

The importance of cross-contamination prevention in the architectural design phase in hospital environments

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Abstract— The Civil Engineer always seeks to reconcile structural security and the lowest cost when designing a work; however, when the work in question is a hospital unit, attention should also be paid to the disposal of the sectors of that, so it provides the lowest possible level of contamination. For this work, nine documents were used as a parameter of study and analysis in order to establish a lineage to be followed in the sectorization of the hospital environment, since no technical notes or re-gulamenting standards were found regarding reducing the hospital infection of the environment as a whole as much as possible. Then an investigation was made on site in a hospital in the Region of Amazonas, Brazil and from this visit was elaborated a plan of sectorization of its ground floor, in order to exterminate foci of cross contamination. Bin this plant, another was created by rearranging the sectors and showing that, in the new sectorization, the foci of contamination can be drastically reduced only by changing some sectors of place, thus altering the flow of people in the dependencies of this hospital floor. The COVID-19 pandemic reinforces the warning about the care of cross-contamination, one of its greatest forms of transmission. Thus, at the end of this article it was found that there is a great literary vacuum referring to hospital projects that prevents cross-contamination; there is no specific standard for hospital sectorization, except for some sectors governed by specific norms; it was also noted the little interest of municipalities in promoting a standard that regulates this sectorization, because one of the documents referring to this dates almost thirty years ago.

I. INTRODUCTION

Cross-contamination is defined as the transfer of contaminant microorganisms from one surface, site or even from one grocery to another, by means of instruments, utensils, equipment, among others contaminated, thus spreading (ANVISA, 2015).

The design of any construction or renovation is more useful to avoid errors before, during and after the execution phase. In civil engineering it is common to have greater concern with the structural part of the project and the structure itself, but in this work will be given greater emphasis on the layout of areas according to possible areas of contagion. Its area of propagation is comprehensive because it has as its own principle the hospital structure to

the utensils and materials used, and it is necessary a joint mobilization of effective measures continuously so that the areas are free of contaminants (MS, 2014).

When analyzing the related concepts on the subject in order to evaluate the location of the environments in the projected plants that meets this analysis, so that it is possible to visualize and understand the internal structure and its sectorization, because it is necessary to observe the movement of people and equipment in the respective areas. Being that, for the creation of any project are necessary the three basic steps such as: a previous study (people flow, material needs, environments, among others), the base project and the execution project (MS, 2002). As the focus is on the prevention of cross-disease, the analysis will be carried out on top of the foundations of the first stage of previous study.

According to RESOLUÇÃO No. 216, DE 15 SEPTEMBER 2004, of the National Health Surveillance Agency, contamination occurs according to the passage of microorganisms of biological origin, substances or even physical substances, which are seen as harm to the health of the human being, through these characteristics, all utensils and surfaces used to handle food must be free of odors, flavors, any toxic issues with is constituted by legislation and be kept in a good state of conservation having to have a corrosion resistance to resist the various cleanings.

In the case of ANUs (Food and Nutrition Units) there is a standardization directed to the dimensioning (Annex G) of these spaces, that is, it follows RESOLUTION RDC N.50, FROM FEBRUARY 21, 2002 that gives the regularization of planning, programming, creation and evaluation of physical projects for health units (MS, 2002).

The building and facilities should be designed in such a way as to enable an orderly flow into the environment, being compatible with all necessary movements and operations, as well as facilitating maintenance, cleaning and, where applicable, disinfection operations. There must be a physical separation between the various activities in order to avoid cross-contamination (MS, 2014).

RESOLUÇÃO No. 216, DE 15 SEPTEMBER 2004, of the National Health Surveillance Agency also provides for measures that, if prevention measures are not sufficient or ineffective, the need to hire a specialized company, in accordance with the specific legislation, using them and products approved and regularized by the Ministry of Health (MS, 2004).

II. MATERIAL AND METHODS

This is a descriptive study, of the type ana

lysiscomparativa, based on lithic reviews and aiming to answer the key question for the entire work, where all available information were collected, through articles, books and resolutions, provided to the public.

As a means of construction, this work was carried out in a process that was established by nine steps, sendo them: the choice of the problematic, object desired, the whole of search, inclusion criteria, the search sites, screening of documents, analysis of results, discussion and the statement of results.

Posteriormente to the choice of the problemática, h hear the selection of the key words or descriptor terms to serve as a source of and search for documents preexistentes, being the following terms used for research: "Hospital architecture", "Hospital structure", "prevention of cross contamination" and "hospital architectural project". The search was to have virtual on reliable sites such as Virtual Health Library (VHL), Ministério da Saude (MS), National Health Surveillance Agency (ANVISA) and Scientific Electronic Library Online (SCIELO).

The search date of the materials had its extension from March to June 2021, where the filter "free full text" was applied in order to present only free texts. Como each search source has different means not following a pattern, searches were made according to each site, however maintaining if the search descriptors.

The documents collected, in the Portuguese language, have an extensive publication date, and the condition used from 1995 to 2018, presents information on the theme abordado, even if in a fractional way, because it was necessary to join cross-section and hospital structures to be able to support the article.

The choice of the cumentos occurred in two stages: the first was the reading of the titulus and its abstract; second its full reading to know if it would cover in a compatible way with the proposed theme.

Nine documents were found, all of which were used during the work-construction process, and only one addressed the subject discussed and the other ones were used as support for the basis and complementary information.

Listen to the need for data storage, so the Program Office - Word, version 2021, with the data: Title, author, type of study, , place, language and year of publication , for the end of the construction of a spreadsheet.

For the elaboration of the sectorization plant, an *on-site visit* was made at the hospital in the amazon state region, because it was not publicly available and there is no need to mention the hospital in question.

III. RESULTS

The general structure has 9 documents, which were selected in the period from 1995 to 2018 as year of publication, the languages in Portuguese and English, being present in table 1, in order of analysis according to title, author, type of study, language, and year of publication.

Table 1. Data used in the analysis, Manaus, Amazonas, Brazil, 2021.

STUDY 1	
variable	definition
title	Use of HACCP in the food industry.
author	Larissa Lagoa Ribeiro-Furtini; Luiz Ronaldo de Abreu.
Type of study	Support study.
language	Portuguese.
Year of publication	2006.
STUDY 2	
variable	definition
title	Architecture in prevention and control of hospital infection: isolation rooms in emergency and emergency units.
author	Thaize Vanessa Bortoluzzi Coast.
Type of study	Supportive study.
language	Portuguese.
Year of publication	2018.
STUDY 3	
variable	definition
title	Standards for physical projects of health care facilities.
author	Ministry of Health Health Department of Health Care.
Type of study	Supportive study.
language	Portuguese.

Year of publication	1995.
STUDY 4	
variable	definition
title	Relationship between hospital architecture and prevention of hospital infection.
author	Tatiana Maia Pereira do Nascimento.
Type of study	Support review.
language	Portuguese.
Year of publication	2010.
STUDY 5	
variable	definition
title	Resolution No 216 of 15 September 2004. Technical regulation of good practices for food services.
author	National Anti-State Surveillance Agency.
Type of study	Support review.
language	Portuguese.
Year of publication	2004.
STUDY 6	
variable	definition
title	It provides for the Technical Regulation for planning, programming, preparation and evaluation of physical projects of health care facilities.
author	National Health Surveillance Agency.
Type of study	Support review.
language	Portuguese.
Year of publication	2002.
STUDY 7	
variable	definition
title	"Case study of general aspects of works in hospital buildings".
author	Juscelino Rodrigues Mariano.

Type of study	Support review.
language	Portuguese..
Year of publication	2010.
STUDY 8	
variable	definition
title	Architecture in the prevention of hospital infection.
author	Domingos Marcos Flávio Fiorentini; Vera Helena de Almeida Lima; Jarbas B. Karman.
Type of study	Review in full.
language	Portuguese.
Year of publication	1995.
STUDY 9	
variable	definition
title	Introduction hospital architecture.
author	Antonio Pedro Alves de Carvalho.
Type of study	Support review.
language	Portuguese.
Year of publication	2014.

It is observed that study material used in Estudo 8 is a support review and only 1 is reviewed in full, and it is possible to highlight that they were researched in another language and were not successful.

IV. DISCUSSION

According to the research carried out for the elaboration of this work, and to the point where knowledge was permissible, it was not found in an accessible way or there was no reasonable amount of specific literature on this theme. This situation shows the need to start studies referring to the hospital structure aiming at non-contamination with phase in the appropriate sectorization.

There is a lack of standardization in the hospital structure as a whole. Offices, various sectors, wards, do not have a specific standard or regulations that define their ideal location in the architectural plant. The designer

engineer always elaborates his project with a phase in the infrastructure, aiming mainly at the safety of the building and the lowest possible cost, however, in a hospital building it is necessary to take into account biosafety, as well as the flow of people in the facilities. As a way of exemplifying, a sector plant of a hospital in the Amazonas region of Brazil was adapted.

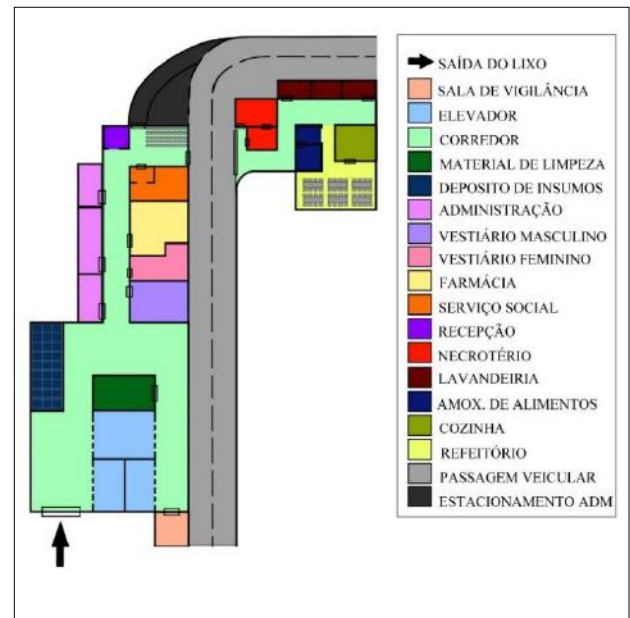


Fig.1: Plant 01 referring to hospital sectorization in the region of Amazonas, Brazil - Adapted by the authors.

Plant 01 refers to a hospital unit in the Amazon region, Brazil, which offers low, low-day, high-complexity hospital services. In this figure, certain incongruities and incoherences regarding the disposition of sectors and the movement of persons are noted.

As evidenced by the sectorization, it can be noticed that the nutrition facilities of the workers (cafeteria and kitchen) are located in the vicinity of the morgue and laundry, and the access to both is unique and the same. That is, through the same entrance pass health workers, raw and cooked foods, companions of patients, dead bodies, hospital clothes (surgical center, bedsheets, clothes of biological risk), being clean and dirty and all the garbage produced in these environments, because the entrance and exit are both through the same door, generating a huge risk of cross contamination in various instances.

According to item 4.1.1 of RDC NRO 216 DE 2004 DA ANVISA that has on the facilities and buildings of environments for the purpose of nutrition, states that they must be designed so that there is no crossing of food with any other insums that may contaminate them, thus

evidencing the impossibility of the facilities described in the paragraph above.

The elevators are of wide and common use, therefore the three available in addition to allowing access to all floors of the complex, convey and confine the people of the most diverse sectors in their interiors. These elevators serve as a route to the wards, intensive care units, outpatient clinics.

Briefly, it can be said that patients, whether these patients, discharged, transferred or even who died; hospital workers, whether nurses, doctors or even general service agents; clothes in general, bed, scratch, clean or dirty; garbage, both common and hospital; finally, absolutely everything goes through these elevators, often even simultaneously, making them serious vectors of contamination and contagion.

The same situation of the elevators is also found in the access corridor. It is noted that it consists of the only entrance and exit that gives access to the hospital complex. Whatever the origin or destination of the material or person transiting through the sectors of the hospital, the only access route is through this corridor.

According to the work of preliminary recommendations entitled Body management in the context of the new coronavirus Covid-19, first version, issued by the Ministry of Health and published on March 23, 2020, the management of bodies in hospital occurrence can *only be* made by professionals properly equipped with specific EPIs for biological risk, that is, any person devoid of such equipment could never stay in the same environment as a see of this nature.

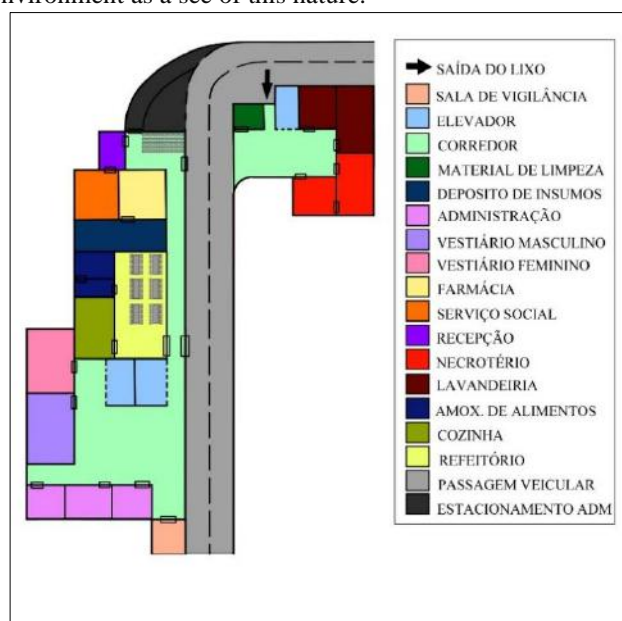


Fig.2: Plant 02 with hypothetical solution for errors found in plant 01

A possible solution for the incongruences applied in plant 01, can be noted in this hypothetical sectorization shown in plant 02. The sectors within the hospital in question were situated in different order in order to restrict the movement of people, considerably reducing the risk of contamination.

The kitchen and cafeteria have been remained, making the access to them with those of the laundry and morgue no longer cross. These, in turn, had their sectors isolated because they were the greatest focus of contamination in relation to the other hospital dependencies.

The garbage path was also re-suited. The garbage, whether hospital or common will no longer circulate throughout the hospital or the elevators intended for employees and patients, because it can be noticed an exclusive and access elevator for situations of greatest contamination.

Such sectorization plant is based on the norms of good practice for the allocation of cafeterias and avoiding cross-contamination from infected materials that once circulated along the same paths as the non-infected ones.

This need for engineering concern when designing a hospital, preventing cross-contamination, was evident with the advent of the Covidpandemic-19 which, when it comes to the abor region given Amazonas, Brazil, led to the collapse of hospital networks as a whole, whether public or private. Among the most distinct factors, we had cross-contamination as the main form of disease contagion, especially within the hospital environment.

Because there is no specific standard, the sectorization of a hospital environment ends up being because of the current management (director or manager) in public hospitals and by the owners in the private sector. As an emergency measure, during the critical phases of the pandemic, some hospitals isolated internal areas to perform differentiated care to patients with suspected covid-19 in order to avoid agglomerations and reduce the spread of the virus.

However, this emergency measure was not enough to avoid contamination of the other facilities, as the areas were isolated, but in some cases, attention was not paid to the flow of people, causing patients with and without covid-19 to go in the same environment, as well as health professionals and even see and being taken to the morgue, all using the same access routes.

It is up to the Engineer to design and sector the facilities of his work; with the hospital should be no different. Once designed, the hospital plant needs to see, from the other situations, the non-contamination of its various ambientes, before its construction and, after

construction, should not be changed without first consulting the responsible engineer or the existing Engineering sector within the Municipal Health Department.

In the Manaus region, Amazonas, Brazil, the inspection related to architectural plants taking care of the use of cross-contamination exists, and is carried out by the engineering sector of the Sanitary Surveillance (VISA) of Manaus, but its competence is restricted only to facilities with nutritional purpose (kitchens, cafeterias, restaurants) including inside hospitals, and in the case of these, it is necessary a standardization for future inspections in other environments and facilities.

The state decrees referring to measures to combat Covid -19 in the Amazonas, the last of NRO 43596 OF MARCH 20, 2021, were given powers of supervision and action to several public authorities, among them visa Manaus for the question of circulation of people of fearing virus dispersion risk.

The Architect, Physician and also Professor of Architecture and Hospital Planning Domingos Flávio Fiorentini published in 1995 by the Ministry of Health a series of texts with the intention, According to him, to make available study material related to architectural projects in complex hospital facilities, because they were almost not widespread at the time and, as can be evidenced, almost 30 years later remains scarce of research material.

V. CONCLUSION

This work concluded that this theme requires a more specific approach and studies. The work shows that there is a need for the engineer to worry about the location of the sectors when designing a hospital, but because it is not a common practice or because there are no specific rules that ratify this, there is no way to charge or supervise the work and who suffers are the people inside the hospital facilities, be they patients or health workers.

The present study shows the importance of the discussion on the theme, because if there was a greater concern with cross-contamination in the hospital environment, the contagion of several disease could be avoided, including Covid19, which shows an unpreparedness in hospital networks related to this item.

In view of the scarcity of literary material on this subject, there is a need for greater visibility and investment in it, so that the perception of the prevention of cross-contamination is taken more seriously, because due to this lack of material the definition of cross-contamination was removed from a DRC for food. There is data collection to design hospital units, which uses some sector localization

standards, but there is no standardization for the leasing of sectors.

In founded documentation, a range of studies and works are based on cross-contamination focused exclusively on the food part, always with the concern of preventing intoxication due to poor handling, transportation or storage of food. However, our study showed that food poisoning should not be the only concern related to cross-contamination, since can be linked by various follow-ups, in any environment and disseminate numerous diseases.

Engineering professionals need to understand that a hospital unit needs more than just environmental structuring standards. To be able to find the need for environments isolating areas of biological risk, canoes and common environments is of paramount importance because many variables intersect the possibility of contamination becomes high and extreme dangerous.

It is possible to see the importance of the prevention of cross-disease in hospital environments according to the literature and the exemplification through the plants because, with a stucco of flow and sectorization becomes feasible isolates grouped risks in only one nucleus, thus making elevators of exclusive use, with only one route of garbage, cadavers, hospital clothes of normal beds and surgical center, minimizing contact and unwanted circulation by areas of common access.

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