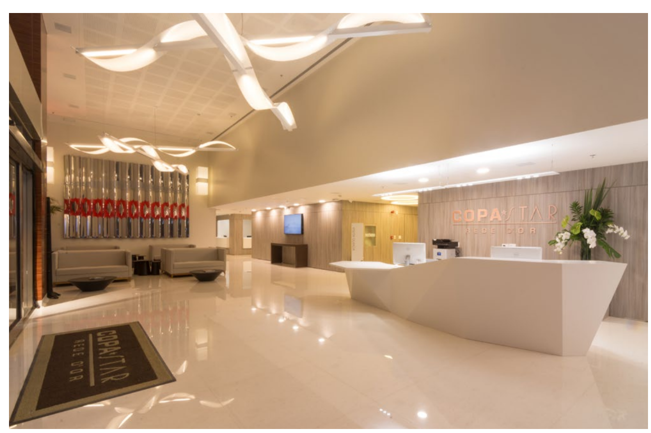
Unimed Hospital Atrium

The urban context also guided the architectural design approach to Copa Star Hospital. However, the legislative restrictions in this area were much more determining.

The land where the hospital was built is an area of environmental and cultural protection in Bairro Peixoto, inside Copacabana. Among the most important restrictions is a height limit of 15 meters.

Therefore, in order to guarantee we would be able to meet the needs of the project, we had to choose an architectural design approach that would allow us to have the largest number of ventilated facades possible for long-term assistance. The result was a ring-shaped building in which the rooms are ventilated in its entire outer perimeter, and they open onto an internal patio as well. We also needed to make the building as vertical as possible. Thus, we created two basements in order to have a constructed area that would meet the demands of the programme.

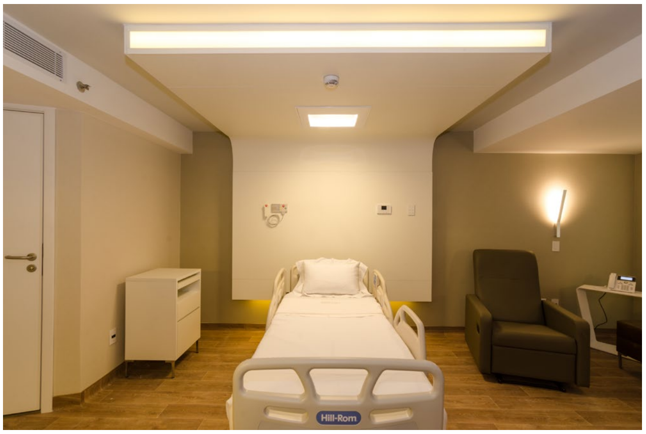
Once again, the simple functional design is the protagonist in our architectural project. The architectural design approach provides an atrium that, despite not being so central, allows the general distribution of entrances to the main customer services' areas. In addition, exam rooms and admission are located in ring-shaped floors, which facilitates the access and circulation. Here, the facades do not have a regular rhythm. Much on the contrary, they are more volumetrically dynamic and irregular.



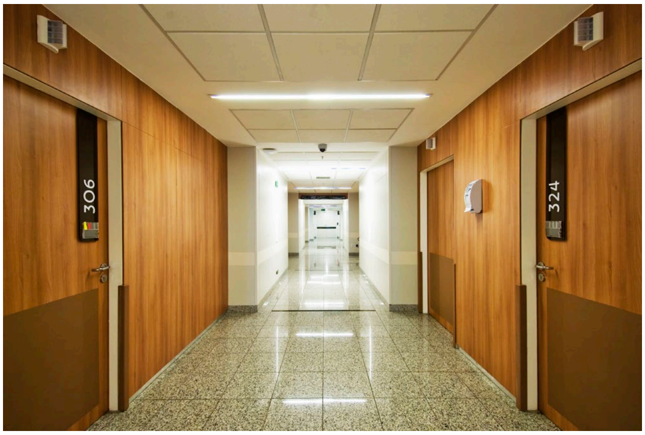
Reception at Copa Star Hospital

In our talk, we intend to present a more detailed description of the concepts that transform these projects with a "differentiated design" into assistance institutions that favour functionality, be it for treatment or work (both logistic and administrative). Moreover, our aim is to preserve the attributes that promote well-being, safety, and a soothing atmosphere for users.

Unimed Hospital Main Entrance



Room at Copa Star Hospital



Unimed Hospital Circulation

Copa Star Nurses' Station

JAVIER SARTORIO - Argentina
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SUSTAINABLE HEALTHCARE ARCHITECTURE: EXPERIENCIES IN ARGENTINA, ADVANCES AND PENDING ISSUES

Introduction

Mainly during the last decade, with the intention of doing our projects increasingly sustainable, the introduction of bioclimatic design and energy efficiency issues became a fundamental guideline to our work, in combination with humanization, user-centered design and functional efficiency criteria, that traditionally are our main focus in designing healthcare architecture.

Reviewing some of our most recent experiences in healthcare projects in Buenos Aires, Argentina, we will mention the concerns that guided the fundamental decisions of architectural design, identifying the problems or limits that we found during the adoption of new sustainability strategies.

As it is known, the project of a healthcare building involves a long process that requires a comprehensive and multidisciplinary work, with differences in each particular case and a high degree of complexity. Despite this complexity, in what follows we will try to identify and synthesize key issues of our design methodology, which we usually apply during project development time. Thinking on these issues, and subsequently applying them in another projects, can be of great help in obtaining more sustainable designs.

1 The first step, clarify the objectives

Sustainability is a fundamental goal of human development, increasingly valued, but today it is not necessarily a priority in the development of healthcare projects. Nor it is an objective that can be exclusively addressed by an architectural design team. The achievement of effective improvements depends fundamentally on the possibilities of the institution and the commitment of its managers and all its members. In this sense, we believe that the first step is to raise the issue and make clear the goals and resources that will be assigned to the sustainability objective.

In addition, inside a healthcare building there are many possible actions that can be adopted that do not have to do with architectural design and nevertheless may achieve a greater improvement on the environmental impact, even greater than the design and construction of a "green" building.

Sanatorio Finochietto (1):
Opened in 2013, the institution was born considering sustainability as a differentiating factor. With this in mind, the Sanatorium was one of the first institutions in the country associated to the "Global Green and Healthy Hospitals" network, committing itself to implement different actions in areas such as waste, chemicals and pharmaceuticals management, purchase of materials, responsible use of energy and water, among others.

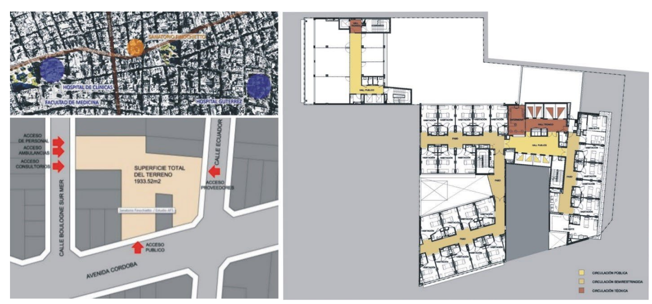
In addition, technology was incorporated to improve safety in healthcare processes, such as medication delivery, handwashing control, safety in the maternity area and automatic registration of certain medical equipment in electronic medical records. All this also requires the correct implementation of follow-up actions, training of personnel and continuous improvement, necessary to maintain and enhance the sustainable characteristics of architectural design.

In existing institutions, changing the "culture" of an organization is often the real obstacle to effective change. Within their role, architects may propose building, constructive or installations improvements which, even if accepted and implemented, will have limited impact if they are not accompanied by user awareness and the implementation of follow-up actions over time.

2 Consider economic sustainability

The economic sustainability of a health institution, the setting up of a "business plan," the scope of the services to be rendered, and how service delivery is sustained over time, is not usually a concern of the architect. However, architectural design is not an independent factor and should be involved in the goal of making the institution sustainable or profitable.

The Sanatorio Finochietto, located in a central area of Buenos Aires city, required the purchase of three additional neighboring lots and the demolition of the existing buildings to release enough land to house 17,000m2 of new construction, with about 180 beds. Once inaugurated, it quickly became fully operational, and work is already underway on an 11,000m2 expansion over four other neighbouring lots, covering all of the available land in the area.



Sanatorio Finochietto (1):
The project had to adapt to a highly complex site and to a consolidated urban environment, and was only economically feasible when a minimum of 180 beds were reached, also including all essential diagnostic, treatment and support services.

The large fragmentation and diversity of competing health providers like prepaid (private) institutions, social welfare institutions and the public sector, has led to the coexistence of numerous and relatively small effectors that were usually born with a minimum scale. In some cases, they were successful and able to develop in time. It is usual to find that the physical resource grew in a disorderly way, without much planning, giving rise to important limitations or functional restrictions.

Corporación Médica de General San Martín (2):
It is a private institution that grew gradually, since 1937. Seven different blocks were built, that in turn received numerous interventions and partial adaptations. At least five different architects worked over time, almost without coordination. Over the last 10 years, we were able to develop a Master Plan, completing blocks 6 and 7 and unifying facades, access areas, and also improving public and technical circulation.

Unfortunately, it has never been possible in Argentina to complement the different healthcare sectors, public and private, to form real networks that could optimize the use of physical resources.

3 Contextualize the project, seeking "socio-cultural" sustainability
The work in institutions with long years of pre-existence requires a special attitude from the designer, in order to contribute to some cultural sustainability of a project. In some way, it implies the search for continuities, elements of compatibility between the new and the preexisting. Architecture must build bridges, trying to respect heritage and integrate different ages in a diverse but unitary organism.

Hospital Alemán (3):
This is an expansion in an institution with 140 years of age. The Master Plan, developed since 2009, respects the oldest building body, which crosses the block and generates two large interior gardens. The last projected building completes the volume towards Juncal street, and relates itself to the preexisting buildings, of very different ages and architectures. The proposed design preserves a large existing tree, recalls the old restaurant building that must be demolished, and allows an increase in the green surface of the main interior garden.

In new institutions, it is fundamental to contextualize the project with its urban situation, respecting and enhancing the characteristics of the site.

Sanatorio Finochietto:
The project arises from the preexisting urban configuration, adapting to the scale of the boundary buildings and resolving the differences of heights between Cordoba Avenue, where the main entrance is located, and the side streets. The projected enlargement will complete the urban profile, using the same language but introducing variations at the new corner. Given the level of consolidation of the surroundings, after this enlargement there will be no further room for expansion.

4 Ensure efficiency and flexibility in the use of space

Sustainability also begins with the development of an effective functional program, an efficient use of every square meter, and a clear identification of the medical, administrative and support processes required. It is essential to achieve a reasonable balance, avoiding unnecessary costs. For example, oversized attention or support areas that are subsequently underutilized, or excessive circulations or technical spaces designed to provide maximum flexibility where it is not really needed, increasing the cost of construction and maintenance.

The dimensioning of support spaces, differentiated circulations, waiting areas, spaces for installations, flexible or free space in prevision for future changes, are all aspects of difficult estimation, which are usually defined based on previous experience. It is not enough to create a functional program that allocates rooms and square meters; more information on the processes that take place in these rooms is required, such as the relationships that must exist between them and the equipment needs. Given the lack of systematized information, the only indicator locally available to check the efficiency in the use of built space is square meter per bed.

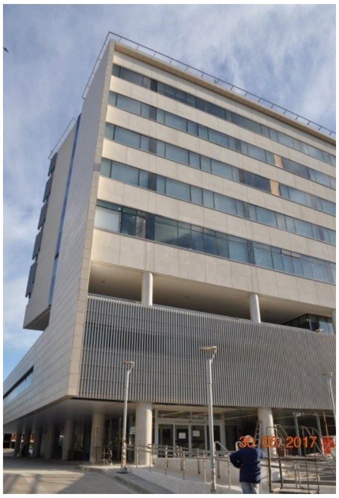
	SUPERFICIE CUBIERTA (m2) (*)							CAMAS					Sup/cama
	Total	Servicios apoyos	%	Halles y Circulac.	%	Salas Maq.	%	Total	Internac. General	Alta comp.	Hosp. Día	Guardia	(m2)
SANATORIO FINOCHIETTO	**13455**	7610	57%	4112	31%	1733	13%	**186**	138	34	8	6	**72**
SANATORIO UP SAN MARTIN	**15361**	10437	68%	3760	24%	1164	8%	**197**	116	52	12	17	**78**

(*) Nota: El cómputo de superficie no incluye semicubiertos, cocheras y consultorios ambulatorios.

Comparison between Sanatorio Finochietto and UP San Martín projects:
Very similar use of space and a relatively low proportion of square meter per bed. More statistics and comparative data are needed to support design decisions, also including energy & water use for operation.

5 Apply bioclimatic design guidelines

Design with climate is almost exclusively an architect's responsibility: layout and building orientation, the configuration and use of exterior and intermediate spaces, façade design & openings sizes and proportions, the study of solar protection and solar gains, the use of daylighting and natural ventilation, the envelope configuration and its insulation level and thermal inertia, the use of vegetated roofs and/or walls, are all factors that build the essence of an architectural project. The energy savings of a good passive design are difficult to measure, since only estimates or simulations can be made, but usually accepted values vary between 15 and 30%. However, there are also important improvements in subjective factors such as human comfort, which are difficult to quantify.



Sanatorio UP San Martín (4):
Northwest facing façades are treated with vertical sunshades. Sun protection is not needed for southeast orientation. To the southwest, there are more blind facades such as circulatory nuclei and less conditioned spaces such as connecting bridges. A ventilated porcelain façade is also used to protect parts of the sun exposed envelope, also architecturally used to unify the exterior volumes of horizontal base and upper bodies.

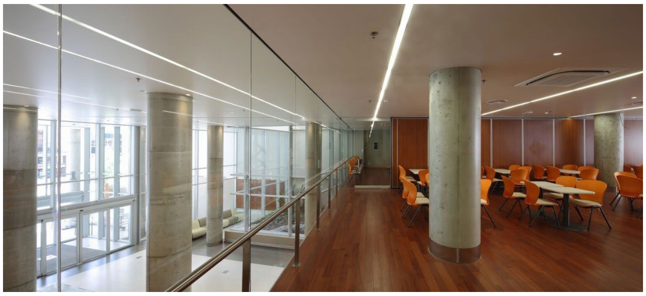
The ground floor, of great transparency, is withdrawn inwards, creating large galleries protected from the summer sun and allowing the basement to "float" over the ground. Between the horizontal base and the upper floors there is a transition floor, with administrative spaces, cafeteria and dining room, with free connection to the exterior by means of semi-covered space and green terraces.

6 Humanize space design, using light, color and vegetation

The quality of architectural space clearly contributes to the well-being of its occupants. In healthcare buildings, it can accelerate patient recovery times and also improve the performance of staff.

The use of daylighting, the creation of a neat relationship between indoor and outdoor space, and the presence of vegetation are fundamental factors in reducing the sense of "seclusion" that can dominate the hospital environment.

The use of color, warm material textures, running water and even artistic manifestations of various kinds can also be very useful in certain environments.



Sanatorio Finochietto:
Combination of ample visuals, daylighting, presence of wood and warm colors for the public space of auditorium and cafeteria.

Sanatorio Finochietto:
The project arises from the preexisting urban configuration, adapting to the scale of the boundary buildings and resolving the differences of heights between Cordoba Avenue, where the main entrance is located, and the side streets. The projected enlargement will complete the urban profile, using the same language but introducing variations at the new corner. Given the level of consolidation of the surroundings, after this enlargement there will be no further room for expansion.

7 Implement solutions with the highest possible energy efficiency

A high complexity Hospital requires an artificial environment in most of its spaces, with temperature and humidity control, air filtration and regulation of lighting levels.

Thermal conditioning is one of the more energy intensive systems, so efficient solutions are essential. In addition to the implementation of passive or bioclimatic design solutions, in a complementary way, there are numerous opportunities to achieve savings and improve energy efficiency through non-traditional design solutions for active conditioning systems:

A hospital requires cold and heat simultaneous generation, although not in an even way. The sources of cold and heat generation used to be independent, and residual heat was lost to the environment. Today, dual systems with simultaneous generation can take advantage of waste energy, resulting in significant energy efficiency improvements, especially during medium term seasons. Systems such as VRF with heat recovery or simultaneous hot and cold water generating machines (dual chillers) solve the cooling and heating simultaneously, and can even contribute to the generation of domestic hot water. For temperate climates like those of Buenos Aires, they are a very effective solution.

UP San Martín:
The thermomechanical installation consists of two dual chillers systems with simultaneous hot and cold water generation, with a primary and secondary pumping plant and air handling units with double coil to condition rooms with air filtration requirements. For rooms with low requirement of air filtration, a VRF heat recovery system was used.

The ventilation levels or air renewal rates required in many of a Hospital's rooms are also high. In these cases, the introduction of heat recovery systems between extractions and external air intakes can significantly reduce energy losses.

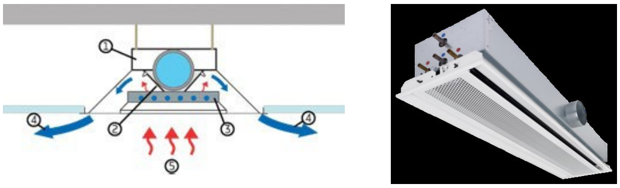
UP San Martín:
The air renewal system for all of the inpatien wards consists of two air handling units with a heat exchanger that allows the preconditioning of the outside air using the exausted air residual heat or cold, filtering it to a medium level, and lowering or raising the temperature until the desired confort level is reached, and then injecting it inside the building.

Within a Hospital there are also different types of spaces, which normally require different types of air conditioning systems:

In double or triple heights spaces, it is advisable to use air displacement methods, with inferior intakes and elevated outlets. These could also be combined with radiant or refreshing slabs, considering the conditioning of the first three meters of air volume exclusively.

In some corridors, halls or waiting areas without dense occupation it is possible to tolerate higher temperature ranges. In the Sanatorio Finochietto, for example, most of these spaces are conditioned exclusively by heat exchangers, without aditional heating or cooling.

An interesting but locally seldom used solution is the active cold beams system, which is especially suitable for rooms with low occupancy like an inpatient bedroom. These systems do not require fans, filters or condensate trays, so they simplify maintenance and avoid possible asepsis problems. On the other hand, they can replace the VRF systems, avoiding the extensive use of refrigerant gas. At the moment we could not implement it, as the main counter is installation cost, which is about 50% higher than VRF.



Active cold beams functional scheme

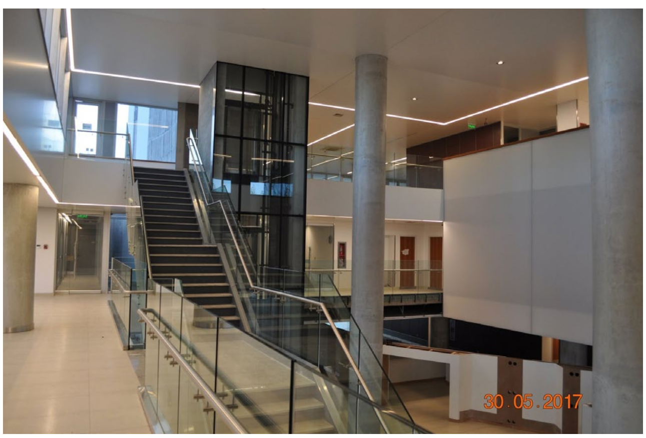
Another very seldom used solution but with great potential for healthcare buildings is geothermal exchange using a heat pump, that allows higher levels of efficiency since it takes advantage of the constant temperature of the subsoil.

UP San Martín:
To optimize the heating of the main public hall, in triple height, a displacement system was projected, with low air intake and air return from the ceilings, and a radiant floor system was installed next to the external glazed perimeter, by means of a hot water coil.

Sanatorio Finochietto:
The picture shows the coil installation of the geothermal exchange system that reduces the use of cooling towers. To obtain greater efficiencies it is possible to use vertical probes of up to 100m of depth.

In artificial lighting, there are two major issues that contributes to energy efficiency:

First is the use of high-efficiency light sources, nowadays practically without discussion with LED technology, and secondly the use of automated or intelligent control systems, that may handle the switching on/off and regulate intensity levels and even the color of light. Lighting control should contemplate, where necessary, regulation according to external levels of illumination and the switching-on according to date and time and presence. At the moment, they are expensive systems with little experience of local implementation.



UP San Martín:
A 100% of artificial lighting systems were solved based on LED technology. Automated controls for the main circulations, waiting areas, and automatic switching-off according to different schedules were used. In the main public hall we combined linear and point luminaires, reinforcing the conception of space. The lighting of operating rooms and imaging studies rooms contemplates dimerization and color change.

8 Design water management systems according to local conditions

Given the presence of the Rio de la Plata, in Buenos Aires there is a good availability of potable water and also satisfactory drainage networks. However, the evacuation of stormwater becomes a critical problem due to excessive ground waterproofing and because of the growing occurrence of rainfall. Therefore, it is fundamental any contribution that can be made favoring the retention of stormwater in situ, either by the implementation of green roofs or by recovering water for toilet flushing or irrigation.

Sanatorio Finochietto:
The project contemplates the recovery of stormwater from the upper terraces and the slowing down of the drainage of the gardens at lower floors. Additionally, the condensate water from the air conditioning systems is recovered. Regarding the consumption of drinking water, faucets with photoelectric cells or timed systems are used, as well as toilets with dual flush and aerators in showers and spouts.

It is important to apply the resources in those aspects that are critical according to the particular conditions of each case: for example, in suburban areas with preponderance of natural land it will have much less positive impact to incorporate green roofs; in dry regions, with little precipitation and scarce availability of drinking water it will make much more sense to use low-consumption systems (faucets and appliances of high efficiency) and even implement gray water treatment and reuse.

9 Build in a more sustainable way, using low impact materials

The sustainable use of materials is an area where no significant progress has been made. On the one hand, it would be fundamental to review the construction processes, in order to reduce the production of construction garbage, which may reach very important volumes, and at the same time give adequate treatment through proper segregation, identification and reprocessing so that these "residues" could be properly reused or recycled.

However, to force the implementation of this kind of measures, it is necesary that the costs of misuse or excessive disposal begin reflecting the true environmental impact that they cause.

As can be seen in the image, the care of the natural terrain, pollution control, construction waste management, reduction, segregation and on-site treatment of waste material are aspects that in the vast majority of cases have not yet been implemented.

On the other hand, the use of healthier materials, materials with recycled content and/or environmentally certified materials is often encouraged as an important aspect of sustainable construction, limiting the use of those more polluting products, such as some types of plastics, adhesives, sealants, paints, etc.

However, in the local market there is little availability of low environmental impact materials with local manufacturing. We do not believe that the extensive use of imported materials is the best solution, as long as they come entirely from abroad, and consume non-renewable energy for transportation without contributing to the strengthening of the local economy. Before encouraging the use of new and low-impact materials, it would be important to favor the development of local technology and regional production.

10 Evaluate, monitor and certify the behavior of the building during operation

Once the architect's task is completed, it is essential to ensure that everything that was designed works according to plan, and also to look for optimization opportunities and implement improvements during operation. It is essential to provide for the installation of a programmable and scalable facilities control system, through which data on energy, gas or water consumption can be obtained, broken down by category and hours of use. It wil also facilitate preventive maintenance. Despite the benefits that could be obtained, even if the system is installed, it is not usual to find good implementation.

The introduction of any certification in sustainability method can help to promote the adoption of more sustainable solutions, although the actual results will depend on the chosen system and the adaptation to local environment. It is fundamental to ensure the rationality in the use of resources, so the standards requested must be adapted to local conditions.

In this sense, the EDGE method for Hospitals, created by the World Bank to use in developing countries, appears as a very adequate tool: it is based on the use of a simple software with a web platform, which any architect can use to make continous evaluations on different sustainability issues applied to his project.

In conclusion

We believe that architecture can only be considered sustainable if it rationally invests the always scarce resources, limiting the negative impacts of any construction as effectively as possible, allowing it to operate efficiently throughout its whole life cycle.

Within the wide variety of topics to be considered in a healthcare project, the architect must contribute to the correct identification of the best design solutions, considering the limitations and potentialities of each particular case.

Important advances have been made in Argentina during the last ten years: the first healthcare buildings with sustainable characteristics were built, consolidating a reference from which to continue to improve.

Towards the future

In Argentina, the energy situation is rapidly changing: the cost of energy, usually subsidized, has grown considerably, and new laws will soon make mandatory the use of renewable energy in a growing percentage, reaching 20% of total energy in 2020. To address these changes, health institutions should both reduce their energy consumption and, in parallel, purchase energy from renewable sources (at a higher cost) or generate their own.

In all cases, it will become increasingly necessary to introduce more efficient systems and solutions, more sophisticated controls, materials with higher performance and increasingly complex technologies, which will surely imply greater initial investments.

The implementation of project certification and evaluation systems may also be extended, but all these issues will not replace good design (bioclimatic, passive, contextualized, humanized) as a fundamental tool to work towards the future sustainable healthcare architecture.

Projects mentioned

(1) Sanatorio Finochietto

Location: Av. Córdoba 2678, Ciudad Autónoma de Buenos Aires, Argentina

(2) Corporación Médica de General San Martín

Location: Matheu 4035, Ciudad de San Martín, Provincia de Buenos Aires, Argentina

(3)Hospital Alemán

Location: Av. Pueyrredón 1640, Ciudad Autónoma de Buenos Aires, Argentina

(4)Sanatorio UP San Martín

Location: Av. Perdriel 4101, Ciudad de San Martín, Provincia de Buenos Aires, Argentina

SERGIO JULIAN - Spain
Speaker

Electrical Engineer
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Electrical Engineer graduated by the Universidad de Barcelona and in Business Sciences by the Universitat Oberta de Catalunya (UOC). Degree in Business Administration and Management from the Universitat Oberta de Catalunya (UOC). Works at Bender GmbH & Co.KG as head of business in Latin America and as Managing Director of its subsidiary in South America. Advises the electrotechnical regulatory committees of Peru, Colombia, Chile and Argentina, in matters such as the electric conductors, renewable energy, mining and hospital facilities.

DAVID KNECHT
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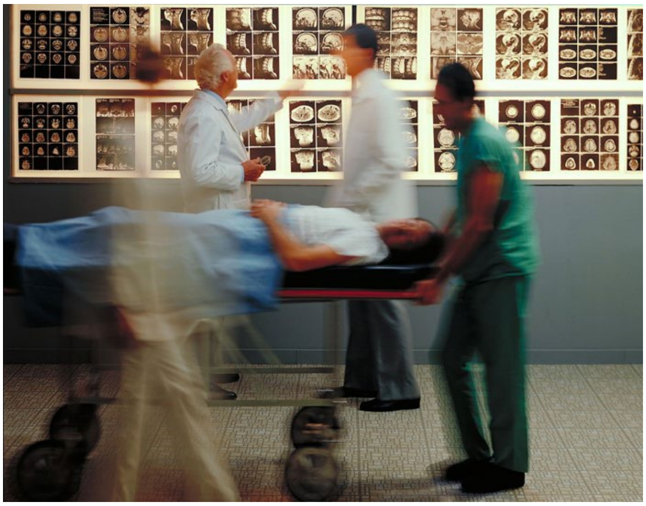
ELECTRICAL SAFETY IN HEALTHCARE SPACES

Electrical Safety in Healthcare Spaces

Advances in modern medical technologies and equipment continues to grow at an expediential rate. Unfortunately, the awareness and implementation of more reliable electrical systems are not keeping a similar pace. Such medical advances cannot be safely realized if critical systems in the physical environment are compromised. In critical care medical spaces, like Intensive Care Units (ICUs), Operating Theatres (OTs) or premature baby room (NICUs), time is of the essence and the reliability of electrical systems could mean the difference between life or death. Any and all feasible precautions should be implemented to ensure safe reliable electrical systems.



Safe and secure electrical power systems
For more than 45 years, electrical systems in healthcare facilities have been developed to be fully reliable and cost effective in regard to electrical safety. Healthcare facilities around the world demand such electrical systems where the safety of patients and the critical performance of their medical electrical equipment is guaranteed under any circumstance.

International standard for electrical safety in hospitals
Bender is acknowledged as the expert in the design and installation of power systems according to international standards NFPA99: Health Care Facilities Code and IEC 60364-7-710: 2002-11: Electrical installations of buildings – Requirements for special installations or locations – medical locations. Bender systems are specially developed for electrical safety management in healthcare facilities. They provide early detection of certain electrical deficiency and insulation deteriorations within electrical systems that supply the facility's most critical functions.

Principles for electrical safety management in healthcare facilities
- Reduction of electrical shock potential:
  - The magnitude of the electrical systems' fault currents shall be reduced to a non-critical level.
  - Insulation faults Fault currents in an electrical system must be reduced to an uncritical level.
  - Non-critical touch voltages between conductive surfaces.
- A single Insulation fault (fault to earth) must not lead to loss of power.
- Permanent continuous monitoring of the power supply for critical spaces must be guaranteed.
- Fault repairs must be able to be planned to suit patient and facility requirements.
- Clear unambiguous labelling and identification, as well as readily available system documentation, shall be available for all power outlets, distribution panels, and associated equipment.

Optimal electrical safety
The healthcare governing body, it means the person or persons who have the overall legal responsibility for the operation of a health care facility, must ensure it provides its patients and staff with safe and reliable electrical systems.

Most important topics concerning electrical safety in healthcare facilities are the following:

A) Which power supply system ensures maximum safety?
- IT systems (unearthed/ungrounded systems) – for a reliable power supply
- Insulation monitoring – safety plus thanks to advance information.

B) How do you avoid dangerous overloads?
C) How do you inform your staff in case of an event or fault?
D) How do you avoid dangers in case of public electricity supply failure?
E) What else can you do for increased safety?

A) Which power supply system ensures maximum safety?

Safety standards in medical locations
According to IEC 60364-7-710: 2002-11, the medical procedures carried out over the patients in a room, define the group classifications of medical locations.
<u>710.3.5 Group 0</u>
Medical locations where no applied parts over patients are intended to be used.
<u>710.3.6 Group 1</u>
Medical locations where applied parts are intended to be used over patients, as follows:
- Externally
- Invasively to any part of the body, but not to the heart, except where 710.3.7 applies.

<u>710.3.7 Group 2</u>
Medical locations where applied parts are intended to be used over patients in applications such as intracardiac procedures, operating theatres and vital treatment where failure of the supply can cause danger to life.

The NFPA99 code follows a similar concept to that of the IEC. However, the NFPA defines the electrical systems requirements for medical spaces according to a risk-based methodology. Thus, the code is focused on what specific procedures (and their associated risks) occur in the respective room, area, or space. There are four risk category spaces as follows:

- Category 4, or Support Space
  Failure of system or equipment has **no impact** on patients or caregivers → similar to Group 0 described in IEC above
- Category 3, or Basic Care Space
  Failure of system or equipment is **not likely** to cause injury to patients or caregivers, but can cause discomfort → similar to Group 0 described in IEC above
- Category 2, or General Care Space
  Failure of system or equipment is likely to **cause minor injury** to patients or caregivers → similar to Group 1 described in IEC above
- Category 1, or Critical Care Space
  Failure of system or equipment is likely to cause **major injury or death** to patients or caregivers. → similar to Group 2 described in IEC above

The most stringent requirements are associated with Group 2 (IEC) or Category 1 (NFPA) medical locations
A first fault must not result in power supply interruption and hence failure of life-support equipment. Therefore, the IEC 60364-7-710: 2002-11 requires utilization of IT system (unearthed system) for all Group 2 medical locations. According to NFPA99, it is common practice and recommended to utilize Isolated Power Systems in all Category 1 spaces; however, the code only mandates use of Isolated Power Systems (unearthed system) in operating theatre spaces.

<u>710.413.1.5</u>
In Group 2/Category 1 medical locations, the medical IT system shall be used for:

- Circuits supplying medical electrical equipment and systems intended for life-support or surgical applications
- Other technical equipment in the patient environment

Among other, the following rooms are of special concern:

- Anaesthetic rooms
- Operating theatres (OT) or (OR)
- Operating preparation rooms
- Operating recovery rooms (SICU)
- Heart catheterization rooms (CATH Lab)
- Intensive care rooms (ICU)
- Angiographic examination rooms (ANGIO Lab)
- Premature baby rooms (NICU)
- Labor and Delivery rooms (LDR)

IT SYSTEMS (UNEARTHED/UNGROUNDED SYSTEMS) – FOR A RELIABLE POWER SUPPLY

The IT system in medical locations
The use of an IT system is the backbone of a reliable power supply in medical locations. Contrary to an earthed system (TN system) there is no intentional conductive connection between active conductors and the protective earthing conductor (also known as a neutral-ground connection) within the IT system.

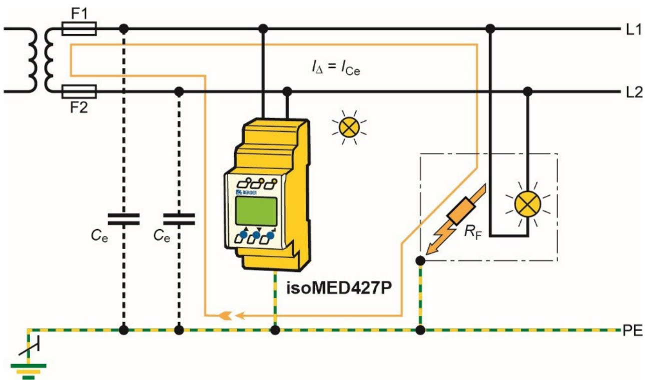
Using IT electrical systems four essential demands are met:

- When a first insulation fault occurs the power supply is not interrupted by the tripping of the over current protective device.

- Medical electrical equipment continues to function.
- Fault currents are reduced to an uncritical level for patient and medical staff.
- Panic in the operating theatre is avoided because there is no loss of power.

Many national and international standards regard the use of the IT system as the backbone of a safe power supply in medical locations, for example:

- International: IEC 60364-7-710 & NFPA99
- USA: NFPA99
- Canada: CSA Z32
- Australia: AS/NZS 4510
- Germany: DIN VDE 0100-710
- Austria: OVE-EN7/ONORM E 8007/A1
- France: NFC 15-211
- Italy: CEI 64-8
- Brazil: NBR 13.534
- UK: BS 7671 GN7/HTM06-01
- Norway: NEK 400-7-710
- Spain: UNEE 20460-7-710
- Belgium: T 013
- Bolivia: NB777-14
- Finland: SFS 6000/HD60364-7-710
- Hungary: MSZ 2040 HD 60364-7-710
- Ireland: ETCI 10.1
- Colombia: RETIE
- Netherlands : NEN 1010
- Slovakia: STN 33 2000-7-710 (332000)
- South-Africa: SANS10142-1
- Russia: GOST 50571.28
- China: GB16895//GB50333
- Indonesia: SNI 0225:2011/BAB 8.27
- Chile: NCH4-2003
- Argentina: AEA90364, part 4
- Malaysia: MS IEC 60364-7-710:2009/MS 2366:2010
- South Korea: KS C IEC 60364-7-710/Electrotechnical Regulation Article 249
- Thailand: TISI 2433-2555/ . 2433-2555
- Vietnam: TCVN 7447-7-710



INSULATION MONITORING – SAFETY PLUS THANKS TO ADVANCE INFORMATION

The medical IT system consists of an isolating transformer, a monitoring device to monitor the insulation resistance (IEC) or the hazard current (NFPA), load and temperature of the mentioned transformer, and a remote alarm indicator and test combination, installed in the operating theatre or nearby nurse station. Continuous insulation monitoring ensures that a deterioration in insulation resistance is immediately detected and proper personnel are notified by signal alarms. Most importantly, when an insulation fault does occur there is no loss of power.

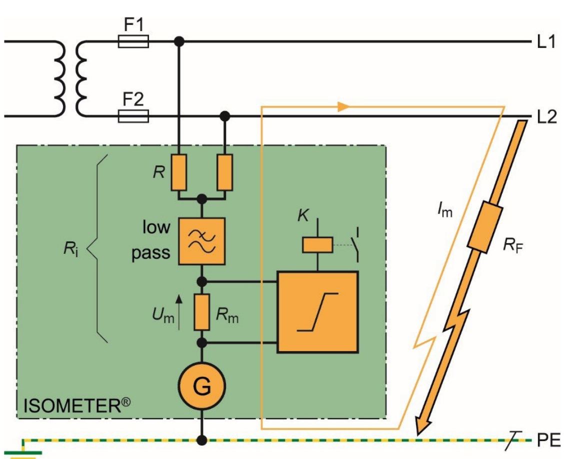
The IT system transformer

This is the heart of the system, and in accordance with IEC 60364-7-710: 2002-11, section 512.1.6, the rated output of the transformer shall be between 0.5 – 10 kVA and not exceed 250V AC (IEC). Single-phase transformers shall be used. Three-phase systems are allowed for equipment requiring three-phase loads only.

As compared to the IEC, the transformer requirements for NFPA99 installations are more stringent in regard to allowable leakage currents between power conductors and ground conductors by a factor >10x. Additionally, the code recommends limiting the transformer capacity to 10kVA for transformers providing power to convenience receptacles (typically rated 120V). Although, larger capacity transformers (up to 25kVA) are permitted, best practice is to reserve such devices to equipment with high current requirements such as surgical lasers and x-ray machines.

The insulation monitoring device

The insulation monitoring device (IEC) or line isolation monitor (NFPA) are the systems' brain, a vital unit to ensure the availability of the IT system. Connected between the power conductors and earth, this device continuously monitors the insulation resistance (IEC) and total hazard current (NFPA). In the IEC application, resistive (ohms) AC/DC faults are precisely measured and displayed. In the NFPA application, we measure AC faults, and the system hazard current (mA) is displayed which is determined from the systems' voltages and impedances (both resistive and capacitive) elements. Thus, the line isolation monitor (LIM) predicts and displays what the highest ground fault current would be if the line with the highest impedance were to have a 0 ohm fault to ground. Whereas the IEC insulation monitoring device (IMD), displays an actual resistive system value and not on an impedance bases predictive current.



Simultaneously, the insulation monitoring device monitors the load current and the temperature of the transformer. Additionally, it meets the requirements of IEC 60364-7-710: 2002-11, section 413.1.5 and IEC 61557-8, Annex A: 2007-01.

Most line isolation monitors produced today have onboard capability of monitoring the transformer temperature and load. Although transformer load monitoring in NFPA99 installations is becoming more and more common, neither temperature or load monitoring is mandated by NFPA99.

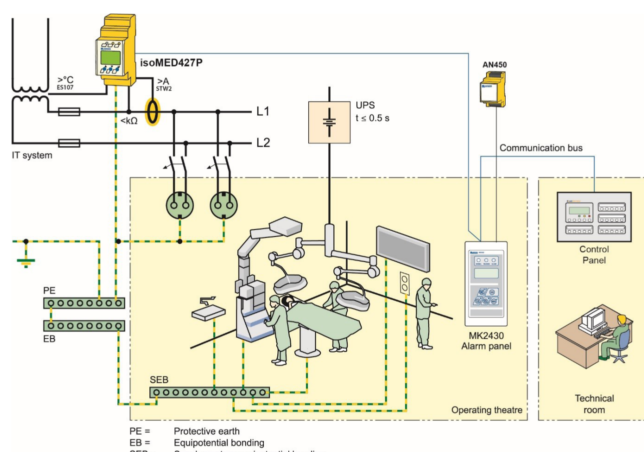
B) How do you avoid dangerous overloads?

Load and temperature monitoring

The available ampacity (load) an IT system can supply is not limitless. Therefore, monitoring of overload and transformer temperature according to IEC 60364-7-710 2002-11, section 413.1.5 is required.

- Measurement and indication of excessive heating of the transformer sensed by PTC resistors. [>°C]
- Measuring and recording of the load current sensed via measuring current transformers. [>A]
- Thus, an overload of the system can effectively be signalled and the staff is informed by visual and audible signals, so that the load can be reduced by disconnecting unnecessary equipment.

In the main feeder of the IT system transformer, overcurrent protective devices are only used for protection against short-circuits, so that an overload does not lead to a power failure. Consequently, utilization of medical technical equipment is not at risk.



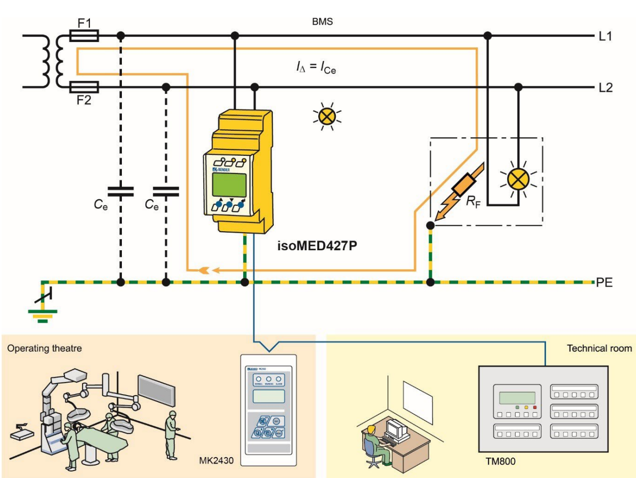
C) How do you inform your staff?

Continuous information about the status of the electrical installation is vital where reliability of supply is of paramount importance.

Remote alarm indicator and test combination

The remote alarm indicator and test combinations must fulfil the respective requirements of IEC 60364-7-710: 2002-11, section 413.1.5, and NFPA 99 for modern information and communication systems in hospitals. Installed in medical locations, these indicators provide audible and visual signals, to immediately inform the staff.

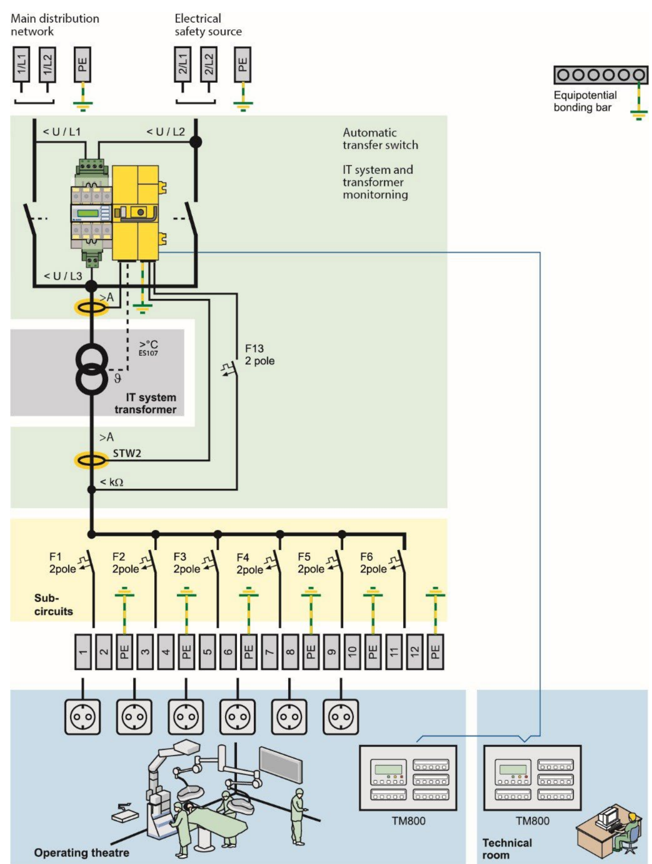
In the NFPA application, it is often common practice to physically install the Isolated Power Panels in the room that is being served and thus the LIM generates this audible and visible alarm locally itself. However, for ease of maintenance some facilities prefer the Isolated Power Panel to be installed in a remote location or directly outside the room being served (sterile corridor). In such instances, a remote indicator is required to be installed wherever the power from the Isolated Power System is being utilized.



D) How do you avoid dangers in case of public electricity supply failure?

Due to the vital importance of electrical safety in hospitals, healthcare facilities mostly have at least two independent sources of power supply at their disposal (e. g. public electricity supply, generators, UPS). In this way, power failures of the public electricity supply do not lead to a failure of medical electrical equipment that exposes patients to danger.

According to IEC 60364-7-710: 2002-11, section 313, in medical locations, the distribution system should be designed and installed to facilitate the automatic changeover from the main distribution system to the electrical safety power source feeding essential loads. This automatic changeover device requires a "safe separation" between systems as defined in IEC 60364-5-536.2.2.4, which does not allow semiconductor devices to be used as isolating devices. IEC 60364-7-710, section 556.5.2.1.1 defines that in medical locations, a power supply for safety services is required, which, in case of a failure of the normal power supply source, shall be energised to feed the equipment with electrical energy for a defined period of time and within a predetermined changeover period. Depending on their medical tasks, Group 1 and Group 2 medical locations have different needs concerning the permitted changeover period and the tolerable duration of a power interruption.

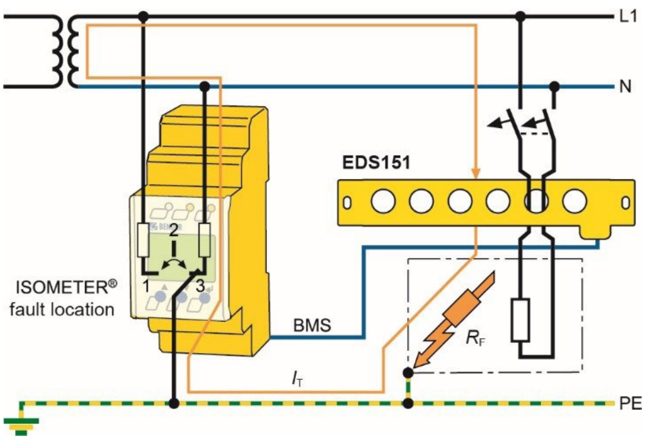


E) What else can you do for increased safety? Insulation fault location for critical rooms

Insulation fault location in IT systems through fault location systems

In medical locations, IT systems with insulation monitoring are intended to supply medical electrical equipment. That ensures reliable power supply, even when a first fault occurs. In addition, a fast location and elimination of the insulation fault is highly recommended, and in some countries, such as Colombia, it is mandatory by the nations electrical code (RETIE 28.3.2 since 2014).

Particularly in the view of the variety of electrical equipment (e. g. socket outlet circuits) used in intensive care units, insulation fault location is disruptive and costly in terms of time and money. The existence of an insulation fault location system is the solution for this problem. It facilitates precise localisation of insulation faults without disruption to the operation of the power system.



Advantages:

- Insulation fault location during operation
- Fast localisation of faulty circuits/equipment
- Reduced maintenance costs
- Central indication through the remote alarm indicator and operator panels.

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Engineer. He started in Industry before working in Health Services Administration. He worked from Assistant Engineer through Deputy Estates Director before specializing in Energy and Environment. In 1971, he joined the Institute of Hospital Engineering where he was for 20 years as Board Member and President of International Affairs. Recently he has again taken on the role of Scottish Branch Chair. In 2009, he created the "Call Harry", a company that deals with Energy, Carbon and Climate Change Management.

YOU DO NOT KNOW WHAT YOU DO NOT KNOW

The talk today is to give you an insight into a system developed within The National Health Service in Scotland, United Kingdom. It is designed to ensure that all relevant staff are aware of their responsibilities and that Estate Services are undertaken in accordance with statutory standards, NHS Guidance and good practice. The system is known as SCART…..

Before going into the actual system it is important to understand why and how the system became to be developed. It is also important to understand the make up of how healthcare is provided in Scotland.

Scotland is a small country in Northern Europe with just over 5 Million of a population, less than the city of Rio de Janeiro, but with an area 80 times larger. Although it is part of The United Kingdom responsibility for Health Care is a devolved responsibility perform by NHS Scotland.

NHSScotland consists of 14 regional NHS Boards, which are responsible for the protection and the improvement of their population's health and for the delivery of frontline healthcare services, 7 Special NHS Boards and 1 public health body who support the regional NHS Boards by providing a range of important specialist and national services.

One of the Special NHS Boards supplying essential services, including health protection, blood transfusion and information. It is an Umbrella Body called NHS National Services Scotland(NSS). NSS works at the heart of NHS Scotland, providing expert services and advice at every level and for every aspect of NHS work.

One of the sub divisions of NSS is Health Facilities Scotland(HFS) who provide technical and operational guidance to the Scottish Government Health, Social Care Directorate (SGHSCD) and NHS Scotland bodies in relation to all aspects of healthcare facilities to support and improve health and well-being services. They are actively involved in the development of national policy, sharing of best practice, development of technology and innovation as well as delivering effective advice and support.

It should be noted that HFS works in a way which may not be common in various other organizations models. It has a mixture of top down and bottom up mechanisms. HFS does not only specify policy and direction to determine the needs of the service but involves the actual users in this process. To ensure thorough consideration and expert advice on the wide range of facilities issues, the following groups were formed from healthcare professionals throughout NHS Scotland:

- Strategic Facilities Group (SFG)
- Scottish Property Advisory Group (SPAG)
- Scottish Engineering and Technology Advisory Group (SETAG)
- Scottish Facilities Management Advisory Group (SFMAG)
- Waste Management Steering Group (WMSG)

It was through one of these groups, SETAG, that two facilities professionals Jim Leiper and Brian Gillespie identified the need for a tool which would identify legislation and guide professionals on methods of ensuring execution of Professional Responsibility and of determining compliance and how to deal with it.

The initial motivation came from the realisation that, in an ever increasingly complex environment, the ability to carry all the requirements in your head was no longer an option. Neither was it sensible for different parts of the organisation to have different and non compatible methods in use. Also without having a dedicated system in place Boards were open to questioning, from the likes of HSE, without having documented evidence on levels of compliance and proposals to rectify any inadequacies. It will never remove the ability of HSE to investigate but would become the first line of defence used by both parties.

So what does SCART do?

SCART gives Health Boards a common way to measure and report on statutory compliance that is consistent with the approaches and interpretations known to be taken by HSE and allows boards to target limited resources on the areas of highest risk. A close relationship had to be made with HSE to ensure a common approach and also to give HSE the confidence that the service was proactively seeking to identify and remedy non-compliance in a structured manner with limited resources and finance. Initially reservations were made that by embarking on a project like this, the service, by showing its inadequacies, was laying its self open to prosecution. Another reason why close association with HSE was essential.

SCART has proved to be a very constructive tool which allows directors to demonstrate a positive, proactive approach to the Management of Statutory requirements, the tool supports the management of existing risks and introduces no new requirements.

Early in the process of development it was recognised that to achieve success, resources, both in hardware, software and personnel would have to be a major consideration. The system had to be robust enough to hold all the information, in the form of question sets,   policies, procedures etc. required by Boards and also the inputs generated by them to produce reports etc. It was also recognised that this would be an ongoing project that would expand in scope and depth of information, statistics, finance information and reporting mechanisms. The system style adopted is what is known as the Deciduous System.

The system can be likened to a deciduous tree which appears in different forms dependant on the time of year, Summer it is in full bloom whilst in Winter the tree is stripped bare. Using the analogy of leaves on the tree being the Question Sets, Summer is a full operational system whereas in Winter it is empty, but the system still exists. As the tree grows, Spring and Autumn give the opportunities to repopulate with additional functions or use it for a completely new project. The basic tree structure remains solid.

To recap on what SCART is about

- Originally produced for Boards to help keep track of compliance on Statutory matters;
- Allow Boards to produce summary of non-compliance issues, the risk associated and any relevant cost implications;
- Addressed key issues within each topic such as Action Plans, Policies, Procedures, etc.;
- It is used by all Boards;
- Helps Boards drive improvement;
- Allows Boards to assess areas of non-compliance taking cognisance of the associated risk;
- Elevates residual risk where needed.

At present SCART has 39 topics being examined by question sets designed to establish levels of compliance, risk, actions required, cost to rectify and time to achieve compliance. The question sets drill down to ensure comprehensive results. In order to let you understand the depth of analysis I have included sample slides from the staff training programme showing the practicality of using the system and have also highlighted one particular topic to give a flavour of how thorough the analysis is.

The first summary slide shows a graphical indicator of the state of play at that moment, the colour coded table indicates maximum and average risk along with compliance levels. The table is based on the traffic light system coded Red, Yellow and Green, and is a well recognised indicator.

The above slide shows an almost perfect situation. In practice what was discovered was that initial runs through the system usually showed a favorable outcome, perception was that we were better than we actually were. This tended to change the further the depth of drilling was implemented, providing a more accurate and realistic position.

The following slides are, as we have said, included to give a flavor of how the system operates in practice. They do not show the amount of preparation work required before input. This would vary location to location dependent on standard of information readily available at the time. This again highlights the need to resource the system adequately and realistically, which in itself could be challenging with reduced available finance.

Each of the 39 Topics included within the system can have specific requirements unique to that topic, but also have a lot of commonality with other topics. This means that each topic has to be dealt with separately. To emphasis this point we are going to look at one particular topic Asbestos and show what is involved within its particular set.

I hope that what you have seen so far has been of some interest. as we said before it is not Rocket Science but the interesting aspect should be that it is so comprehensive, and importantly, it is not fragmented but is a single source which can be used internally and externally if required.

As with all safety systems it is still a work in progress and is always being improved. Continuous Development is required, perfection always just out of reach, but if we go back to the eggs again I hope you will agree, a little bump on the head is far preferable to being totally smashed up.

I would like to acknowledge the assistance given by Health Facilities Scotland in the production of this paper. Also to former colleagues Jim Leiper and Brian Gillespie.

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CONTEMPORARY PANORAMA OF HEALTH BUILDINGS IN BRAZIL

Nowadays the design of Health buildings is one of the most complex building typology in the architecture and engineering areas:

- continuous and growing scientific evolution demanded by the challenging conditions in the research and in the clinical and hospital treatment of diseases that occur in urban centers and in distant regions with relapse occurrence and their continuous consequences;
- rapid climate change, poor sanitation conditions, poor health care, and low public health investments in the country, resulting in precarious and accidental treatment and not as part of global urban and agrarian planning;
- the increasing challenge of growing aging and the resurgence of yellow fever epidemics, continuous influenza outbreaks, tuberculosis and high rates of mental illness due to the indiscriminate use of drugs and medicines and recently by the increasing migration of poor and disaffected populations from conflict countries Warlike and religious politicians;
- low public investment in the areas of health care and medical care in urban and rural areas;
- lack of research investments and preventive planning, including public assistance at the federal, state and municipal levels;
- lack of public prevention and medical care networks in states and municipalities, especially in peripheral areas of urban centers;

This set of challenges forces us to think about health with a holistic and systemic vision that constitutes the Health System in different spheres and places of care.

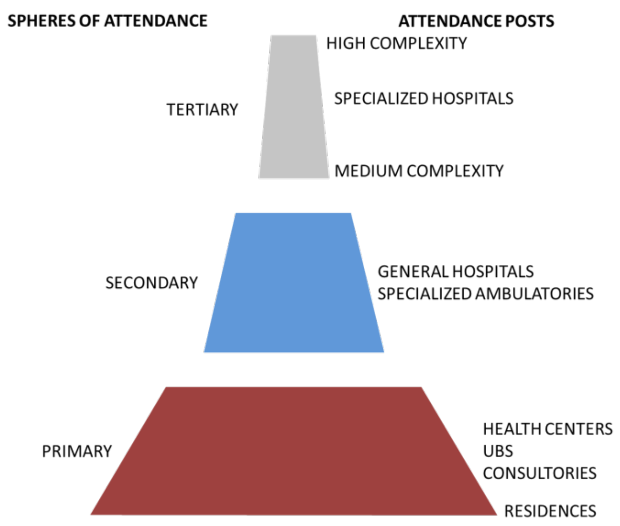

Figure 1: Health system structure

To better understand the Health System under the three spheres of care, three elements are the key:

- incorporated material technology;
- staff training;
- morbidity profile of the target population.

Therefore, it is possible to deduce on what is based these elements involved:

- Economics;
- Care complexity at each level to ensure service integrity;
- Operational using as main criterion the prevalence of occurrences for the allocation of attention levels.

It is possible to deduce that the distribution of these elements does not present the same regularity, since they all depend on available financial resources, materials, staffs and the health policies implemented.

The primary level is the one that, in view of the supply of equipment, allocates those with a lower degree of technological incorporation (electrocardiograph, x-ray, sonar, and ultrasound) and personnel with general training with an emphasis on family approach, home care cases:

- As the efficient attention from what we knew as the family doctor;
- In the series of procedures for the care and treatment of current diseases;
- Possible home visits, (medical consultation services, prescription for collection of exams, injection applications, inhalations and vaccines).

At the level of primary care, the UBS are carefully distributed throughout the urbanized area and constitute the main gateway to the entire health care network. It was estimated for São Paulo years ago, in the Metropolitan Health Plan, that for each general hospital implanted in a region, it was necessary about 8 UBS with free basic care, located where people lived or worked, specialized mainly in pediatrics, gynecology, General practice, nursing and dentistry, medical consultation services, inhalations, injections, dressings, vaccines, dental treatment, supply of basic medication and collection of laboratory tests.

Specialized offices next to the home care and the BHU would satisfactorily complete a significant portion of the population. It is estimated at the time that between 85% and 90% of the cases demanded for primary care were able to be met at this level of care.

At the secondary level there should be equipment with an intermediate degree of technological innovation along with the professional training of doctors and nursing, including prepared staff to attend situations that the primary level do not absorb. At this level there are general hospitals and specialized outpatient clinics.

At the third level, there are the specialized hospitals of medium and high complexity, which have equipment with high technological such as tomography, magnetic resonance, Pet Scan, robotic medicine, among other advancements and staffs with specialized training. In the case of medical super-specialized neurosurgery, hand surgery, pediatric nephrology, cancerology, among others.

Therefore what is understood as contemporary vision of health buildings mainly occurs in specialized hospitals of average and mainly of high complexity.

A number of requirements make the conceptual framework of health buildings part of this view of architecture.

> "The architecture depends on a series of specialties where the human, biological, environmental, economic and exact sciences converge. All these structured sciences can influence architecture, sometimes directly as in the case of the environmental sciences, or indirectly, but always supported by scientific bases to meet its constant evolution. This multidisciplinary work is important so that the work can express its aesthetic and functional qualities. Meeting needs, being efficient, economical, having durability constitutes a series of attributes that are as important as the architectural form. These holistic and systemic views are the basis of architecture that is completed with other areas of knowledge."[2]

> "Contemporary architecture is identified by light, transparency, lightness, technological evolution and by relying on concepts: multidisciplinary conception; Holistic and systemic visions; Overcoming conceptual and constructive paradigms of fashion suiting the culture of each time; Integral domain of clean technologies; Innovation and the evolutionary use of scientifically based knowledge; The importance of the project in the explication of the notion of quality and the question of the environment as a structural part of the architectural repertoire."[3]

This architecture produced five decades ago, altered the one-dimensional condition of modern architecture marked by the aesthetics of form. It is multi-dimensional in overcoming this vision, integrating scientific reason with artistic sensibility.

The hospital architecture has its peculiarities and it is necessary to understand that in this it is specific, and also like the other typologies it has to serve the man in all his needs and physical and mental conditions. Man is the central reference for the architecture.

These predicates that integrate these sets of concepts do not differentiate hospital architecture from the others. It is architecture without adjectives.

We list the requirements that constitute this contemporary panorama of architecture, which in the case of health must reach the buildings in the three spheres of service.

In the units of medium and high complexity, considering the concepts of the contemporary posture in health buildings, the design should contain the following recommendations:

- Sustainability, which has its structuring tripod in the social, economic and environmental spheres, is not limited to energy efficiency. It is increasingly comprehensive to increase its performance, efficiency and economic issues in order to recover impoverished urban spaces of citizenship: forest areas with their wealth and heterogeneity destroyed; Recovery of air and water quality; Decrease, separation and reuse of urban and industrial waste; Recycling of materials for the various constructive requirements; Development of innovative projects; Use of clean and safe technologies that have the flexibility to attend the evolution of the various uses and have costs compatible with their needs. This set of issues requires that we have efficient buildings, master plans and complete well-developed designs, with the integration of the various disciplines and their professionals. The more nature takes place for patients and the rest of the occupants who work, the more we will contribute to better performance in patient recovery and pleasant environments. Humanization refers to optimization of the use of the environment by the patient and other users;

- Environmental quality by the growing application of solar lighting and natural ventilation in spaces that require aseptic and mechanical control with air conditioning:
  - Circulations;
  - Living rooms and short stay environments;
  - Visitor waiting areas;
  - Administrative areas;
  - Service areas in general;
  - Professional dressing areas for complementary services;

  The reduction of investments in the areas mentioned is possible by the proper orientation of the building, considering the appropriate wind direction to each latitude in our continental dimensions country.

• Be aware of the importance of zoning and functional sectorization, as well as flows. Sectorization is very important, since it determines the adequate location of the areas, placing them in a strategic location such as PS (Emergency Room), PA (Emergency Care) and ambulatory areas so that they do not conflict with the other internal areas of the hospital.

• Use correct orientation of spans and openings in long-stay environments, avoiding the building's entry faces to very hot, humid and cold sides. It is necessary to design the building with a good sectorization and implantation, solving access problems as well as the solar orientation of the hospitalization in relation to the solar movement and the humid and cold winds. The correct implantation adapting to the morphology of the terrain, optimizing better the local conditions such as relief, vegetation cover, differentiated accesses of external patients, hospitalization and discharge, first aid and services;

•The choice of terrain is the key, as is its location. It is desirable to provide easy access to ambulances, outpatients and inpatients, and other areas of services and parking for companions and visitors;

• Whenever possible, block the access to restricted areas, such as surgical and obstetrical centers, ICU, nursery, image sector, medical wardrobe and nursing. Correct settling of service areas such as kitchen, laundry, material center; Separate conditioning of clean and dirty clothes, especially this one can be contaminated and needs to be conditioned and later taken until its treatment; Hospital waste can´t be collected with the common waste due to the high level of contaminated or radioactive waste, and therefore properly separated;

• Another important issue is the care of those who work in the hospital. Designing an environment that has nice places to work and rest at intervals of work is recommended in a hospital building. There are hospitals where there is no place for sit-ins to rest, so them end up sleeping in vacant beds. A 48-hour day-care worker needs comfortable conditions to rest, so he can perform his work with more productivity and safety. Environments with these characteristics, in addition to improving patient care, provide to the staff team comfort, satisfaction and well-being;

• Infection control is one of the issues that should receive greater attention in critical environments, such as operating rooms, UTIs, image center and laundry where individualized control equipment must be placed. Each operating room should have specific air conditioning equipment. If for any reason the room is contaminated, it is blocked, the disinfection is done and the rest of the operating room remains in operation, avoiding the need to insulate the entire center.

CONTEMPORARY BUILDINGS/RECENT EXPERIENCES

Moriah Hospital

This hospital presents a standard of excellence that excels at the accuracy of results and early detection of health problems. The use of contemporary technologies with high quality equipment and reliability makes Moriah a "showcase" that places it as unique in the country, in the context of hospital medical care of high complexity.

This contemporary building with high technology that is constructive in functionality and equipment presents solutions of Eco efficiency, sustainability and spatiality, structural and systems conditions and state-of-the-art technological resources.

We can highlight:

• Surgical robot "Da Vinci XI"

Implanted in the robotic surgery center, the machine reduces to minimally the impact of invasive surgeries from several specialties, like head and neck, urology, general surgery, gynecology, thoracic and cardiac. The structure has four long arms that increase the range of work, counting with optical sensors that provide greater mobility and sharper images, allowing reaching cavities where the human hand is not possible.

Another example of use is the deep brain stimulation therapy, one of the most modern functional neurosurgeries, which consists of implantation of a pacemaker capable of stimulating specific areas of the brain. Patients suffering from Parkinson's disease, Alzheimer's disease and other neurofunctional diseases may regain considerable control over their movements, thanks to the electrical signals emitted by the device. Robotic surgery is minimally invasive also in cardiology, spine, hip and gynecology surgeries.

Figure 2: The "Da Vinci XI" robot

• O-ARM® – 3D Radiology

Easily transportable equipment with 360º surgical arch that revolves around the table, 2D/3D radiology system with robotized drive and integration with surgical navigator that has fluoroscopy with all the controls of movement and angulation aided electronically. Indicated for use in open and minimally invasive spine surgery for arthrosis, discectomy, facet degeneration, vertebroplastide.

Figure 3: ARM® – 3D Radiology

• Divine Scanner

Detects a microelectronic device and designs the breast in 3D in a computerized monitor which allows an excellent visualization of the operative field.
This technology is available for silicone breast prostheses and also for gluteal prostheses with a chip.

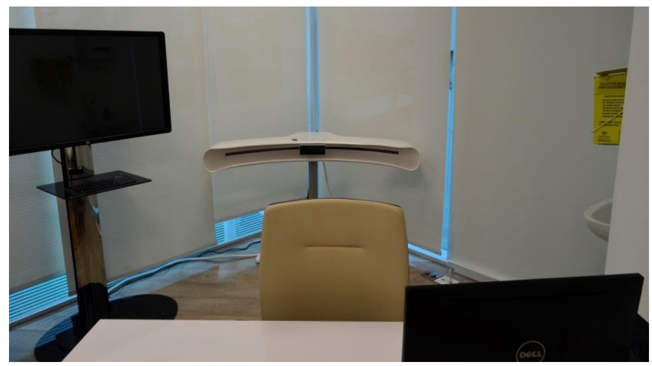

Figure 4: Divine Scanner

• Orthopedic surgical table

Complex equipment for orthopedic surgery that meets any operative situation.

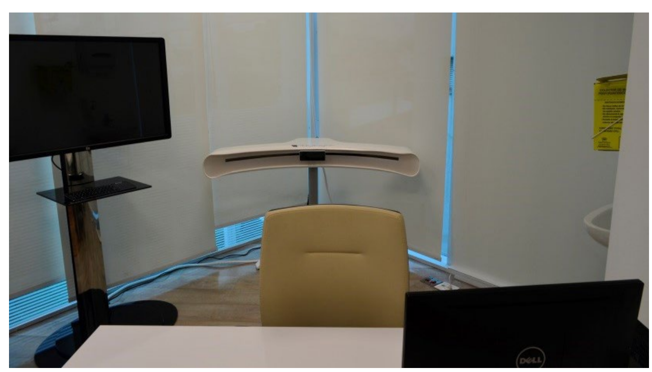

Figure 5: Orthopedic surgical table

• Hemodynamic room

It uses invasive techniques to obtain functional and anatomical data of the various cardiopathies. It is through catheterization that the study of cardiac dynamics is performed, which consists of the insertion of radiopaque catheters under ploscopic control and electrocardiographic monitoring, following the path of the peripheral arteries and veins to the cardiac cavities and large vessels.

- Equipment: Hemodynamics Artiz Zee Ceiling Siemens
Surgical specialty: Vascular, Neuro and Cardio;
Description: equipment installed inside the surgical center for minimally invasive procedures guided by X-ray images, leaving the room with hybrid room designation, allowing the realization of different procedures of different specialties, software for 3D reconstruction of areas of interest, images High resolution, allowing the surgeon greater safety and agility.

Figure 6: Hemodynamic room

• StealthStation S7 navigation system Medtronic
Surgical specialty: Neuro, Orthopedics and Otorhinolaryngology
Description: Through imaging of tomography, X-ray and magnetic resonance imaging it is possible to navigate for removal of brain tumors, placement of screws, Passage of catheters, everything being guided through the system, which merges the real (patient) with the virtual (3D reconstruction with the images) with total security.

Note: It has integration with O-arm.

Figure 7: Navigation System

• Video Rack with STORZ Immunofluorescence Technology
Specialty: Gynecology, Gastro and Plastic
Description: Through Immunofluorescence equipment it is possible to visualize the arteries and veins in the organs and tissues in the intraoperative period and to diagnose the blood supply, after applying a medicine called Green Indocyanine that highlights the area of interest.

Figure 8: Video Rack

• Auditorium
The Hospital has a fully equipped auditorium that makes it possible to make video conference with live transmission in the Surgical Center and transmit to the world.

São Luiz Anália Franco Hospital

The building occupies the central part of the court. The remaining area is transformed into a covered square surrounded by integrating and invigorating all the space, to four border streets and all the buildings facing the square.

Consisting of two independent blocks: one of general hospital and another of maternity, united by catwalks, the configuration creates a large central area with windows and mirror of water where the living environments of the upper floors turn.

Below the 4th Floor the volume joins longitudinally, sheltering in the center the services common to the two parts.

The parking at its ends widened the access spaces. On one side the entrance of the hospital and on the opposite side the public spaces of auditorium and restaurant on the ground level. On that side, taking advantage of the declivity of the terrain, we installed on the lower floor the accesses of the emergency room and emergency room, offices, diagnosis and treatment, laboratories and image sector.

Areas such as restaurants and hall of high turnover have natural lighting and ventilation, and in the case of hospitalization areas, balconies were inserted, for convenience between people and the hospital environment.

Figure 9: External Area

Figure 10: Internal Area

Hospital Mater Dei Contorno

The adopted design portrayed a dynamic and innovative design, valuing the architectural identity of the building and meeting the criteria of sustainability, ecoefficiency and local urban plan.

The high cost of foundations for the construction of 5 underground garage floors led us to place them between the 7th and 11th floors. All hospital services were placed from the first basement and five lower floors. The hospitalization occupied from the 12th to the 19th floor, resulting in 554 parking spaces. This was facilitated by the steep incline of the court where ramp access was placed at the top.

Parking is expressed on the facades by a mosaic of white and green ACM panels and the ventilation vents of the landscape pavements.

Mater Dei/Contorno is the first hospital in Brazil in metal structure that develops in a 1.25m mesh, steel deck slabs. Drywall closures and partitions provide flexible spaces and systems that allow for easy future changes, extending the life of the building, as well as a better final quality, greater agility in the construction process and a cleaner construction site. The hospital with 70,000m^2 of construction was a sequence of assemblies executed in 18 months. All windows were assembled components.

The architecture was a strategic element for sustainability, since it articulates from the reading of the Client's needs and the place of implantation of the enterprise, aesthetic and technological solutions, of high credibility and technical rigor, resulting in spaces that generate sustainable internal environments besides Obtain a good relation of the enterprise with the external environment. In the conceptualization of the project, the foundations of contemporary architecture were taken into account, all the conceptual predicates of sustainability incorporated in the project.

The main technical areas, covered and discovered, were all leased in the coverage by helipad. This same level of quality was the combination of high complexity guaranteed by the spaces and current equipment to meet all levels of medical care. Also included are new assistance programs, which have been carried out by this unit Contour:

- Human reproduction center
- Integrated Cancer Hospital
- Diagnostic medicine
- Sports medicine

Figure 11: Perspective from Mater Dei Contorno

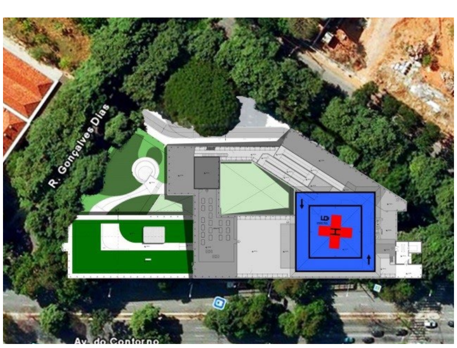

Figure 12: Hospital Location

Mater Dei Hospital In Betim/Contagem

The direction of the Hospital Mater Dei acquired an area to be urbanized in Betim/Contagem, where a land of 275,000m² was chosen for the implantation of a hospital of high complexity. We separated from it, an area of 26,800m² along the expressway, for the construction of the Betim unit of Mater Dei Hospital.

This project was leased to a strategic point of this great site aiming for visibility with the first intervention in the field that will in the future include commercial, corporate, housing, service and green areas planned.

For the implementation of the hospital we had to effect the dismemberment of the area of the same to meet the urban norms of the city hall of Betim in order to meet the legislation of land use.

Approved the location of the area we had to improve the legal project with a second internal parallel route for access to the hospital regularizing the implementation and approval of it.

This project had its program structured with the Mater Dei medical team, dimensioning as an important unit to expand Mater Dei Network as a result of the success of Mater Dei Contorno Hospital in Belo Horizonte.

The architecture project defined spaces, medical and ambulatory services to be provided, implementation of the main block that due to the slope conditions of the terrain involved in the connection of access roads and ramps to the service areas and underground parking and landscaping of the entire existing area. In addition to the architectural design, we coordinate all the disciplines and systems that should be compatible with it.

The structure consists of a mixed system with tubular steel pillars filled with concrete, beams and steel deck slabs. In this project, architecture and structure were concomitantly executed in BIM technology.

Figure 13: Perspective of Mater Dei Hospital in Betim/Contagem

Figure 14: Isometric cut made with BIM tecnology

University Hospital - HU

This large and complex project of revitalization and modernization of the University Hospital - HU Hospital School in USP (University of São Paulo) was carried out by Zanettini Arquitetura with the responsibility of elaborating the Master Plan and the Executive Architecture Project with global compatibilization of the Projects.

Aiming to meet the great goal of this Institution belonging to the University of São Paulo to transform HU into a Center of Excellence in Teaching of medical and paramedical areas, the Master Plan and architecture project faced this great challenge with concepts and solutions that translate our Contemporary view on architecture, which we highlight:

- total revision of the existing 36,000 m^2 built area with new internal environmental solutions and external global treatment;
- Educational Center with 7,500 square meters of construction, with two 200-seat auditoriums that can be integrated in a single space of 400 seats, library, laboratory and workshops with large foyer spaces, cafeteria exhibitions, training rooms and eight classrooms (Two 96-seater classrooms, two 60-seater classrooms that join together two other 52-seater classrooms and two 48-seater classrooms), totaling 500 classrooms, Same sorting and archiving area, Research, directors and managers, subsoil for parking of ambulances, cars and motorcycles, and complete machinery house in the cover surrounded by green cover.
- necessary increase of new and important areas:
  - New block attached to housing as activities, totaling 5,000sqm;
  - Expansion of the 170sqm morgue;
  - New emergency stairs and external ramp with 1,200sqm;
  - New booths with 200sqm;
  - Walkway and footbridge connecting the hospital to the educational center with 360sqm.
- expansion of the current block of Energy to house and centralize clinical maintenance and emergency activities with 2,230sqm;
- new block for central warehouse with 1,400sqm, with the construction of a sunroom between the new blocks and the existing hospital as cover of the loading and unloading area with 890sqm;
- treatment of all facades of the Hospital block and attachments with the use of unitized panels, composed of ACM boards and facade frames in a glass system, and all the decks (including the floor of the superintendence and administrative area) will have to Double glazing with internal adjustable blind. As ACM plates in the white color are interspersed by bands of ACM in red color, also used in the blocks of stairs;
- Important internal intervention occurred on all floors of the vertical block of hospitalization, transforming the old wards into two-bed apartments with attached bathrooms. The horizontal pavements (1st and 2nd floor) were also intervened in the zoning of the sectors, integrating them by related activities

and with new global internal treatment of floors, walls and ceilings with chromatic solutions through painted or ceramic panels;

- General retrofit of the entire hospital infrastructure, modernizing the various air conditioning systems, electrical installations, hydraulics, gazes, controls, warnings, computers, security, etc;
- landscape treatment of the entire external area of buildings with solutions of floors, gradis, ordinances with use of existing plant species;
- visual communication of the complete hospital through solutions with external panels that guide the users to the main accesses and the signaling of the internal circulations of all the ambulatories and several rooms;
- production of project execution in BIM Platform.

Figure 15: Perspective from the University Hospital

Figure 16: Hospital Research Cente

University Hospital In Caratinga

In this hospital complex of Caratinga, besides being integrated to all the instruments related to a hospital of high complexity, it will develop researches and training in the centers: Outpatient clinics, diagnosis, oncology, physical rehabilitation, psychiatric and veterinary medicine.

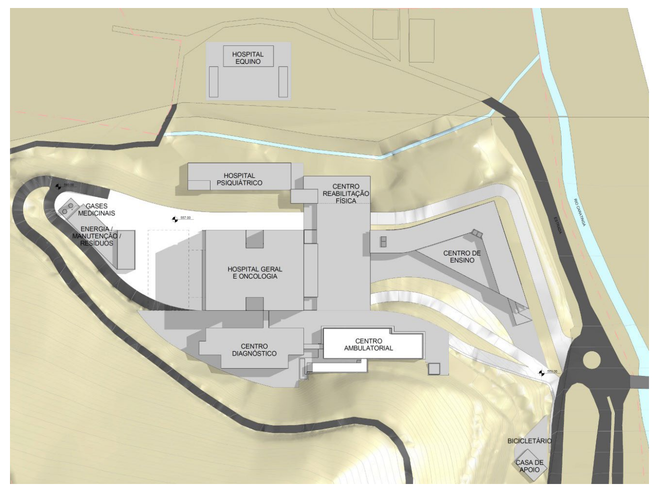

Figure 17: Location of the Complex

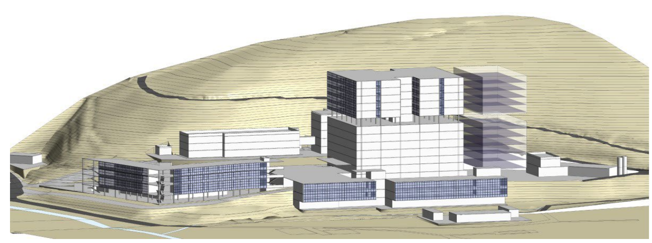

Figure 18: Perspective of University Hospital in Caratinga

São Camilo Pompéia Hospital – Block 5

It involves the expansion of a Hospital Complex, with an increase of 93 beds of hospitalization and 46 offices, as well as new examination rooms and procedures. The new Block of the São Camilo Pompéia Hospital will be integrated into the four existing blocks, located in a neighboring block, through a tunnel and footbridge.

From the beginning, the project was developed with the use of BIM technology, integrating architecture, structure and building systems. BIM technology allows visualizing the effects of design decisions (such as solar orientation, facade materials, building infrastructure systems) on deployment cost and performance.

The projects builded, besides being awarded and published in the specialized media, broke paradigms and contained countless conceptual advances.

Figure 19: Perspective of São Camilo Pompéia Hospital

Figure 20: Hyperbaric Medicine

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EVIDENCE BASED DESIGN FOR SUSTAINABLE HEALING ENVIRONMENT

Introduction

This article discusses on creating sustainable healing environment in hospitals and other health care buildings which provide safe and comfortable situations for patients and effective/worthwhile working conditions for staff under the main theme of the seminar, "Hospital environment for patient and worker safety". Safety in hospital must be considered in normal, emergency and natural/manmade disaster situations.

An overview of many critical issues facing current hospital environment is followed by a major discussion that is part of the article. Several topics are mentioned such as Evidence Based Design (EBD), Post Occupancy Evaluation (POE), Facility Management (FM) and Business Continuity Plan (BCP) in the healthcare environment.

Architectural Planning and Design Theory

The late Professor Yasumi Yoshitake, of the the University of Tokyo, started Evidence-Based Design (EBD) studies in the 1950s. Evidences were collected based on the field surveys conducted in hospitals. The first field survey was carried out in several wards of a couple of hospitals, observing the movement of nurses during their daily duties in 1952 (Yoshitake 1964). The survey method was defined as a POE (Post Occupancy Evaluation). The procedure was based in 5 steps: preliminary field surveys in hospitals, definition of problems found in the use of hospitals, detailed field surveys in selected cases, finding out contradiction of design policy and actual building use, and development of planning principles.

Fig-1 shows nursing activities study in wards during evening and night shifts (Nagasawa 1986). As a result, 40% of duty hours of each nurse were allocated to writing discussion. The result suggested that if some tools of reducing time for writing/discussion are successful, the result is increasing direct nursing care to inpatients. As a matter of fact, discussion and reporting on patients' care among nurses, physicians and co-medical staff is currently carried out through laptop communication systems in current Japanese wards.

It was also discovered that nurses were walking an average of 2.5 km/day during their duties. This means planning for shorter walking distances is needed, especially between patient rooms and staff stations. Currently, nursing activities are carried out by each nurse with a wheeled desk with laptop computers. In other words, the nurse station is moving along with the nurse in the corridor, facing each patient room.

The survey also revealed that hand washing was carried out on average 11 times per hour. The layout of hand washing basins must then be carefully considered. Now, patient room with hand washing basins located at the entrance of the room is the norm in many Japanese wards. These series of POE surveys in various themes of hospital planning and design, resulted in the establishment of architectural planning and design theory of hospitals in Japan (Ito et al 1987).

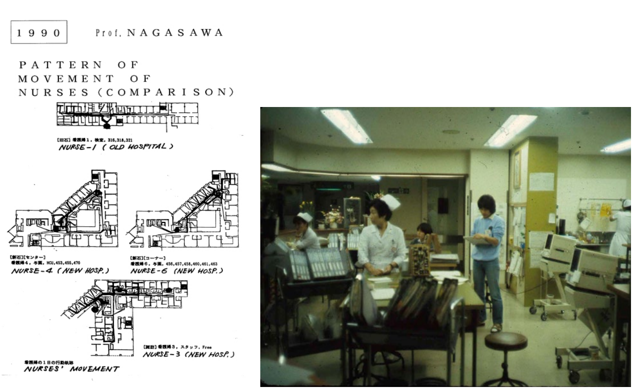

Figure 1: Nursing Activities Survey in Wards
Source: (Nagasawa 1986)

Currently, design evidences have been shared in national and international organizations. The Japan Institute of Healthcare Architecture (JIHA) which has direct relation to UIA/PHG (Public Health Group) and Healthcare Engineering Association of Japan (HEAJ) is also an official member of International Federation of Hospital Engineering (IFHE) and is publishing seasonal journals which contain many design evidences.

Major planning/design and engineering considerations in hospitals

There are several major items need to be considered in hospital architecture and engineering.

1. Space Planning

The acute care environment in modern hospitals is composed of five functional units, i.e.: Wards, OPD, Diagnosis & Treatment (D/T), Administration and Logistics departments. Space planning is one of the crucial items. A series of statistical surveys on the floor areas of functional units in Japanese hospitals have been reported in each decade since the 1960s (Ito et al 1987). Analysis of functional unit area in Japanese hospitals built in the 2000s, particularly newly built hospitals completed from 2001 to 2007, was completed by JIHA members (Kawashima et al 2009).

Total floor area per bed is shown in Fig-2. Composition ratio of each functional unit was also surveyed (Fig -3). For example, ratio of floor area in wards to total floor area changed from 45% before 1965 to 37% in 2000s.

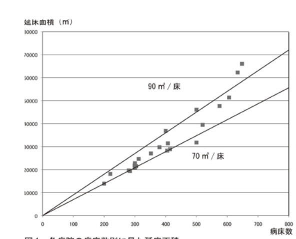

Figure 2: Total floor area per bed
Source: (Kawashima et al 2009)

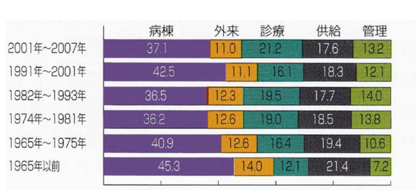

Figure 3: Composition ratio of functional unit
Source: (Kawashima et al 2009)

Space measurement of bedside medical/nursing activities was carried out in 1980s (Nagasawa 1987). It was discovered that at least 1.5m was needed for appropriate medical/nursing procedures (Fig-4), which surprisingly coincides with the bedside space of a Nightingale Ward conceived in the 19th century, as shown in Fig-5.

After more than 10 years since this survey was carried out, Japanese space standards in patient bedrooms were revised 1.5 times as much as the old standard.

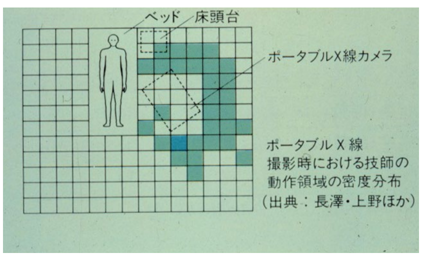

Figure 4: Measurement of bedside activities
Source: (Nagasawa 1987)

Figure 5: Bedside of Nightingale Ward
Source: (Nagasawa 1987)

In the case of Intensive Care Unit (ICU) bed spacing was also surveyed, as shown in Fig-6 (Zhao & Nagasawa 2000). A 3.5m space was the minimum distance that resulted from this study.

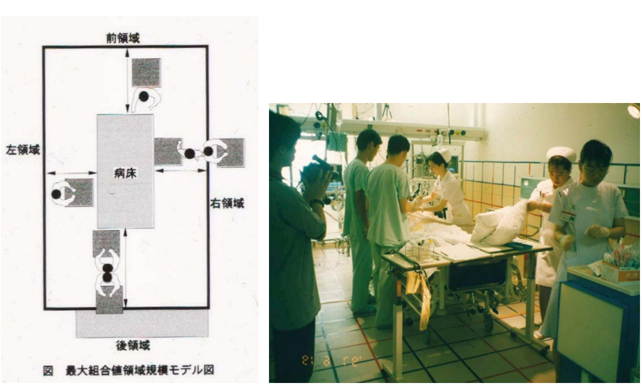

Figure 6: Measurement of bedside medical/nursing activities in ICU
Source: (Zhao & Nagasawa 2000)

2. Block Locating Planning

Appropriate departmental relationship is based on movement of various people, i.e. inpatients, out-patients, hospital staff (physicians, nurses, pharmacists, radiological and path-lab technicians, PTs, OTs, STs, etc.), visitors, patients' family members etc.

Patient movement in outpatient department is introduced here, as an example, in the University of Tokyo Hospital project. The first design policy was providing patients with a well-orientated geographical built-environment (Nagasawa 1993,1995,1996). Corridors were paved with bright yellow color, faced to outside windows, making it easy for patients to find their way by themselves, as shown in Fig-9.

Figure 7: OPD in University of Tokyo Hospital
Source: (Nagasawa 1993,1995,1996), Shinichi-Okada, Archit. & Assoc.

The second design policy was to provide patients with a calm waiting environment. Based on consultation/examination time appointment system, average waiting time was reduced. In addition, as each patient was handed a special beep handy phone, he/she was allowed to stay in any place of the hospital until his/her device ringed with melody, vibration and a red lamp. As the result, patients did not need to stay in crowded waiting areas.

Another example is Ashikaga Red Cross Hospital, which was awarded as gold prize of international health care facilities in IFHE-NVTG congress 2016. The OPD is faced to the main hospital mall with see-through lift and provide easy access without disorientation (Passini 1984), as shown in Fig-8. What is called a "one-stop" reception system is administratively installed, to avoid unnecessary movement by the patients.

Department relationship is also depended on material handling, in another words, logistics of various materials, i.e. medical equipment, pharmaceutical, D&T materials, sterilized goods, linens, nursing tools, stationaries, specimens, food, waste, and deceased persons, etc. Movement of people and materials were surveyed and summarized in the diagram shown in Fig-9.

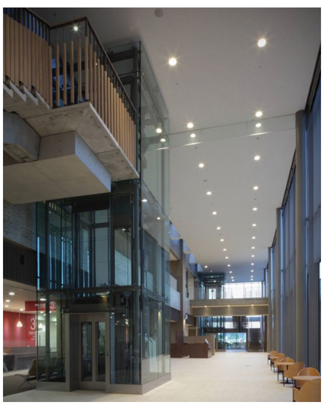

Figure 8:
OPD of Ashikaga
Red Cross Hospital
Source:
Nikken Sekkei Archits. & Engrs

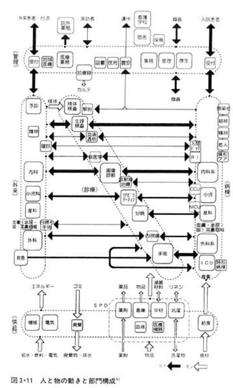

Figure 9: Diagram of movement of people and materials
Source:
AIJ, Iryo, Kenchiku-sekkei-shiryo-shusei, No.4, Maruzen

3. Development Control Planning

In the report on hospital design published by Nuffield Provincial Hospitals Trust, (Nuffield 1955), especially since British hospital architect John Weeks proposed that every hospital buildings must to cope with growth and change for the future (Weeks 1986) several planning/design policies have been developed all over the world.

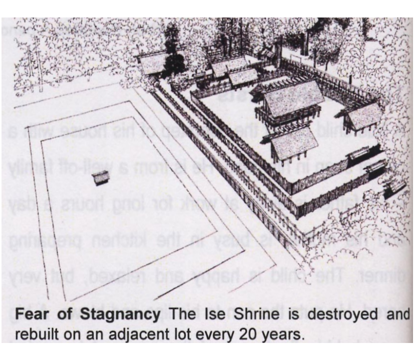

Figure 10:
Ise shrine, Japan
Source:
Nikken Sekkei Architects & Engineers

Figure 11:
Multi wings type, Chiba Cancer Center, Japan
Source:
(Yoshikake et al 1974)

Figure 12:
Hospital street type

Northwick Park Hospital, London, UK

Figure 13:
Interstitial space (ISS) type

McMaster Health Science Center, Hamilton, Canada

They are respectively: A) Preservation of the site for extension and rebuilding. For good example, Ise shrine in Japan has been rebuilt every 20 years in the reserved neighboring site for more than 2000 years (Fig-10). B) Multi wings type. Chiba cancer center (Yoshikake 1974) is designed to have open ended multi-wings capable to extend from main hospital street (Fig-11). C) Street-Type Hospital: Northwick Park Hospital has a layout of independent blocks are connected to main hospital street (Fig-12) and D) Interstitial Space (ISS: Space for maintenance and renovation) type McMaster Health Science Center, Hamilton, Canada is an good example (Fig-13).

Even though this policy is well prevailed among the hospital architects/engineers, the only effective way to cope with this requirement will be to establish master plan of development control planning for future. In addition, it is recommendable to move from the tailored suits type to the loose fit clothes type buildings which equipped with ample floor area/long span without rigid walls and floor height.

4. Safe and Security Planning

Florence Nightingale described in the first page of her book "Notes on Hospitals" (Nightingale 1863) the following,

"It may seem a strange principle to enunciate as the very first requirement in a hospital that it should do the sick no harm"

Safety and Security are basically different concepts. Security will not be satisfied even in sufficiently safe conditions, unless the users themselves consider to be safe. On the other hand, non-safe conditions can also become a secured condition as far as the users regard it as such.

Safety and Security must be established in ordinary and unordinary situation. It is very important in the healthcare environment in the year 2050 both safe and secured situations be attained for not only patients but also hospital staff as well as community members in the surrounding area (Nagasawa et al 2004).

In ordinary situation, daily hazard will be various accidents, e.g. patient's fall to floor/ground, robbery, etc. In the situation of hospital, cross infection especially nowadays new type of diseases as TB resistant virus, HIV which claimed a total of 35 million HIV infected people in 2001 in the South Equator and 25 million people in Africa have been infected, similarly in Asia and in Eastern Europe. In addition, mal-practice in medical/nursing procedure is increasing depended on complicated modern medical development.

In unordinary situation, natural disaster, i.e. earthquake, landslide, avalanche, flood, cyclone, volcano eruption etc. and man-made disasters i.e. wars, terrorism, explosion, epidemics, etc. are equally considered. Architectural solutions for the protection against the above hazards are in need.

Earthquake-prone nations like Japan must be well prepared to mitigate disaster during and after earthquakes. In recent years, Japanese islands were attacked by several devastating earthquakes e.g. Great Kanto (1924, M7.9), Niigata (1964, M7.5), Tokachi-oki (1968, M7.8), Miyagi-oki (1978, M7.4), Nihonkai-Chubu (1993, M7.7), Kobe (1995, M7.2), Chuetsu (2000, M7.5), Higashi-Nihon (2011, M9.0) and Kumamoto (2016, M7.3).

The counter measures are in terms of Structure (Fig-14)/Non-structure (Fig-15), Equipment/Engineering and Planning/Operation.

Figure 14:
Structural damage,
Kobe Earthquake 1995

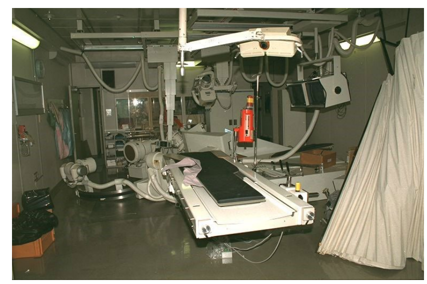

Figure 15:
Non-structural Damage,
Kobe Earthquake 1995

After KOBE Earthquake (M7.2) in 1995, E-Defense laboratory belonging to National Research Institute for Earth Science and Disaster Resilience, was established in Kobe where the world biggest shaking table was equipped and in recent years, four floor height life size mockup hospital building was constructed. Inside the building, various medical instruments, e.g. CT-Scanner, surgical operating table, computer, patient bed, dialysis equipment, water tank on the roof were installed, shown as Fig 16.

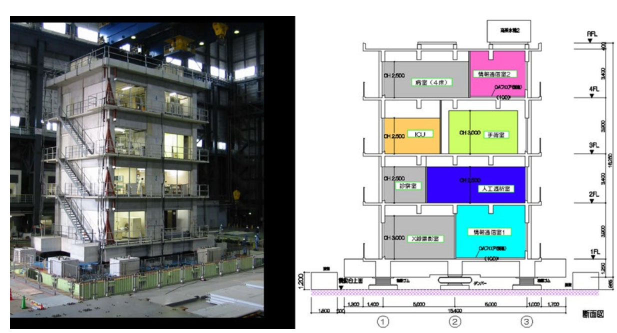

Figure 16: Life size mockup hospital building on shaking table
Source: National Research Institute for Earth Science and Disaster Resilience, Japan

Several actual seismic waves were input and shaking the mockup building. The result after the experiment in surgical operating room is shown in Fig-17.

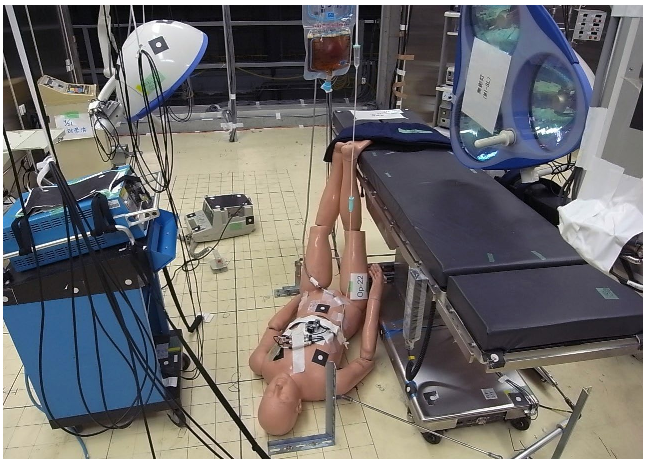

Figure 17: Inside of surgical operating room after the experiment
Source: National Research Institute for Earth Science and Disaster Resilience, Japan

The experiment revealed that base isolation structure is effective to reduce damages inside hospital building unless seismic wave is not long cycle.

Figure 18: Aso shrine was completely crushed
Source: Nikken Sekkei Archits. & Engrs

Kumamoto earthquake (M7.3) was occurred on April 14 in 2016, and Aso shrine was completely crushed shown in Fig 18.

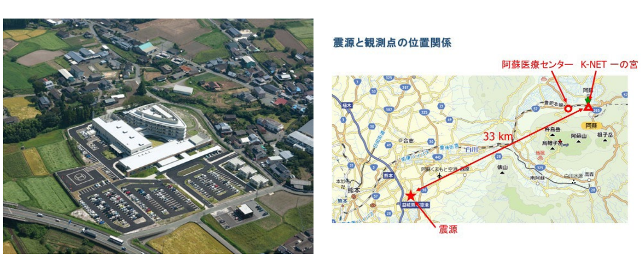

Figure 19: Aso Medical Center located 33km away from epi-center
Source: Nikken Sekkei Archits. & Engrs

Aso Medical Center (124 beds, Total floor area/11,000sqm) located 33km away from epi-center was suffered from big wave. (Fig-19) As OPD block is anti-seismic RC structure, while Wards and Diagnosis & Treatment (D/T) blocks are base isolation RC structure, expansion joint between these different structure blocks were destroyed. In the case of base isolation blocks, 460mm (920mm diameter) horizontal movement was recorded which is the maximum record in Japanese history (Fig-20). There was no damage of base isolation rubbers (Fig-21). The building itself had been slightly damaged.

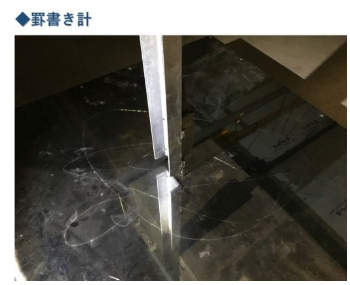

Figure 20: 460mm (920mmΦ) horizontal movement was recorded
Source: Nikken Sekkei Archits. & Engrs

Figure 21: No damage of base isolation rubbers Aso Medical Center
Source: Nikken Sekkei Archits. & Engrs

Direction in design for future hospitals

Most of us already recognize that our global capacity is limited. *"We haven't inherited the earth from our parents; we are borrowing it from our children."*

Reducing LCC (Life Cycle Cost), especially, operating cost is essential. To eliminate CO2 emission is also important. Passive and Active way must be introduced in health care buildings to save energy. In this aspect, "Green Hospitals" concept is important. Ashikaga Red Cross Hospital, introduced alternative energy source e.g. solar energy (Fig-22), wind generator and underground heat sources (Fig-23) etc.

Figure 22: Solar energy panels
Source: Nikken Sekkei Archits. & Engrs

Figure 23: 2,000t Heat storage tank (Underground Pit)
Source: Nikken Sekkei Archits. & Engrs

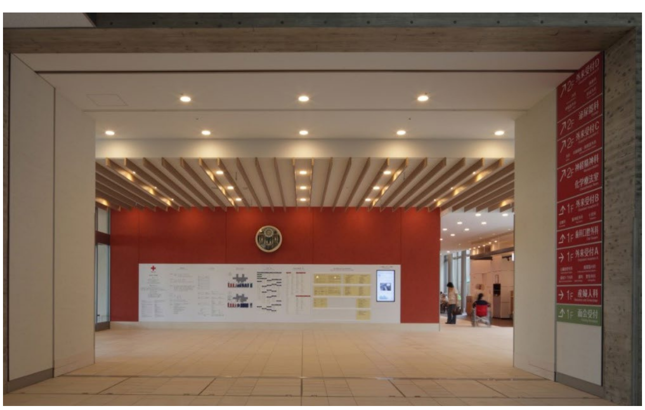

Figure 24: Eco information panel, Ashikaga Red Cross Hospital
Source: Nikken Sekkei Archits. & Engrs

Common awareness about the consumption of energy in health care facilities is remarkable. Ashikaga Red Cross Hospital installed Eco information panel at the main entrance of the hospital. Every one can recognize how much electrical power is currently being consumed (Fig-24).

Another direction in design for future hospitals is providing healing environment for patients. Architect Peter Scher discussed on the role of EBD in an article (Scher 2006) where he cited definitions in medical literature on related keywords. He found two definitions of Evidence Based Clinical Practice (EBCP), thirteen definitions of Evidence Based Medicine (EBM), five definitions of Evidence-Based Healthcare and one definition of Evidence-Based Practice (EBP). He described that design practice comprises three stages – Analysis, Synthesis and Evaluation. According to his description, EBD is useful to consider better healing environment for patients, their families as well as staff.

There are three major factors for healing environment. The first is providing Natural Environment. Prof. Roger Ulrich said (Ulrich 1984) that it is statistically proved the length of stay after the surgery was shorter for patients staying in the room facing to green than facing to brick wall (Fig-25).

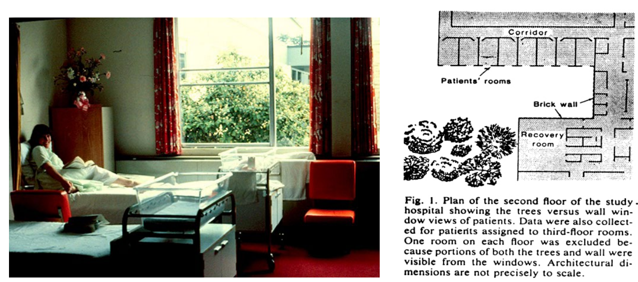

Figure 25: View Through a Window May Influence Recovery from Surgery
Source: (Ulrich 1984)

The second is Communication in Society. The years moving from aging society (65years+ = 7%) to aged society (65years+ = 14%) was 125 years in France, 65 years in USA but only 25 years in the case of Japan. To cope with rapid aging population in Japan is critical. Increasing elderly inpatients in hospitals lead to quite high medical expenditure.

The third one is Spaces in Built Environments. Most of inpatients rooms in current Japanese hospitals is a 04-bed room, but the design which is called private-room-like 04 bed-room is now prevailing (Fig-26). This is the trial to get private window for each patient to provide better personal space in each bed. Ashikaga Red Cross Hospital succeeded to complete all single bed room for the first time of Japanese Red Cross hospitals (Fig-27).

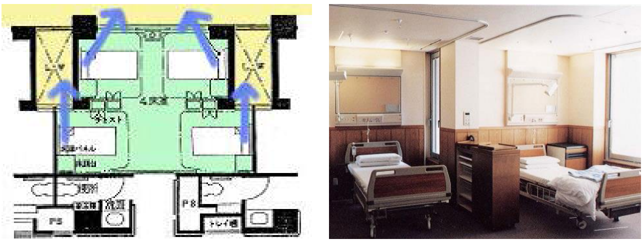

Figure 26: Private-room-like 4 bed-room/Nishi-Kobe municipal hospital
Source: Kyodo Sekkei Archits. & Assoc./Ashikaga Red Cross Hospital

Figure 27: Single bed room
Source:
Nikken Sekkei Archits. & Engrs

Discussion

At the end of 20th century, we succeeded in designing centralized functional units in hospitals, which promoted efficient and effective hospital management. Modernization and maintenance of up-to-date medical technology require more effort and know-how. 800 to 1000 beds compact hospital block is hence proposed for economic efficiency, fully utilizing professional human resources. The centralized modern hospitals, on the other hand, created various complicated traffic systems for people and materials. Staff and patients were usually forced to walk long distances.

Communication tools have been historically changing from voice, notes, telephone, photos, video and now internet. Recent rapid development of telecommunication technology will change the working methods in health care services. For instance, there will be possibility of reducing unnecessary outpatient visits because hospitals are in a large net where all types of patient data will be transferred and stored. The patient data handling is expected to be solved in a few years from now.

In 2050 most industrialized countries, where information networks will be in routine use, will solve the patient's problem based not on site but online consultation. Patients are visiting neighborhood health centers instead of remote hospitals supported by area based health care system, where electrical patients record is available. Other diagnostic information is available for consultation through PACS (Picture Achieving and Communication Systems). The data was transmitted through wired system but currently through wireless system. In other words, hospital function will move from concentrated one to de-concentrated one. Moreover, the importance of ICT security technology is highlighted.

An aging population and growing consumer (patients) demands means that the shortage of qualified personnel will be evident. Changing work processes and work environments is therefore worthwhile to consider. Developments in biotechnology, medical and Information technology, health care financing systems seems to be diversified.

In one sense, large centralized facilities become inefficient and costly. Then networks of smaller facilities become more efficient and create the concept of rationalization. As European and Japan populations are decreasing, only a few new hospitals will be required to be built. The British government announced in 2001 a need for only 100 new hospitals for medical service of the ageing society.

Alternation of Japanese medical laws follow this direction. Better caring environment for patients and families, and upgraded working environments for staff are expected. Many weak signals are found for radical new solutions that the services are moving from impatient care to ambulatory care. In radiology units, the images and report of the diagnosis will be done immediately. Each impatient ward will not need to be nominated to certain medical specialties. A study was published in BMJ in 2001 confirming that the nurse can change the lens in cataract operation with equal results as ophthalmologist. The present boundaries in staff work may be reorganized.

In the coming 50 years, the continuous modernization for many hospitals is the only way. The management of the refurbishment process is important. Most of the hospitals to be used in 2050 in OECD countries already exist. Only in the USA, 100 million population will increase by the year. New effective high-tech hospitals will be needed.

Integrated healthcare network will be prevailed not only in developed but also developing areas. Self-Reliance is very important. The only workable preventing solution is healthier environments for the society including healthy housing, infrastructure, urban environment with effective home care. The hospital complex is not only one building, but also a network of buildings from different ages, with different technical standard and condition. (Nagasawa et al 2004)

The Facility management (FM) is regarded as general strategy of people, place and process (3Ps). In addition, Information and Resource (Money) are also included. FM of healthcare buildings will become increasingly important in healthcare facilities planning including hospitals and other health related facilities, both in developed and developing nations.

When it comes to the issues of the most expensive part of all the life of a hospital in terms of life cycle cost (LC C), 80% of LCC is devoted to operating stage cost, while 19% is consumed to construction stage cost. It means that more consideration should be put on the planning of operation after accomplishing buildings.

The problems of natural and man-made disasters (earthquake, landslide, avalanche, flood, cyclone, etc.) requires interdisciplinary cooperation between architects, engineers and medical faculties (health care staff, crisis management clue, etc.) as well as psychologists in some cases to be solved. Architectural solutions for the protection against the above hazards are in need.

Research on disaster management has produced a shift of focus from the structural strength of materials to the elasticity in human living. The purpose is to enhance sustainability (synonymous with recoverability after disasters including provision of disaster medical services and maintenance of healthcare for those suffered), and management in both ordinary and disaster situations is relevant. For example, it is important to provide pathways and squares for people to walk and stay in a city in the situation that most buildings are destroyed. The reservation of such vacant spaces in urban areas is more meaningful, if they can be used to full advantage in non-disaster situations. People's understanding gained from disaster experience needs to have more impact on future planning. Disaster mitigation through FM and hospital BCP (Business Continuity Plan) is apparently required. However, 2050 future hospital will be non-site-specific architecture, 'Mobile Hospitals'.

All of us now realize that 'functionalism' is so much prevailing in hospital design aiming at efficient and effective function same as in our daily living. (Thompson and Goldin 1975), (Verderber and Fine 2000) As Ancient Greece physician, Hippocrates said; *"It is not beneficial to count everything in money"*, it is suggested to seek another way of design hospitals.

We have been designing every building to cope with the designated function, However, in 21st-22nd century, we will be able to use existing stock of buildings, built-environment, more flexible. School buildings will not the only places for educational functions. For example, quite many people were living in nearby schools after the area was suffered from devastating earthquakes when most of the houses were destroyed. While education can also be carried out outside of school buildings. It is the same in the case of hospital buildings in the future, hospitals are not the only places for medical functions, but also for various other health activities. While, medical functions are supported by networks of various built-environment in surrounding community even in people's houses.

References

Ito M., Otaki K., Kawaguchi K., Nagasawa Y. (1987), Planning of Hospitals, No.31, *Shin-Kenchikugaku-Taikei (New Series of Architectural Theories)*, Shokokusha, Tokyo, p.46-50, pp.345

Kawashima H., Fujita E., Takahashi H., Kosuge R., Matsuda Y. (2009), Study on Departmental Floor Ares of Hospitals, *J. of Jiha*, No.164, p30-31

Nagasawa Y. (1983), Activity Analysis of Ward Nurses for 24 hours, *J. of Archit. Plann.*, Kanto Chapter, AIJ, No.329, pp.74-86

Nagasawa Y. (1986), Survey on Activity Analysis of Ward Nurses, Studies on Hospital Ward Planning 1, *J. of Archit. Plann. Environ. Eng.*, AIJ No.361 pp.42-52

Nagasawa Y. et al (1987), Survey on Bed-side Nursing Area based on Simulating Experiment, *J. of Hospital Administration*, JSHA Vol.25 No.4 pp.55-63

Nagasawa Y. (1993), Hospital Out-patient Department Based on Patients' Behavior and Cognition, Studies on Hospital Geography 1, *J. of Archit. Plann. Environ. Eng.*, AIJ No.452, pp.75-84.

Nagasawa Y. (1995), Hospital Architecture as Geographical Environment, *Hospital Management International*, London, No.361, pp143-145.

Nagasawa Y. (1996), A Study of Hospital Environment Based on Changes of Patients' Consciousness and Behavior over Time Lapse, Studies on Hospital Geography 2, *J. of Archit. Plann. Environ. Eng.*, AIJ No.483, pp.121-128.

Nagasawa Y. et al, (2004), Global Hospitals in the year of 2050, *Report of Subsidiary Study by Ministry of Education, Culture, Sports, Science and Technology, Japan, 2001-2003*, pp.333

Nightingale F. (1863), Notes on Hospitals, third edition, London, Longman, Green, Longman Roberts and Green, pp187

Nuffield Provincial Hospitals Trust (1955), Studies in the Function and Design of Hospitals, Oxford university Press, London, New York, Toronto, pp.192

Passini R. (1984), Wayfinding in Architecture, Van Nostrand Reinhold Company.

Scher P. (2006), Evidence-Based Practice in the Design of the Environment for Health Care, *The XXVIth International Public Health Seminar of the UIA-PHG and WHO Public Health Work Programme, 13th -16th July 2006*, Pretoria, South Africa

Thompson J.D., Goldin D. (1975), The Hospital : A Social and Architectural History, Yale University Press, pp.349.

Ulrich S. R.,(1984) View Through a Window May Influence Recovery from Surgery, *the America Association for the Advancement of Science*, 27 April 1984, Vol.224, pp421-422

Verderber S., Fine D. V. (2000), Healthcare Architecture in an Era of Radical Transformation, Yale University Press, New Heaven and London, pp.404

Weeks J. (1986), Geography of Hospitals, *World Hospitals*, September, London, p.13, pp.368.

Yoshitake Y. (1964), Studies in Architectural Planning, Kajima Institute of Publishing, p.224-239, pp.425

Yoshitake Y., Ura R., Nishino N., Ito M., (1974), Chiba Cancer Center, *J. of Jiha*, No. 22, p.1-17, pp.21

Zhao X., Nagasawa Y., (2000), Quantitative Analysis of Medical/ Nursing Operating Area Based on Simulation and Experience, *J. of Archit. Plann. Environ. Eng.*, AIJ No.530, pp.179-184

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