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Review article

The impact of the COVID-19 pandemic on hospital biosafety practices

O impacto da pandemia da COVID-19 nas práticas de biossegurança hospitalar

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ABSTRACT: The pandemic of COVID-19 has changed life globally. Economic, cultural, and social damages were noticed on a large scale, along with countless deaths. Therefore, changes in hospital practices have become necessary to prevent the spread of the virus among hospital staff and patients. In this context, the study aimed to discuss the impacts brought by the pandemic of COVID-19 to the hospital environment, including the main changes in order to avoid the spread of the virus. For the research, original articles published in bibliographic reference platforms, such as SciELO and PubMed, in Portuguese language, in the last 20 years were used. Thus, we observed impacts on the hospital environment, especially in relation to the increased use of Personal Protective Equipment (PPEs) and Collective Protective Equipment (CPEs). Moreover, the use of 70% alcohol has proved to be of great value as an antiseptic agent, minimizing the risk of contamination. Therefore, it is possible to infer that although hospital practices before the pandemic were very relevant, the high transmissibility of the SARS-CoV 2 virus forced new measures to be included in biosafety contexts, culminating in lower risks of self-contamination and heterocontamination in the healthcare system.

KEYWORDS: Hospital biosafety. Contamination. COVID-19.

RESUMO: A pandemia de COVID-19 modificou a vida em âmbito global. Prejuízos econômicos, culturais e sociais foram notados em grande escala, junto às incontáveis mortes. Diante disso, mudanças nas práticas hospitalares tornaram-se necessárias para evitar a propagação do vírus entre os profissionais e os pacientes internados. Diante desse contexto, o estudo objetivou discutir os impactos trazidos pela pandemia de COVID-19 ao ambiente hospitalar, incluindo as principais mudanças no intuito de evitar a disseminação do vírus. Para a realização da pesquisa, foram utilizados artigos originais, publicados em plataformas de referência bibliográfica, como SciELO e PubMed, em língua portuguesa, nos últimos 20 anos. Sendo assim, observou-se impactos no ambiente hospitalar, principalmente em relação ao aumento da utilização de Equipamentos de Proteção Individual (EPIs) e coletiva (EPCs). Além disso, a adoção do álcool 70% mostrou-se de intensa valia como antisséptico, minimizando os riscos de contaminação. Portanto, é possível inferir que apesar das práticas hospitalares anteriores à pandemia apresentarem relevância, a alta transmissibilidade do vírus SARS-CoV 2 obrigou que novas medidas fossem incluídas em contextos de biossegurança, culminando em menores riscos de auto e heterocontaminação no sistema de saúde.

PALAVRAS-CHAVE: Biossegurança hospitalar. Contaminação. COVID-19.

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INTRODUCTION

COVID-19 is an infectious disease generated by the SARS-CoV-2 virus and has, among its main symptoms, fever, tiredness, and a dry cough. In addition, other symptoms may occur to a lesser extent, such as loss of taste or smell, conjunctivitis, nasal congestion, sore throat, headache, muscle and joint pain, chills, dizziness, nausea, vomiting, skin rashes, or diarrhea[1].

Social isolation has made individuals more susceptible to stress and, as a consequence of this social deprivation, has favored the increase in the main mental health-related disorders, such as anxiety disorders, depressive disorders, and altered sleep quality. The economy was also strongly impacted, especially small businesses, and some registered a decrease in sales of about 88%. The most affected segments were: Tourism, Education, Creative Economy, Fashion and Beauty. In this scenario, some companies were able to use digital commerce as an escape valve, but not all were able to adapt[2].

Tourism, more than any other sector, is the most sensitive sector to any situational change, and is very retractable to any changes, whether related to exchange rate oscillations, seasonality issues, weather risks, political instability, violence, health risks such as endemics and pandemics, like COVID-19[3].

Besides the economic sectors, health suffered exponentially with the pandemic, and hospital biosafety, consequently, needed to undergo significant changes. The concept of biosafety came into sharper focus in the mid-1970s, concomitantly with the genesis of genetic engineering. Thus, this terminology involves several areas, being described as a set of actions aimed at the prevention, minimization or elimination of risks inherent in research activities, production, teaching, technological development and service provision. These risks inherently threaten the health of individuals, the environment, animals, among others.

Due to the pandemic scenario, hospitals that already had effective biosafety measures in place needed to adapt to the high rate of virus transmission. Thus, new measures began to be adopted in order to minimize the transmissibility of SARS-CoV 2, both among health professionals and among patients and visitors to health services[5]. Given this, the present study aimed to understand, directly, the impacts of the COVID-19 pandemic on hospital biosafety, targeting the main changes that occurred in this environment in order to mitigate the risks arising from the SARS-CoV 2 virus.

MATERIAL AND METHODS

To build the present bibliographic review, original articles published in Portuguese and English, between 1991 and 2022, in the main bibliographic research platforms, such as SciELO and PubMed, were used. As main descriptors, in the databases, “hospital biosafety”, “COVID-19”, “contamination”, “hospital biosafety” and “contamination” were used, obtaining, at the end of the selection, the articles that served as the basis for the review.

A total of 137 articles were collected, 117 from the SciELO platform and 20 from PubMed, of which 32 were included because they were relevant to the development of the research. In addition, we excluded the 105 articles that were not related to the central theme or that the abstract/ key words did not correspond to the focus of this project. Thus, in addition to ensuring greater reliability to the results obtained through the comparative analysis between the selected bibliographies, a greater understanding was made possible regarding the general impacts of the pandemic on hospital practices.

RESULTS

Epidemiological Concepts

Understanding, in this context, some epidemiological aspects becomes fundamental in order to understand the processes and consequences involving the Pandemic. Epidemiology is defined as the study of the distribution, frequency, and determinants of health-related events in certain populations and regions, as well as the application of this study to act in the control of health problems. Thus, it can be said that it is a discipline of utmost importance involving the field of public health, with the aim of understanding the health-disease processes in populations and devising ways to act within this scope. Therefore, it is important to understand the differences between certain definitions, such as endemic, epidemic, outbreak and pandemic. Endemic can be characterized as the habitual presence of a certain disease occurring in a given geographic area, within predicted limits, in a period of time that is not limited[7].

The epidemic, on the other hand, is characterized as the occurrence of the event in a certain region or community of a group of diseases with similar nature, arising from a common source of spread, exceeding, notably, the normal expectation for that region. Thus, it can be said that it results in a clear excess of the number of cases that is beyond what is expected for that region or community, compared to the usual frequency in that population, and, it is worth adding, that it is not necessarily many cases, but a number above normal[8].

The outbreak can be defined as an epidemic that is restricted to a circumscribed geographic space. Thus, it is possible to state that an outbreak is an epidemic event, where all the cases occurring are related to each other and, furthermore, occur in a small and delimited geographical area, such as neighborhoods and villages, or even in an institutionalized population, such as individuals belonging

to nursing homes, day care centers, or prisons.

Finally, the pandemic is defined as an epidemic that has reached large geographical proportions and, therefore, affects several countries and can even cross the continental barrier. In this context, we can cite as an example not only the recent pandemic of COVID-19, but also the occurrence of the Influenza A (H1N1) disease during the year 2009, where the first events appeared in Mexico and later spread to regions such as Europe, Central America, South America, Asia, and Africa[7].

SARS-CoV-2

Belonging to the family Coronaviridae, SARS-CoV 2, is a virus that has positive single-stranded RNA. In addition, the virus constitutes a capsule of lipids and proteins that form the S or Spike structures. This encapsulation is responsible for the viral resistance, while the S proteins give the microorganism a strong binding to the Angiotensin-converting enzyme 2 (ACE 2), which is abundant in the human lung tissues, thus justifying the greater involvement of the respiratory system in individuals infected by this virus[10].

The virus emerged in Hubei province, Wuhan city, China, on December 31, 2019, and as early as January 13 there were reports of cases of COVID-19 in Thailand, starting the pandemic. Regarding etiology, hypotheses point to emergence through gene mutations. In the face of morphological mappings and genetic studies, PAHO[11] stated:

> "Research prior to the COVID-19 pandemic showed that betacoronaviruses are present in several mammalian species and exhibit particularly high phylogenetic diversity in bats. It was confirmed that bats likely played a role in the evolutionary history of SARS-CoV-2 by identifying a close relative of SARS-CoV-2 (termed RaTG13) in a species of horseshoe bat (Rhinolophus affinis) sampled in Yunnan Province, China, in 2013. RaTG13 and SARS-CoV-2 have approximately 96% sequence similarity in the genome as a whole, although this does not rule out decades of evolutionary divergence between them." (p. 18).

In this sense, the theory that suggests the creation of SARS-CoV-2 from clonal evolution in the laboratory is refuted and understood as improbable. And it strengthens the hypothesis that the new coronavirus has natural genesis, being an individual contaminated, in an unknown way, by a host animal. It should also be noted that the likely viral evolution arises as a result of human crowding, lack of personal hygiene, and inadequate slaughter and transport of animals[11].

Biosecurity

The concept of biosafety gained more vigor around the 1970s, with the genesis of genetic engineering. Consequently, the experiment based on the transfer and expression of the insulin gene to the bacterium Escherichia coli was the pioneer in this scenario, generating a strong reaction in the scientific community and culminating in the Asilomar Conference, in California in 1974[12].

> Genetic engineering techniques or, more correctly, recombinant DNA (rDNA) technology, began to be defined in the early 1970s, with the use of cloning vectors, usually plasmids and viral genomes, using the so-called restriction enzymes that allowed cutting DNA at well-defined points, thus isolating nucleic acid fragments that could be introduced into the genome of an organism with identical DNA molecules[13] (p. 3).

In this vein, it can be said that the Asilomar Conference dealt with fundamental issues of biosafety. In this context, there was a debate about the risks that genetic engineering techniques offer, as well as about the safety of laboratory spaces. Thus, it is fair to say that the biosafety standards of the National Institute of Health (NIH) in the USA were supported at Asilomar and aimed to warn the scientific community about safety aspects. As a global result, most of the central countries were faced with the need to establish current legislation on this scenario.

> Biosafety and biosecurity refer to the use of knowledge, techniques and equipment in order to prevent the exposure of professionals, students, laboratories, the community and the environment to potentially pathogenic biological agents. To this end, they establish safe conditions for the handling and containment of biological agents, including: safety equipment, laboratory techniques and practices, the physical structure of laboratories, and administrative management[14] (p. 91).

In 1995, therefore, the Technical Commission on Biosafety (CTNBio) was created, which sought to establish rules for all activities involving the construction, cultivation, handling, marketing, transportation, storage, as well as the disposal of any genetically modified organism in Brazil. Thus, in addition to CTNBio dealing with the minimization of risks related to experiments and the minimization of risks in relation to modified organisms and their relations with the work environment, the environment, health promotion and the community[12].

> CTNBio, the Brazilian agency responsible for commercial approvals of genetically modified organisms, has made controversial commercial releases, disregarding some of its rules, as well as the precautionary principle[12] (p. 168).

Given this, the World Health Organization (WHO), in 1980, besides conceptualizing biosafety, also worked on classifications that could encompass risks. Thus, in

2022, in order to create strategies for action, as well as generate assessments and monitoring methods in all actions involving biosafety, the Commission on Biosafety in Health (CBS)[4] was created.

In this vein, conceptualizing biosafety involves several scopes, being described as a set of actions aimed at the prevention, minimization or elimination of risks inherent in research activities, production, teaching, technological development and service provision. These risks inherently threaten the health of individuals, the environment, animals, among others. For there is a difference between risk and danger, the first being characterized as something known, which biosafety aims to ensure, and the second as an unknown consequence.

Biosafety concerns the protection of life, involving who develops the work, to whom it is directed (user/patient) and the institutional, social and environmental space where it occurs. Biosafety measures create barriers between professionals and harmful agents, in addition to the availability and correct and proper use of materials and equipment contribute to collective protection[15] (p. 8).

Thus, in order to develop these theoretical and practical measures in a concrete way, a compilation of actions such as organization and planning, standardization and control, risk analysis and prevention is necessary. In addition, the site of biosafety action also involves universities, laboratories, hospitals, among others. In accordance with Sangioni[14], there must be a safe handling for the containment and manipulation of biological agents from safety equipment to even administrative management.

Thus, in 1980, the World Health Organization (WHO), besides conceptualizing biosafety, generated classifications encompassing biological, chemical, physical, radioactive and ergonomic risks. Moreover, in order to minimize the risks inherent in the handling of microbiological agents, the Biosafety Commission (CBC) classifies risk agents ranging from number 1 to number 4, which is an increasing scale of risk, i.e. in risk 4 there is a greater risk in handling than the agent classified as risk 3. The classification also includes the imminent risk to the collective and even if there is therapy or prophylactic measures to a certain agent, as described in the table below:

Frame 1 - Biosafety risk classification.

Risk class	Individual risk	Collective risk	Prophylaxis or effective therapy
1	Low	Low	Exist
2	Moderate	Low	Exist
3	Elevated	Moderate	It usually exists
4	High	High	It doesn't exist yet

Source: Adapted from Binsfeld, et al[16].

In this vein, in view of the measures and biosafety standards, it is necessary that every laboratory offers containment barriers and a safety project, aiming at the effective protection of the professionals present and working in the area. Thus, the protection of the environment, efficient laboratory operations, as well as ensuring the quality control of the work performed in the enclosure are of paramount importance. In order for all of this protocol to be followed in a functional manner, there must be a division based on safety levels (NB). With this, there are denominations such as: NB-1, NB-2, NB-3, and NB-4, and these levels, in turn, correlate directly with the biological agents, considering facilities, safety equipment, and procedures appropriate to each level. Therefore, what will determine a higher degree of NB for a test will be the actual biological agent involved.

Table 1 - Biosafety levels.

NB1	NB2	NB3	NB4
Level appropriate to the handling of biological agents known not to cause disease in healthy adults.	Level appropriate to the handling of biological agents whose individual risk is moderate and low for the community. It can cause infections, but efficient therapeutic and prophylactic measures are available. Limited risk of spread.	Level appropriate to the handling of biological agents with the potential for route transmission and to cause potentially lethal pathologies, for which treatment and/or immunization measures are usually available.	Level appropriate to the handling of exotic or dangerous biological agents, with high power of transmissibility by respiratory route or unknown transmission and high lethality. There is no effective prophylactic or therapeutic measure against infections caused by them.

Source: Adapted from Ministry of Health[17].

Given this, the World Health Organization (WHO), in 1980, besides conceptualizing biosafety, also worked on classifications that could encompass risks. Thus, in 2022, in order to create strategies for action, as well as generate assessments and monitoring methods in all actions involving biosafety, the Commission on Biosafety in Health (CBS)[4] was created.

Hospital Biosafety

Hospital biosafety acts in different areas, valuing practices that help to control possible threats, along with the dissemination of information and instructions for implementation. The implementation of biosafety standards helps, mainly, to minimize the biological risks that circulate

within the hospital environment. After all, it is a place where there is a large circulation of sick people, who can spread viruses or bacteria. Health agents, in this dynamic, can be susceptible to its effects, as well as serve as "transport" for the contagion of others. Therefore, the continuous use of PPEs and EPCs is a practice that must be exercised, required, and inspected. The importance of biosafety is due to contaminating pathologies, equipment used on patients, such as the proper use of PPEs. Its importance is the prevention of a bad consequence if PPE is not used[18].

In hospitals, biosafety must be applied in some ways, aiming at the functioning of its practices. Among the ways we have the managers and employees who must work together. In general, the pillars that help disseminate a work routine based on good practices are: efficient management, use of safety equipment and correct cleaning and sanitation practices[15].

For biosafety rules to be adopted, everything must start in the hospital's management area. It is the leaders who must assess the risks and define what should be done and what safety equipment should be provided to each professional.

The next step concerns the use of safety equipment, which means that every employee needs to receive adequate information and training before they even start work. And, of course, where necessary, refresher courses and new information must be clearly communicated to the workers as well. Finally, it is important to make clear the fundamental role of proper cleaning and sanitizing of every area of the hospital. The team responsible for this must work according to a controlled and daily monitored plan. Health surveillance rules must be respected and appropriate products and equipment for the job must be used. According to Campos[19], the environment is pointed as an important reservoir of microorganisms in health services, especially when they are multi-resistant. Therefore, the presence of organic matter favors the proliferation of microorganisms, in addition to the appearance of insects, rodents, and others, which can carry new microorganisms in health services.

> New biosafety technologies and associated guides have significantly improved safety in laboratory and healthcare settings in general, especially with regard to the handling of microbiological materials[2]. (p. 44).

Only by taking all the above precautions into consideration can a biosafety policy be successfully implemented in a hospital. Organization, planning, availability of the correct PPE and adequate training are also essential. It is noteworthy that these actions should be part of the overall infection control program, prioritizing and establishing policies that minimize the risks of infection transmission between healthcare workers and patients[20].

The division and allocation of patients to different sectors in hospitals depends on the demands and care that their clinical picture requires. The ward is the most basic sector of the clinical environment, providing non-intensive care to the hospitalized individual. The ICU and ICU are responsible for dealing with the most severe cases in the hospital environment, ensuring a more intensive and constant treatment to patients allocated to these sectors, with the main divergence being that the ICU deals with individuals who need intensive care in general, while the ICU is responsible for those who require specific care, such as cardiac problems, neonatal, burns, etc. Finally, the operating room is responsible for direct intervention in patients who need specific, more invasive care, such as organ removal, transfusion, and repair[21].

DISCUSSION

Facing the Covid-19 pandemic, caused by the SARS-CoV-2 virus, the need for measures that contribute to the control and prevention of this disease has been increasingly discussed. As far as biosafety is concerned, it is about the protection of life, involving those who promote the work (doctors, nurses), to whom it is directed (user/patient), and the institutional, social, and environmental space where it occurs. Biosafety measures create barriers between professionals and harmful agents, and also promote the availability and the correct and proper use of materials and equipment that contribute to collective protection[22].

In the context of health services, such as hospitals and basic health units, biosafety measures are implemented by means of rules, regulations and safety protocols, which must be respected by the professionals involved. This avoids exposure to certain types of risks, such as exposure to biological agents, which have the ability to promote harm to human health and the environment. Among the biosafety measures, the use of Personal Protective Equipment (PPE) stands out, and for this equipment to be really effective, it is necessary that health professionals are trained in advance regarding paramentation and de-paramentation, as well as informed about measures to spread and slow the disease[15].

In view of this, the correct use of these PPEs reduces the risks of infection, besides promoting greater safety in each professional. In this sense, protection and safety measures are indispensable, given the high degree of contamination and virulence of SARS-CoV-2, in addition to the high transmissibility, being disseminated through respiratory droplets, contact, and secretions, besides being able to generate lethal cases, especially in risk groups. Furthermore, preventive actions must be taken in order to avoid exposure and unpreparedness, especially in the hospital environment, ensuring the safety of all involved. In addition, some other practices are extremely important, such as isolating the infected patient and controlling the number of professionals, properly dressed, in these environments[23], [24].

Then, health professionals should be aware and use the standard precautions in suspected cases, which are: washing hands before and after contact, use and distribution of PPE´s (required by NR 32) as headgear, masks type PFF2 (N95), goggles and protective clothing; prior training on the use of this equipment; carrying out shift schedules to reduce exposure and overloading of professionals, reducing the exposure of professionals who have a higher risk and vulnerability. Thus, there is a need to focus on the knowledge of good techniques in the management of patients with COVID-19, linked to the correct use of PPE´s and notions of biosafety. Moreover, it can be emphasized that such basic measures contribute to the reduction of occupational risks and quality of life of health professionals[15'24].

Therefore, the use of PPE's such as N95 mask, face shield, gloves, aprons and caps, are of utmost importance in the intensification of physical barriers, since they aim to protect the face, body, hair, arms and feet of the worker, so rigorously, significantly reducing the transmissibility of COVID-19, in addition to maintaining the care with hygiene, and proper disposal of contaminated waste. Besides the facts mentioned, for the protection of all involved, the right thing to do is to minimize and avoid procedures that produce droplets or aerosols, such as spittle ejectors, because they carry a high risk of contamination. Regarding radiology, new protection measures against coronavirus are required for patients undergoing radiotherapy, as well as for the medical staff, it is recommended to divide the radiotherapy department into two areas: a clean area and a semi-contaminated area with PPE used in these areas, in order to minimize contamination and exposure[25], [26].

Furthermore, it is observed the concentration of efforts in the execution of protocols that aim to reduce the transmission of the SARS-CoV 2 virus both in the professional environment and at home. Thus, in Primary Care, the collective mobilization of professionals is noted, due to the concern with safety in the care of patients with COVID-19. Such actions are linked to the availability of quality information, both for society and for the family of the patient undergoing treatment. Despite the mobilizations, studies show that there is still no consensus among health professionals about which PPEs are the most effective in the pandemic context[27,28].

In addition, the precariousness of the health systems with regard to the supply of inputs was also evidenced. Such perspective was noticed due to the increase in the use of PPE's, leaving some localities in a state of emergency and alarming the health authorities. On the other hand, the needs have led the scientific community to search for new options or rearrangements that could provide a way around this situation. In this sense, innovative surgical masks were obtained and distributed to several health services. Furthermore, the precariousness of the infrastructure for care, as well as the poor working conditions faced by health professionals that are translated into long working hours and low wages were also noted. These factors combined with the lack of knowledge about the new coronavirus, contributed to the loss of quality of life, both physical and mental, as well as the death of many professionals[29'30].

Finally, we also emphasize the adoption of measures in the areas of Management, Teaching and Research in some university hospitals after the beginning of the pandemic. Such measures, focused on safety, quality of life, and training of professionals and students, have contributed significantly to the prevention of the transmission of COVID-19, as well as to a better understanding of this disease. A measure that exemplifies this concern is the suspension of consultations not related to COVID-19 and elective surgeries, as well as the adoption of Distance Learning (DLT)[31], [32]

CONCLUSION

For all these reasons, the article concludes the core of the discussion by affirming the need for effective biosafety actions, which enlist all those involved in the processes and activities that encompass risks. Moreover, it is worth pointing out the great impacts that the COVID-19 pandemic has brought to the current biosafety scenario, once the care becomes more effective. Moreover, it is eminent that there is an effective and correct fulfillment of all protocols to minimize the risk of contamination, since the complete absence and total elimination of risk is utopian. Thus, this theme is of important discussion in the health area, as well as in ethical, social, and political aspects.

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