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# Operational response capacity of Naval Health Centers in the face of a new pandemic: A multicenter observational study.

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## Abstract

**Introduction:** A pandemic represents the greatest threat to public health worldwide, and addressing this emergency requires extensive knowledge of prevention, preparedness, and response, as well as scientific strategies for organization and planning. The objective of the study was to determine the level of Hospital Safety of the naval health centers in the event of a potential new pandemic.

**Materials and methods:** This multicenter observational study was conducted in 15 first and second-level centers of the Naval Health System during the period June-October 2025. The Hospital Safety Index (HSI) was used. Interviews were conducted with the technical directors of each center.

**Results:** A total of 11 primary-level centers and 4 secondary-level centers received a C classification, while only 1 secondary-level center achieved a B classification. The average HSI classification score in primary-level centers was 0.252 ± 0.048, and in secondary-level centers it was 0.248 ± 0.084, $P$=0.45.

**Conclusions:** The analysis identifies critical areas of opportunity in specific planning for pandemic contingencies. Optimizing infrastructure, equipment, and personnel would mitigate operational risks and ensure service continuity. Similarly, formalizing response committees and strengthening institutional coordination are essential steps to enhance expansion capacity and ensure patient safety during periods of high healthcare demand.

**Keywords:**

Strategies, planning, pandemic, safety index, hospital.

# Introduction

Global industrialization and population growth predispose to the expansion of emerging and reemerging diseases, which constitute a real threat to humanity, due to outbreaks that can become pandemics and their nature of health emergencies, with serious consequences that transcend the health sphere and deeply impact social, political, economic, and environmental spheres [1].

The COVID-19 pandemic was one of the greatest challenges for the healthcare system worldwide. With its devastating figures of 687,225,609 million infected and 6,866,733 million deaths worldwide as of May 5, 2023 (the date when the WHO declared the end of the public health emergency), it was a clear example of this reality [2].

The COVID-19 pandemic had a significant demographic impact in Latin America, as health systems and their workers were subjected to immense pressure due to their lack of preparedness for this prolonged crisis [3] . In Latin America, 27 countries reported the highest percentage of paralysis or interruption of essential health services (55%), compared with 28% in 23 European countries, and the greatest disruptions were recorded in primary care services (70%) [5].

Changes in standardized programs to support emergencies, coupled with shortages of healthcare workers and specialized medical personnel for emergencies and intensive care, forced the remaining available staff to focus on pandemic-related activities. Additionally, the physical and mental exhaustion of healthcare workers prevented the provision of quality care [6].

In institutional contexts such as Naval Health, the impact was more complex due to the need to maintain military operability and healthcare under adverse conditions, which tested the capacity of the naval healthcare system for primary and secondary level care. According to the Directorate of Naval Health and the General Hospital HOSNAG (2023), during the pandemic, these centers treated a total of 15,324 military patients (active, retired, and dependents), of which 674 required hospitalization, 119 were transferred to other centers, and, unfortunately, 128 died (mortality rate of 4%). The need to transfer 119 patients to the public network, due to hospital saturation, underscores the operational limitations faced by [7].

Addressing a pandemic requires responses grounded in deep knowledge of prevention and preparedness, which involve providing strategic responses based on scientific evidence, as well as having the capacity for continuous operation of a healthcare facility, such as building safety, proper functioning of biomedical equipment, availability of medical supplies, and the ability to manage risks in the face of biological threats.

Hospital preparation is crucial to respond immediately and effectively to a new pandemic. This involves developing and implementing planning and management strategies to ensure efficient hospital care for all patients.

Given the possibility of a new pandemic with unknown characteristics, it is imperative to assess whether first and second-level healthcare units are adequately prepared to respond promptly. Therefore, the general objective of this research is to determine the level of preparedness of the Naval Health Centers in the event of a potential new pandemic. The results obtained will not only provide valuable information on the current state of the system but also serve as strategic inputs for decision-making, contingency planning, and the design of institutional policies aimed at improving the operational resilience of the naval health system.

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# Materials and Methods

## Study Design

This is an observational, prospective study. The design is cross-sectional.

## Setting

The present study was conducted at 11 first-level healthcare centers and 5 second-level centers of the Naval Health of Ecuador (see Table 1), located in the provinces of Esmeraldas, Guayas, Manabí, Santa Elena, El Oro, and Galápagos. The sample is limited to a 5-month collection period from June 1, 2025, to October 30, 2025.

**Table 1.** Participating Centers of the Naval Health of Ecuador.

| First Level of Care |
|---|
| Health Center A BASALI |
| Health Center A ESNALO |
| Health Center A Limonar |
| Health Center B CESAFA |
| General Clinic ESANGU |
| General Clinic ESANMA |
| General Clinic CODESC |
| General Clinic BIMJAM |
| General Clinic BASCRI |
| General Clinic BASJAR |
| Health Post BASESM |
| **Second Level of Care** |
| Specialty Center Base Naval Norte |
| Specialty Center Base San Eduardo |
| Basic Hospital HOSNAE |
| General Hospital HOSNAG |

## Participants

Reports from 15 technical directors of the participating centers were included.

## Variables

The Hospital Safety Index (HSI) of the World Health Organization (WHO) and the Pan American Health Organization (PAHO) was assessed [8].

## Data sources/measurements

The source was direct. Data was collected through a survey. The Hospital Safety Index (HSI) comprises 8 modules and enables the assessment of the structural, functional, and organizational dimensions of healthcare facilities (Tables 2 and 3). Once the form was completed, a weighting was assigned to each module based on the healthcare facility's performance. The resulting HSI classifies facilities into categories (A, B, or C) based on the quality of patient care and pandemic-response capacity (Table 4) [8].

**Table 2.** Dimensions of the HSI for evaluation of first-level care centers.

| No. | Module | Parameters |
|---|---|---|
| 1 | Biological threat faced by the first level of care. | 1 |
| | **Security Index** | |
| 2 | Threats affecting the safety and function of the first level of care in pandemic preparedness and response management: infrastructure, medical gases, equipment, supplies, laboratory, and imaging. | 13 |
| 3 | Coordination, planning, and monitoring for pandemic preparedness and response. | 4 |
| 4 | Response of the first level of care to a pandemic and recovery planning. | 6 |
| 5 | Focus on the response to the infectious agent causing the pandemic at the first level of care. | 14 |
| 6 | Organization and preparation of human resources in the event of a pandemic. | 5 |
| 7 | Logistics and finances during the pandemic. | 4 |
| 8 | Continuity of essential services during the community transmission stage of the pandemic. | 3 |

**Table 3.** Dimensions of the HSI for evaluation of secondary care centers.

| No. | Module | Parameters |
|---|---|---|
| 1 | Biological threat faced by the second level of care | 1 |
| | **security index** | |
| 2 | Threats affecting the security and function of this in pandemic preparedness and response management: infrastructure, medical gases, equipment, medical supplies, laboratory, and imaging. | 22 |
| 3 | Coordination, planning, and monitoring for pandemic preparedness and response. | 7 |
| 4 | Hospital response to a pandemic and recovery planning. | 4 |
| 5 | Communication and information management | 4 |
| 6 | Human resources | 5 |
| 7 | Logistics and finance | 4 |
| 8 | Patient care and support services | 9 |

**Table 4.** Classification of HSI and general intervention recommendations [8].

| ISH | Classification | What should be done? |
|---|---|---|
| 0 - 0.35 | C | Urgent interventions are required. It is unlikely that the health center can function properly during or after a pandemic, and the current levels of safety and emergency management capacity are insufficient to protect the lives of patients and staff under such circumstances. |
| 0.36 – 0.65 | B | Short-term interventions are needed. Current levels of safety and emergency management put at risk the security of patients and hospital staff, as well as the capacity of the hospital to function during and after a pandemic. |
| 0.66 – 1 | A | It is likely that the health center will operate in the event of a pandemic. However, it is recommended that the establishment continue to implement measures to improve emergency management capacity and put into practice short- and medium-term measures to enhance the level of safety in emergency situations. |

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### Biases

Observation and selection bias were avoided by applying participant selection criteria. The principal investigator always maintained the data using a guide and records approved in the research protocol to prevent potential interviewer, information, and recall biases. Data collectors were trained on the forms. Two researchers independently analyzed each record in duplicate, and variables were entered into the database after verifying their consistency.

### Study size

The sample was non-probabilistic. All health centers of the institution were included.

### Quantitative variables

The results are presented as frequencies and percentages. The variables collected on a scale were not converted into categorical variables.

### Statistical analysis

Qualitative variables were analyzed using frequencies and percentages. Proportions were compared using the chi-square test, and means were compared using Student's t-test. The statistical package used was IBM Corp. (2018). IBM SPSS Statistics for Windows, version 26.0. Armonk, NY: IBM Corp.

## Results

### Participants

All participating centers responded to the questionnaire. There were 11 first-level health centers and 4 second-level centers.

### Description of the study group

Most centers received a "C" classification, except for 1 second-level center, which received a "B" classification (Table 5). There were no differences in the average HSI classification between first-level and second-level centers (Table 6).

**Table 5.** Pandemic Preparedness Index and Classification of the First Level of Care.

| No. | Health Center | HSI | Classification |
|---|---|---|---|
| 1 | Type "A" Health Center BASALI | 0.33 | C |
| 2 | Type "B" Health Center CESAFA | 0.33 | C |
| 3 | General Clinic ESANGU | 0.19 | C |
| 4 | General Clinic CODESC | 0.22 | C |
| 5 | Type "A" Health Center ESNALO | 0.28 | C |
| 6 | General Clinic BIMJAM | 0.26 | C |
| 7 | Health Post BASESM | 0.21 | C |
| 8 | General Clinic BASJAR | 0.26 | C |
| 9 | General Clinic ESANMA | 0.25 | C |
| 10 | Type "A" Health Center LIMONAR | 0.24 | C |
| 11 | General Clinic BASCRI | 0.20 | C |
| 12 | Specialty Center BASEDU | 0.22 | C |
| 13 | General Hospital HOSNAG | 0.22 | C |
| 14 | Specialty Center BASNOR | 0.18 | C |
| 15 | Basic Hospital HOSNAE | 0.37 | B |

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**Table 6.** HSI comparisons between groups.

| | Center Level | N | Average | Standard Deviation | *P* |
|---|---|---|---|---|---|
| HSI | 1 | 11 | 0.252 | 0.048 | 0.450 |
| | 2 | 4 | 0.248 | 0.084 | |

**HSI Classification**

According to the C classification of the HSI used in the health centers of the naval health system, a critical level of preparedness for a potential new pandemic was observed, indicating the need for interventions. The results indicate that it is unlikely that these units will remain operable during or after a large-scale health emergency (Table 3).

# Discussion

The results obtained through the Hospital Safety Index (HSI) in the health centers of the naval health of the Ecuadorian Navy revealed, in general, a classification C, which indicates a critical level of preparedness and safety in the face of health emergencies, implying that the evaluated units cannot guarantee their continuous operation, neither during nor after a pandemic, representing serious structural, organizational, and functional limitations [8].

These results necessitate implementing actions to strengthen institutional capacities in risk management, emergency protocols, secure infrastructure, and the availability of human and logistical resources [9] . According to the WHO, the resilience of health services is an essential component of preparedness for pandemics and disasters, especially in strategic environments such as the military health system, whose operability is key to the national response in crisis situations [10] .

In contrast to this research, which was conducted in first- and second-level healthcare centers, Sughra conducted a cross-sectional study evaluating two third-level hospitals in Pakistan. She used the complete WHO ISH (151 items, 4 modules) as a tool. Both hospitals achieved Category A (0.66–1), indicating that they will continue to operate during disasters. The author also notes that, although they met all structural and organizational requirements, the main weaknesses of the ISH lay in waste management, operational continuity, and long-term planning for prolonged pandemics [11].

In another study conducted in China, researchers developed a specific tool (complementary to HSI) using the Delphi technique and the Analytic Hierarchy Process (AHP) to evaluate hospital resilience against emerging infectious diseases. The proposed index consisted of a matrix with 5 dimensions (infrastructure, human resources, medical supplies, planning, and inter-institutional coordination) and 25 validated sub-indicators. Their main conclusion was that Delphi-AHP is a tool designed for prolonged pandemics like COVID-19, which complements the traditional HSI, and that its main weakness is the lack of institutional integration [12].

Another relevant finding is the work conducted in Beijing, which aimed to evaluate the responsiveness of tertiary hospitals to respiratory infections. Methodologically, they assessed tertiary hospitals using a scale adapted from the HSI and employed the Delphi method to develop indicators across 3 dimensions: structure, process, and outcomes. 19 validated indicators were obtained. They concluded that this tool is effective for evaluating and preparing hospitals for emerging respiratory diseases and that it should be used alongside the HSI. The main strengths of these tools are isolation protocols and ventilation systems,

whereas the main weaknesses are the lack of formal training and limited integration with external institutions [13].

In Sanandaj, Iran, Rahimi used a combination of an ISH (WHO) list and a questionnaire as the primary tool to assess the awareness of nursing staff (n=167) across different public hospitals regarding hospital preparedness for disaster-type emergencies. The main results indicate that nurses' awareness of emergencies was 77.9%, classified as good. The assessment of the general preparedness of public hospitals for emergencies was 69.2%, which was considered strong. Among the preparedness dimensions of the evaluated hospitals, the command-and-control dimension had the highest percentage (83.3%), whereas the human resources dimension had the lowest (56.7%). The areas considered strong are triage protocols and immediate response. The areas considered weak are the continuity of essential services and communication [14].

More than 500 hospitals (public and private) in 18 countries self-assessed their preparedness for a pandemic. The results indicated moderate levels of preparedness in certain key areas, such as diagnostic laboratories, isolation, and case management. The areas with lower scores corresponded to services that provided direct medical care to patients, due to the limited availability of biomedical equipment, such as ventilators, and personal protective equipment [15].

According to the evidence presented in the previous paragraphs, the WHO HSI is a valid tool for assessing hospital preparedness for emergencies. However, it has also been shown that its structure is insufficient to address prolonged health emergencies, such as pandemics, as indicated by two articles [10, 11]. In response to these limitations, the researchers previously mentioned in this section developed new tools to complement the HSI, such as Cheng's study [12] with its Delphi-AHP index containing 25 new indicators aimed at resilience to emerging infectious diseases; the study conducted in Beijing [13], which validates 19 new indicators focused solely on respiratory diseases, and the study carried out in Iran, which evaluated the level of awareness among nursing staff along with institutional preparedness, demonstrating that the role of nursing staff is key in the effective implementation of the HSI and in the daily management of emergencies [14].

In summary, all these studies demonstrate the usefulness of the HSI as a tool to assess hospital safety in the face of emergencies, but it needs to be complemented with adaptable, more dynamic, and pandemic-focused systems for low- and middle-income hospitals, which raises the need for a hybrid approach that encompasses both the structural part of the HSI and indicators of organizational and operational resilience.

In pandemic-type emergency preparedness, the WHO considers every pandemic high-impact, so health systems must always be prepared, including ongoing staff training, infrastructure maintenance, functional safety, and management of medicines and medical supplies [16].

These results not only serve as a technical diagnosis but also provide key inputs for the formulation of policies and health strategies in the naval domain, thereby strengthening institutional preparedness for future pandemics or complex emergencies.

# Conclusion

The analysis of the readiness status of Naval Health Centers highlights key areas for improvement in pandemic contingency planning. Improving infrastructure, equipment, and staffing would reduce operational risks and guarantee service continuity. Likewise, formalizing response teams and strengthening institutional coordination are crucial steps to increase capacity and ensure patient safety during periods of high healthcare demand.

**Abbreviations**
HSI: Hospital Safety Index.
WHO: World Health Organization.
Delphi-AHP: Delphi Hierarchical Analysis.

**Supplementary Information**
Supplementary materials have not been declared.

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**Sara Benítez Burgos**: Conceptualization, formal analysis, software, validation, visualization, writing – review and editing.
**Allison Michelle Moreno Ubilla**: Conceptualization, data curation, investigation, project administration, and drafting of the original manuscript.
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**Valentina Evelynne Valverde Nowak**: Conceptualization, data curation, investigation, project administration, and drafting of the original manuscript.
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# Declarations

**Ethics committee approval and consent to participate**
The study was approved by the Ethics Committee of the Faculty of Medicine at the Catholic University of Santiago de Guayaquil, Ecuador.

**Consent for publication**
Not applicable when specific patient images, X-rays, or photographs are not published.

**Conflicts of interest**
The authors declare no conflicts of interest.

**Use of generative AI**
The authors declare that they have not used generative AI.

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