AVOIDING SARS-CoV-2 INFECTION IN HEALTHCARE WORKERS, IS BEHAVIORAL CHANGE THE ANSWER?

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Bogotá - Colombia

2025

frontiers

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Submitted to Journal:
Frontiers in Public Health

Specialty Section:
Public Health Policy

Article type:
Community Case Study Article

Manuscript ID:
1204878

Received on:
12 Apr 2023

Revised on:
06 Aug 2023

Journal website link:
www.frontiersin.org

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

Author contribution statement

VM-B contributed to the first draft of the manuscript. SL-R contributed to the context and the editing and reviewal of the manuscript. All authors contributed to the conceptualization of this viewpoint, made a substantial contribution to the design of the work, contributed to the bibliography, the refinement of the final version, and have approved and accepted responsibility for the entire content of the final manuscript.

Keywords

behavioral change, SARS-CoV- 2, Healthcare workers, PPE (personal protection equipment), Education - active learning

Abstract

Word count: 350

Background: The COVID-19 pandemic has become an important cause of morbimortality, and healthcare workers are at the highest risk of infection. As a result, policies and guidelines have been issued, and in hospitals, behavioral changes have been crucial. Among the measures, the implementation of personal protective elements (PPE) and their appropriate use in workplaces are key to avoiding contagion, as well as understanding the new measures regarding patient admission, distribution, and constant education in virtual platforms, among others, changing conduct to reduce contagion. However, behavioral change interventions in healthcare workers are challenging as contextual characteristics, attributes of the intervention, and psychological factors are involved.

Study objectives: The problem elucidated is COVID-19 striking frontline emergency department healthcare workers at Fundación Cardioinfantil (FCI). The objective was to describe the behavioral change in emergency-department healthcare workers by studying and monitoring SARS-CoV-2 infection and their relationship through process tracing during 2020.

Methods: We conducted a case study to identify and relate the SARS-CoV-2 infection rate within the personnel in the department, and healthcare workers' response to the implementation and adherence to the use of PPE through the analysis of the different variables that contributed to behavioral change. Data were collected by a single author and analyzed by the two authors using both the individual-level logic model technique and triangulation of the information, with approval from the institutional review board.

Discussion: Several interventions for behavior change were registered in the data collection process. Implementation, embedding, and integration as collective and individual behavior processes were perceived in the data obtained, with evidence on healthcare interventions: education, incentivization, training, restriction, environmental restructuring, modeling, and enablement.

Conclusion: Behavioral science should be part of public health responses, as the theoretical base suggests change may enhance the answer to avoid infectious diseases' transmission. Therefore, individuals at the highest risk appear to adopt guidance with targeted behavior adaptation interventions. Efforts to inform, instruct, and motivate healthcare workers must be continuous, and actions at the community level strengthened, as it is human behavior which determines the spread and mortality of infectious diseases, where community compliance with prevention behavior plays a crucial role.

Contribution to the field

COVID-19 has demonstrated that infectious diseases are a threat to humanity and that health policies need to be designed and implemented in order to diminish the impact on morbimortality around the world. Special attention needs to be addressed to the front-line healthcare workers who have proven to be at an increased risk of infection by the SARS-CoV-2 virus, when compared to the general community, accounting for an important number of all COVID-19 cases. Therefore, the present study aims to determine and evaluate behavioral change as the answer to avoid transmission in healthcare workers by studying and monitoring SARS-CoV-2-infection during 2020. Behavioral science can be used as a crucial tool to guide interventions in healthcare, incorporating clinical evidence into everyday practice where the enactment is a complex social process in which individual and organizational behaviors should be handled as essential findings to achieve positive results. Moreover, it should be part of public health responses, as there is a solid theoretical base to believe that behavioral change may enhance the answer to avoid the spread of infectious diseases, among them COVID-19.

Ethics statements

Studies involving animal subjects

Generated Statement: No animal studies are presented in this manuscript.

Studies involving human subjects

Generated Statement: The studies involving humans were approved by Fundación Cardioinfantil-La Cardio Ethics committee and institutional review board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Inclusion of identifiable human data

Generated Statement: No potentially identifiable images or data are presented in this study.

Data availability statement

Generated Statement: The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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Abstract:
Background: The COVID-19 pandemic has become an important cause of morbimortality, and healthcare workers are at the highest risk of infection. As a result, policies and guidelines have been issued, and in hospitals, behavioral changes have been crucial. Among the measures, the implementation of personal protective elements (PPE) and their appropriate use in workplaces are key to avoiding contagion, as well as understanding the new measures regarding patient admission, distribution, and constant education in virtual platforms, among others, changing conduct to reduce contagion. However, behavioral change interventions in healthcare workers are challenging as contextual characteristics, attributes of the intervention, and psychological factors are involved.

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Conclusion: Behavioral science should be part of public health responses, as the theoretical base suggests change may enhance the answer to avoid infectious diseases' transmission. Therefore, individuals at the highest risk appear to adopt guidance with targeted behavior adaptation interventions. Efforts to inform, instruct, and motivate healthcare workers must be continuous, and actions at the community level strengthened, as it is human behavior which determines the

spread and mortality of infectious diseases, where community compliance with prevention behavior plays a crucial role.

Introduction:
The COVID-19 pandemic has rapidly spread globally, with more than 6,873,477 deaths associated in 224 countries, and 760,360,956 confirmed cases by March 2023 (1). Ever since the proclamation of the pandemic by the World Health Organization (WHO), front-line healthcare workers have denoted an increased risk of infection by the SARS-CoV-2 virus. When compared with the general community, it accounts for 10-20% of all COVID-19 cases, given the direct contact with infected patients and exposure to droplets, with a mean basic reproduction number (R0) of 1.4-4 and a mean incubation period of 6.4 days (2-3). As a result, multiple policies and recommendations from policymakers, healthcare organizations, and governments have been issued, embracing diverse scopes. Among them are administrative controls, such as resource allocation, infrastructure, infection prevention, and control policies. In terms of patient care, access to laboratory testing, an appropriate triage designation, adequate staff-to-patient ratio, staff training, and environmental and engineering control, must be considered to reduce viral transmission (4).

Moreover, healthcare workers need additional protection to evade contagion and contain transmission as they are at the highest risk of infection. In response, two main strategies have been suggested by health authorities worldwide. First, considering a priority the appropriate use and disposal of PPE to prevent droplet exposure, and second, the demand for a separated area/route in the emergency department for respiratory patients, retaining the entrance to an area without the necessary protection and, therefore, reducing the risk of infection within the healthcare environment (5). These responses are part of behavioral transformation interventions since they are designed to change the health workers' conduct regarding SARS-CoV-2 infected patients, which can be analyzed from the Theoretical domain framework (TDF).

The TDF is the result of integrating multiple behavior and behavior change theories that were initially intended to be implemented in research regarding influences of evidence-based recommendations in health care behavior (6). Therefore, behavioral science is a tool that should be explored and used by policymakers, health managers, clinicians, and healthcare staff, to design and implement interventions in healthcare to allow the incorporation of clinical evidence into everyday practice. However, the effectiveness of behavior change interventions in healthcare is challenging, as they must be studied describing their strengths and limitations to understand the outcomes of the intervention, where the context of the action in question plays an important role.

The following research presents a case study in the context of the COVID-19 pandemic regarding the behavior of healthcare workers in the emergency department of Fundación Cardioinfantil. The study aims to identify and relate the SARS-CoV-2 infection rate within the personnel in the department, and healthcare workers' response to the implementation and adherence to the use of PPE. This is in order to analyze how the modification in their behavior, based on new healthcare policies adapted to the pandemic context, can impact the risk of infection, which is an example of how public health depends on behavioral change.

Context:
<u>The setting and population</u>:

Fundación Cardioinfantil-La Cardio is a 4th level internationally accredited healthcare center in Bogota, Colombia. According to America Economia, is the second-best health provider in the country and 5th in Latin America (7). The inpatient capacity is 347 beds, and the emergency department (A&E) provides care to more than 69.000 patients every year, with a team of professionals from diverse degrees (physicians, nurses, pharmacists, administrators, security, among others), that are committed to offering the best available care for patients and their families. However, healthcare workers have been denoted as a high-risk population for reporting a positive SARS-CoV-2 infection test when compared to the general population, with estimations of up to 10-20% of total SARS-CoV-2 infections, related to prolonged and direct exposure to infected patients (2). Therefore, the observed population in the study are the healthcare personnel of the emergency department, who have direct contact with the highest number of patients and in whom we observed the impact of behavior change.

Measures:
The observed measure is the implementation of personal protective equipment (PPE). It includes surgical gloves, face shields, goggles, gowns, aprons, face masks, and respirators. These elements are used to prevent infection as the SARS-CoV-2 virus is transmitted among people through close contact and droplets, with the airborne transmission not being clear enough.

Behavioral change:
The theoretical domain framework is a consensus of multiple behavior theories used for investigating behavior conduct in diverse settings. Regarding healthcare, it has been especially useful in implementation research, where behavior change interventions are activities designed to change specific behavioral patterns required to offer the best available practice (8-9).

Behavior science theories are evidence-based principles and models created to explain and predict behavior; however, selecting one or a few for an intervention design is challenging. Behavior theories and construct for behavior transformation in healthcare professionals can be divided into twelve main theoretical construct domains or approaches: knowledge, skills, social/professional role identity, beliefs about capabilities, beliefs about consequences, motivation & goals, memory-attention & decision processes, environmental context & resources, social influence, emotions, behavioral regulation, and nature of behavior. The assembling of these constructs results in the theoretical domain framework, which represents theories of behavior that can either be individual or collective within an organization. These are used as mediators of behavioral change to address implementation problems and analysis, designing interventions, theorizing, and testing pathways of change as well as identify process measures (10).

Behavior theories applied to emergency response or outbreaks of infectious diseases seek to understand and influence engagement with a protective health behavior that includes the health-believe model, theory of planned behavior and protection/motivation theory, precaution/adoption process model, and social cognitive theory, as well as the theory of reasoned action. (11). Complex interventions in intricate settings tend to be implemented as a collective action rather than a result of individual behavior processes where context is important. The behavior of people and social phenomena, in general, is determined by diverse causes. Therefore, simple causal models are insufficient, and statistical interaction between causal and contextual variables is necessary (12).

Several observations and studies on the effectiveness of behavior change interventions in healthcare have been analyzed, and strengths and limitations described and compared evaluating outcomes and a change in practice. During the last decade, professional behavior change has acquired particular attention, and literature regarding this involves defining and categorizing interventions, as recommended by the methodological program of Cochrane Effective Practice and Organization of Care (EPOC) Review Group, as well as trying to understand success or failure of the intervention (13).

Designing behavior-change strategies begin with a broad approach that results in a specific intervention component. These should target specific behavioral changes considering the context and population being targeted (9). Implementing interventions for behavior change in healthcare workers has been challenging since contextual factors (i.e., attributes of the intervention) and psychological factors (i.e., vocabulary) are involved (8). The description of the behavior and why it occurs based on the theoretical domain framework will help understand the implementation.

An explanatory framework to investigate implementation in the social context is the Normalization Process Theory (NPT) which appears from the assumption that individual and collective factors are crucial for the effective implementation of behavior change interventions, making everyday practices elements of interest. It involves four social mechanisms: coherence, cognitive participation, collective action, and reflexive monitoring. Coherence refers to what we do to make sense of new practices; cognitive participation to what we do to engage in new practices; collective action to what we do to enact a new practice; and reflexive monitoring is what we do to appraise the effects of a new measure. NPT as a social theory comprises implementation, embedding, and integration (13,14). These mechanisms create implementation processes and enable us to understand the processes through which behavior change interventions are endorsed; hence, focusing on action and not on beliefs, attitudes, or intentions.

Furthermore, interventions described by Michie et al, comprise the following elements (9). Education, which aims to increase knowledge; persuasion, using communication skills to induce positive or negative feelings or stimulate action; incentivization, creating an expectation of reward; coercion to create the expectation of punishment or cost; training, for imparting skills; restriction, using rules to reduce the opportunity to engage in the target behavior; environmental restructuring, changing the physical or social context; modeling, providing an example for people to aspire to or imitate, and enablement, increasing means/reducing barriers to increase capability or opportunity (9).

Policies play a role in behavior change and interventions as they incorporate communication/marketing, using diverse channels (print, electronic, telephonic, or broadcast media), guidelines, creating documents that recommend or mandate practice, changes to service provision; fiscal, using the tax system to reduce or increase the financial cost; regulation, establishing rules or principles of behavior or practice; legislation, making or changing laws; environmental and social planning, designing and controlling the physical or social environment; service provision, delivering a service (9).

Implementing evidence-based practice is fundamental for effective clinical outcomes, where public health depends on behavioral change (9,15). Encouraging people to follow Public Health

measures, strengthening healthcare systems with strict infection control procedures in hospitals to protect healthcare workers and patients, and prevention of hospital outbreaks, as well as guaranteeing supplies of personal protective elements (PPE), will decrease the number of nosocomial transmission of the disease, where encouraging adaptive and protecting behavior change in human behavior will determine how rapid COVID-19 will spread and its mortality.

Key programmatic elements:

Methods:

This research was conducted under a case study methodology, aiming to evaluate the behavioral change in the pediatric emergency department's healthcare workers, after the promotion and implementation of personal protection elements (PPE) as a measure to avoid infection by studying and monitoring SARS-CoV-2-infection during 2020. The authors of the following study were the healthcare manager of the pediatric emergency department, also a member of the COVID-19 committee, and a medical doctor involved in a different area of the pediatrics department in the institution; neither were involved in the population to be observed. This is in order to analyze the results, and from the obtained analysis, sustain or develop new recommendations and institutional policies to execute in the future, not only in the emergency department setting but also transversally within the different hospital departments.

Data collection process:

The data collection process was carried out by one of the authors using a manual data extraction method created by the authors shown in **Table 1**, approved under the data management plan, without computer-assisted qualitative data analysis software use. Instead, we used conventional processor tools to analyze the information (i.e., MS Word, Excel), and all the data were stored in a Case study database where the compilation of the information was available to ensure the reliability of the case study. There were multiple sources and types of evidence taken into consideration, such as documentation from the Covid committee and infectious committee minutes, institutional statistics, documents, programs, plans, processes, protocols, archival records within the virtual campus and communications department, interviews performed by the epidemiology department, observation of the adherence to the use of PPE, and reports of the talent and development area in human resources, the epidemiology department and the occupational health and safety office. They were selected because these were the implemented methods during the development of the regional policies towards COVID-19, the internal recommendations on infection contention strategies, as well as the methods to review and analyze the results obtained and develop new strategies to reduce the risk of infection. The rationale for including these sources of evidence was to perform an in-depth study of the phenomenon in the real-world context; therefore, most of the evidence came from the organization itself, but it also included external sources of evidence as a strength for the construct of validity, (Ministry of Labor, Ministry of Health and Social Protection, and the District's Health Secretary), all listed and available.

The search for evidence within the organization was performed through the institution's quality management system (SGC), as well as its virtual campus, obtaining information from the educational virtual courses and materials saved and available. Other sources included the communications department archive, reports from the talent and development management area in human resources, and the epidemiology department and occupational health and safety office. Sources for evidence included documents and minutes from the organization's COVID-19

committee, created in March 2020 to address the pandemic and explore infection outbreaks within the hospital and their assessment to improve infection prevention strategies and healthcare safety. Specific emphasis was made on the reports completed from COVID-19 cases in the A&E department among healthcare workers.

Guidelines, protocols, instructives, plans, and processes regarding the healthcare workers' protection and risk of infection reduction were reviewed. These were crucial sources for the behavior change within the A&E environment because they allowed education of the healthcare workers, recognizing and carrying out the latest updates on the PPE to be used, allowing entrance in each area, the routes within the department, therefore modifying the conduct of the workers constantly, based on their adherence to these elements. The improvement plans regarding the pandemic were also incorporated, with special emphasis given to improvement plan No. 1102, found on SGC. It contains a complete analysis of an outbreak of COVID-19 infection in the A&E department, with interview reports from conversations conducted by the epidemiology team under the National Health Institute (INS) guideline for epidemiological field research to trace COVID-19 infections (16). Direct and indirect observations were performed, measuring the recommendations given to healthcare workers regarding the use of PPE, reported in SGE as indicators, and indicator reports regarding COVID-19 within the organization's workforce.

Several virtual campus courses of interest for this investigation were reviewed. For instance, courses on PPE instructives and adherence to their adequate use, as well as those on social distancing, hand washing hygiene, waste disposal, and those including healthcare workers' support, were also embraced for data extraction. Reports of assistance and course completion, as well as hours of educational activities within the unit of analysis, were examined to verify that evidence-based recommendations were given. Archive records from the communication department were also reviewed, including multimedia information such as videos, screensavers, bulletins, and campaigns, among other communication strategies of behavior education. Other sources of evidence were consulted for relevant documentation regarding the local government's COVID-19 response, the Ministry of Labor, the Ministry of Health and social security, the District's health secretary, the National Health Institute, and guidelines from infectious diseases organizations.

The sources of evidence and data extracted from the organization's SGC are listed, with code and title on the case study database. However, information has limited access through the quality platform or the archive. Evidence from sources outside the organization is also listed, and documents were included in the database **(Table 1).** All the information gathered in this study is the result of the organization's processes and procedures by the departments involved. To protect human subjects involved in this research, general unit of analysis reports were examined as a whole and not as a particular subject; consequently, no personal identification data was inspected or mentioned.

Data analysis:

Using the Individual level logic model technique for analysis **(Figure 1**), the extracted data and evidence were coded by the author in 6 groups to match the findings and trace the events and interventions as it follows:

Covid response: the interventions, understood as the actions carried out by the organization for implementation of procedures and international and local policy due to the pandemic; *PPE:* evidence on actions and interventions for implementation of recommendations for the adequate use of PPE; *Consumption:* Evidence on PPE consumption, shortage or issues with the supply chain in the organization; *Education*: evidence on training, learning and delivering information regarding COVID-19 to people from the organization and the community; *Routes*: evidence on implementation and identification of separate areas to give care for COVID-19 patients; *Risk:* evidence of increased risk of infection in healthcare workers including epidemiological trace, interview reports and observations in the unit**.**

Since multiple sources of data were analyzed, triangulation aimed to encounter converging lines of inquiry. As shown in Table 2, methodological, data, and theoretical triangulation between the different sources of evidence mentioned (documentation, institutional reports, interviews, observation, and archival records), allowed us to understand and study the variables regarding the different interventions or policies, among them, education on virtual campus courses, persuasion through communication and media, incentivization with holiday bonus and public recognition, training on PPE use, and adequate hand hygiene, coercion through covid guard, restriction and restructuring with the creation of different routes within the A&E department and admission only with the appropriate equipment, role models and enablement giving attention to all patients coming into A&E without deferrals, guaranteeing more access and reducing variables. Therefore, this triangulation allowed to test validity based on the study variables, providing a better understanding of the situation **(Table 2).**

Discussion:

Theoretical models for behavior change in healthcare at the individual and community levels are numerous, and interventions, as well as their implementation, embedding, and integration, are challenging for any organization. However, efforts to implement, embed and incorporate actions to avoid COVID-19 in the workforce at the A&E department at FCI suggest promising results. The analyzed evidence on the relative effectiveness of some of the interventions exhibits a positive impact reflected by outcome measures; however, it is as a multi-component strategy tough to evaluate and isolate the effect of a particular intervention. Triangulation of the data extracted from the sources established, and the analyzed behavioral theories support that there is evidence to determine that the organization, in its response to the COVID-19 pandemic, performed a structured multi-component strategy plan and followed the recommendations given by the authorities, based on previous infectious disease outbreaks, considering the importance of protecting frontline health care workers, specifically with the implementation of PPE and the adherence to recommendations.

The unit of analysis of this study is the emergency department healthcare workers at FCI with proven COVID-19 infection. The data extracted from the year 2020 (taking into consideration the first COVID-19 case in Colombia reported in March 2020) demonstrates coherence with the institutional evidence regarding the ratio of attendants infected with SARS-CoV-2. Reports indicate that from the total workforce, 18.8% had COVID-19 infection as an occupational disease by December 2020; and from those positive for SARS-CoV-2 in the institution, 16.4% were from the A&E department, where behavioral-change efforts and specific training were implemented the earliest regarding the higher risk of infection (**Table 3**). Moreover, reports from the talent and management area in human resources display the efforts of the organization, at the early stages of

the pandemic in Colombia, by training and supporting academic activities for the workforce, particularly those in the frontline of care (example: A&E department), as shown in **Table 4**. It occurred because of identifying these workers as the ones with the highest probability of infection due to their exposure to droplets and close contact with respiratory patients, despite their admission to in-patient care or out-patient follow-up.

The analyzed data suggest a proven causal effect on the appropriate implementation, use, and adherence of PPE within healthcare workers to avoid healthcare-acquired infection with the use of guidelines, institutional policies, and protocols. This can be proposed as the interviews conducted by the epidemiology department revealed that frontline healthcare workers, and in the context of this study, the ones in the emergency department at Fundación Cardioinfantil, had been given the personal protective elements (PPE) and their training, as well as the necessary information to address the infection, showing an understanding of the process. To support this finding, the organization has indicators on behavioral change interventions and actions, such as the appropriate use of PPE with the routine embedding of the procedure, with indicators showing the percentage of adherence to the recommendations in the emergency department, rising to 93% by December of 2020.

However, interviews conducted by the epidemiology department to trace the source of infection, following the parameters from the governmental level according to the INS, expose illogical series of events. They revealed that community-acquired infections, accounting for 3.4% of the total workforce with proven SARS-COV-2 infection, were not due to providing care to patients in COVID-19 areas or inadequate use of PPE, but acquired at the community level, being coherent with the data from the occupational health and safety office. It is a spurious finding from the logic model applied and a rationalization of why personnel in the emergency department of Fundación Cardioinfantil became infected with SARS-CoV-2. Therefore, showing that there are variables implicated in reducing the risk of infection, among them, the use and adherence to PPE in the in-patient setting, with a higher rate of infection outside of the organization, probably related to avoiding the use of these elements at home or social scenarios, which were variables not included and measured due to limitations of the study.

The evidence suggests that the implementation of behavioral change interventions, such as training and education, has increased the knowledge of the approach to the disease in terms of the behavior of the A&E personnel and is now part of the daily practice within the institution, showing a positive response with outcomes measured and evaluated continuously. Compliance with the recommendations and policies on infection control precautions such as the use of masks, including during off-work activities and the compliance with social distancing when indicated, the division between respiratory and non-respiratory routes, as well as reviewing the updated guidelines and protocols when treating positive patients, are part of the outcomes that if reinforced could improve COVID-19 incidence.

In summary, the data analyzed within the triangulation of information showed evidence of behavior change interventions in healthcare (table 2). First, regarding education, with enrolment and assessment of different courses. Also, persuasion is composed of communication tools inducing actions to prevent infection among healthcare workers of the organization. Evidence of incentivization was also found with reward bonuses (i.e., extra holiday time) at the end of the year

for those in the frontline of care, evidence of training, imparting skills to address the pandemic, and displaying the organization's solid training program and guideline adoption.

Regarding restriction, implementing rules to reduce the opportunity to engage in the wrong behaviors and raise the risk of infection is crucial. The environmental restructuring was also evident, adopting recommendations for infectious diseases, like dividing the pediatric emergency section from the main adult A&E area, and creating separate routes for respiratory and non-respiratory patients. Modeling, which refers to evidence on providing an example for people to aspire to or imitate; in this aspect, managers of the organization and leaders in the emergency department had a part in the communication and training strategy as role models. Finally, enablement is approached by implementing actions that reduce the barriers for healthcare workers such as access to preferential care if symptoms appeared. **(Table 2)**

Potential limitations should be considered when interpreting the results of this study. A case study methodology can be controversial as a research method where multiple case studies are preferred. Nevertheless, single case studies such as the one proposed are recognized as a tool in social science and have proved a role in finding explanations of behavior change where the researcher goes beyond quantitative methods to provide an in-depth explanation of the behavior. Since this is an embedded study, although it refers to a single center, it includes information from the healthcare workers in the emergency department, considering it as a whole. The validity of the process increases by triangulation of the extracted data. The next step to corroborate the findings would be conducting a multi-case study involving different units of the organization (ICU, inpatient wards, surgical theatres). Additionally, another limitation of the study is the access to data of similar institutions in the region to establish an infection rate comparison based on behavior change strategies due to confidentiality matters and the absence of public data reports; however, it would be interesting to denote which strategies were reinforced during the same period of time in each hospital and how did they impact on the risk of infection among healthcare workers in different emergency departments in the region.

While case study research methodology makes it difficult to reach a generalized conclusion because of the limited sampling of cases, it enables the examination of micro-level data, and reveals real-life situations, providing data on detailed behaviors of the subjects of interest like the ones presented in this research. Therefore, this research is an initial attempt to determine why healthcare workers in the frontline of care in the emergency department at FCI get infected with SARS-CoV-2, despite their high adherence to recommendations on PPE and how a change in behavior and application of behavior theories link to different outcomes.

It is important to understand the context from which the present situation is being analyzed, as FCI is the second-best hospital in the country, with resources and budgets overcoming others of the region where funding is a constrain for implementation of behavior change actions like training and education as well as environmental planning, to give an example. Therefore, while in FCI the interventions can be easily applied due to the availability of technology and financial capability, guaranteeing constant education, reviewal, and implementation of the diverse actions regarding the pandemic, this could not be sustainable in a hospital within the region with limited access to funding.

Conclusions:
Worldwide infection and mortality associated with COVID-19 arose in 2020, and as a result, diverse efforts have been made at the governmental level to address the pandemic, adopting measures to contain the spread of the disease and to ameliorate the consequences on the economy and labor market, having policies implemented according to the countries' needs and capacity. Colombia is not the exception, and FCI has contributed to the cause.

The contribution to morbimortality by frontline workers attending COVID-19 patients must not be ignored, corresponding to at least 20% of the total infection rate (7,17). The risk of hospital-acquired contagion is the result of direct contact with patients and co-workers, inadequate PPE use, and increased work-related stress, factors that require attention. Therefore, several policies have been executed to protect frontline workers, the ones with the highest risk of infection, while taking care of COVID-19-diagnosed patients.

Within the public health response, behavioral science plays a determinant role, as it is the human conduct that determines the spread and mortality of infectious diseases, where community compliance with infection-prevention behaviors, like social distancing, the use of masks, and vaccination, are fundamental. However, efforts to reduce the transmission of infectious diseases, in this specific context of SARS-CoV-2 at the community level, need to be reinforced, as well as strengthening the measures in frontline healthcare.

The presented study demonstrated that a multi-component strategy plan regarding the protection of frontline healthcare workers, particularly through the implementation of PPE and by providing the resources and strategies to facilitate education on their manipulation, use, and disposal, as well as education on the latest implemented measures and adjustments in the different areas of the institution was crucial to contain the incidence of COVID-19 within the attendants. As the exposure and infection risk is higher, especially in the context of the emergency department workforce, behavioral change was crucial to obtain the expected results. This was reinforced with prompt, continuous education through institutional communications and media within the organization, lectures and interactive courses on the institution’s virtual campus based on global and local policies and recommendations based on previous infectious disease outbreaks, allowance of admission to respiratory areas only to the personnel who had the adequate equipment and proved their appropriate use and disposal, as well as holiday bonuses.

This was demonstrated during the interviews and analyzed data by reviewing the SARS-CoV-2 positive tests by denoting a direct relation between the adherence to PPE among healthcare workers to avoid healthcare-acquired infection and the occupational rates of SARS-CoV-2 infections. In contrast, the ones acquired at the community level occur because the individuals do not have access to all the equipment needed to prevent the infection, or do not use PPE because of familiarity with their contacts. Workers need to include individual and collective variables. These are important for the effective incorporation of behavioral change interventions delivered as a multi-component strategy, being challenging to evaluate as it is difficult to isolate the effect of a particular intervention. The original contributions presented in the study are included in the article/supplementary material, and further inquiries can be directed to the corresponding author.

In summary, the theoretical base suggests acknowledging behavioral change as the answer to avoid infectious diseases, although the implementation of actions and their effectiveness in different circumstances is difficult to measure. The individuals with the highest risk, such as frontline A&E healthcare workers, adopt recommendations within their work environment when targeted behavior change interventions are established but do not apply them at the community level, with infection striking outside their work environment. Fundación Cardioinfantil has followed policy recommendations, and immense efforts have been made to inform, train, motivate, and give confidence to those in the frontline of care in the A&E department. This, in response to the pandemic with many patients seeking medical care, has been evaluated as appropriate within the context, but continued efforts to promote social distancing and self-care at a community level for the organization's workforce need to be strengthened.

Data availability statement:
The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement:
All the research meets the ethical guidelines and ethical approval for the research was obtained from the Clinical Research Ethics Committee of Fundación Cardioinfantil-Instituto de Cardiología, Bogotá, Colombia.

Author contributions:
VM-B contributed to the first draft of the manuscript. SL-R contributed to the context and the editing and reviewal of the manuscript. All authors contributed to the conceptualization of this viewpoint, made a substantial contribution to the design of the work, contributed to the bibliography, the refinement of the final version, and have approved and accepted responsibility for the entire content of the final manuscript.

Conflict of interest:
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

LIST OF ABBREVIATIONS:
COVID-19: 2019 novel coronavirus disease
SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2
FCI: Fundación Cardioinfantil
PPE: Personal protective elements
WHO: World Health Organization
EPOC: Cochrane Effective Practice and Organization of Care
R0: Basic reproduction number
NPT: Normalization Process Theory
SGC: Organizations quality management system (Sistema de Gestion en la Calidad)
INS: National Institute of Health (Instituto Nacional de Salud)
A&E: Emergency department

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FIGURES AND TABLES

Table 1: Source of evidence

SOURCE OF EVIDENCE	FCI	No.	District's health secretary	No.	Ministry of Labor	No.	Ministry of health and social security	No.	Other	No.
Documentation	Covid Committee Minutes	84					Guidelines	7	Guidelines	2
	Infectious Committee minutes	14								
	Statistics	1								
	Documents	1								
	Programs	3								
	Plan	1								
	Process	4								
	Protocols	4								
	Indicators	11								
Archival records	Virtual Campus	26	Circular	2	Circular	2	Circular	1		
	Communications department	1					Resolution	1		
Interviews	Epidemiological Trace report	1								
Observation	adherence % in the use PPE	4								

Reports	Talent and development management area in human resources epidemiology department occupational health and safety office	1 1 1								

Source: Study Data base

Table 2: Theory Triangulation: intervention/policy

Intervention	**Evidence**	**Policy**	**Evidence**
Education	Virtual campus courses	Communication/ marketing	Campaigns Covid response
Persuasion	Communication and media	Guidelines	Covid response FCI Guidelines FCI protocols
Incentivization	Holiday Bonus Public recognition	Fiscal	Covid response
Training	PPE Hand hygiene	Regulation	Social distancing Surgical mask use
Coercion	Detention strategy Covid guard	Legislation	Healthcare workers
Restriction	Routes in the A&E department, No circulation without PPE Official communications	Environmental/ Social planning	Quarantines Shifts Areas
Restructuring	Separate pediatric & adult route in the A&E Separating areas No patient companions Implementation of telephone information	Service provision	Support services
Modelling	Leaders of the adult, pediatric and ICU units participating as role models of the PPE in multimedia material		
Enablement	Giving attention to all patients coming into A&E, no deferrals guaranteeing access and reducing barriers		

Table 3: Positive SARS-CoV-2

2020	**FCI**	**A&E**	**LITERATURE**
OCCUPATIONAL DISEASE	18.8%	89%	10-20%
COMMUNITY AQUIRED	3.4%	11%	N/A
POSITIVE SARS COV2	22.2%	16.4%	10-20%
TOTAL	712	117	
WORKEFORCE (NUMBER)	**3200**		

Source: occupational health and safety office (Study Data base)

Table 4: Training and Education

Courses implemented	Number of persons trained in the A&E department	Hours of training delivered	Type of training	Audience
26	2815	4056	In person Virtual	Nursing Medical Students Administrative Patients

Source: occupational health and safety office (Study Data base), reports from the talent and development management area (Study Data Base)

Figure 1. Individual level logic model

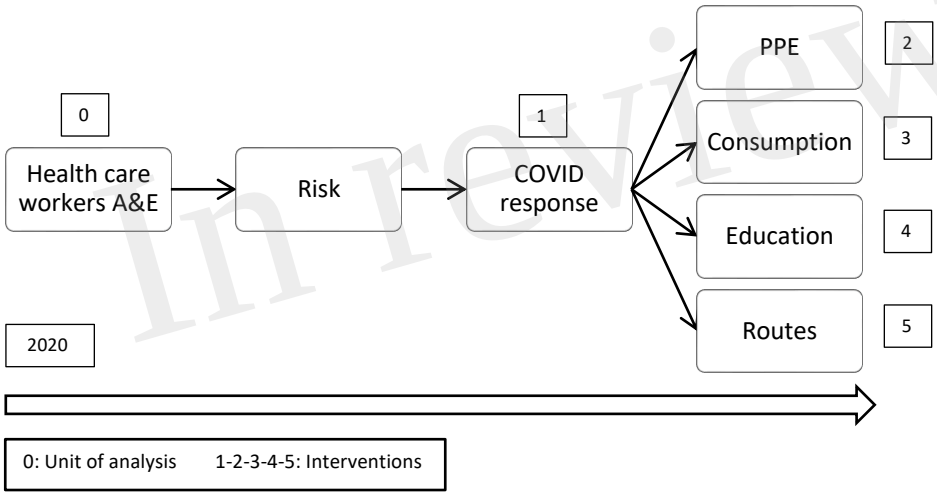

Figure 1.JPEG