**ARTÍCULO ORIGINAL**

# GICA-Covid: web application to manage the information in the Isolation Centers for COVID-19 patients

*GICAcovid: aplicación web para gestionar la información en Centros de Aislamiento de pacientes con COVID-2019*

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## ABSTRACT

**Introduction:** in the current battle that Cuba faces to deal with the pandemic, numerous mathematical models and computer applications have been developed. These analysis instruments depend on the necessary parameters to estimate from the data generated to obtain real-time information regarding the behavior of the disease from the local settings for the behavior of the disease and the implementation of editions.
**Objective:** to develop a web application to manage the information in the Isolation Centers for COVID-19 patients in Pinar del Río province.
**Methods:** technological development research, to create the processes of analysis, design and implementation of a web application of the information generated from the isolation centers for pandemic care. The scientific methods used during the development of the research are described and the technologies used to build the application are defined.
**Results:** *GICA-Covid* was created, a web application for the management of all the information collected in the isolation centers opened in the province to fight Coronavirus. This web-application registers the data of patients and their companions; the isolation centers themselves according to their type, it also generates reports and creates graphs that improve the statistics that follow the behavior of the disease in *Vueltabajo* region.
**Conclusions:** the development of the web application called *GICA-covid* favors a rapid management for the clinical and epidemiological study of the situation of the disease in the isolation centers of Pinar del Río province and timely decision-making.

**Keywords*:*** Isolation Centers; Patients; Companions; Information Management; Covid-2019.

**RESUMEN**

**Introducción:** en el combate actual que enfrenta Cuba contra la pandemia, se han desarrollado numerosos modelos matemáticos y aplicaciones informáticas. Estos instrumentos de análisis dependen de parámetros necesarios para estimar a partir de los datos que se generan y así obtener una información real del comportamiento de la enfermedad desde los entornos locales.
**Objetivo:** desarrollar una aplicación web para la gestión de la información en los centros de aislamiento de pacientes con la COVID-19, en Pinar del Río.
**Métodos:** investigación de desarrollo tecnológico para crear los procesos de análisis, diseño e implementación de una aplicación web de la información que se genera en los centros de aislamiento para atención a la pandemia. Se describen los métodos científicos utilizados durante el desarrollo de la investigación y se definen las tecnologías empleadas para la construcción de la aplicación.
**Resultados:** se creó GICA*covid,* aplicación web para la gestión de toda la información recibida en los centros de aislamiento designados en la provincia para combatir el Coronavirus. Registra datos de pacientes, acompañantes, los propios centros de aislamiento según su tipo, genera reportes y elabora gráficos que enriquecen las estadísticas que siguen el comportamiento de la enfermedad.
**Conclusiones:** la aplicación web denominada GICA*covid* favorece una gestión rápida para el estudio clínico y epidemiológico de la situación de la enfermedad en los centros de aislamiento de la provincia Pinar del Río, y la prontitud en la adopción de decisiones.

**Palabras clave:** Centros De Aislamiento; Pacientes; Acompañantes; Gestión De Información; Covid-2019.

## INTRODUCTION

In early December 2019, in the city of Wuhan, capital of Hubei Province, China, cases of pneumonia of unknown origin were reported. Some of the patients were sellers or merchandise operators from the Huanan seafood market, which was later closed for disinfection, the pathogen was identified as a new betacoronavirus that is currently called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) because of its phylogenetic similarity to SARS-CoV and Middle East Respiratory Syndrome virus (MERS-CoV).[1,2,3]

The Chinese government attempted to contain this pathogen through complete isolation of the aforementioned province and by conducting epidemiological monitoring of all contacts to bring them into mandatory quarantine. However, in view of the appearance of new cases in several countries of the world and their exponential increase produced by the same infectious agent, the World Health Organization (WHO) declared the situation as a pandemic on March 11, 2020. The disease is manifested mainly by pneumonic, interstitial and multifocal respiratory involvement, accompanied by a diverse symptomatic cortex that may include fever, cough, dyspnea, congestion or runny nose, diarrhea, headache, anosmia, etc., and the eventual involvement of other systems.[4]

At the time of writing this article, more than 23,7 million people were reported to be infected, of which more than 815,000 have died with the most affected countries being the United States, Brazil, India, Russia and South Africa.[5] The first case reported in the Americas was in the United States on January 23, 2020, but it was in late March that the number of cases increased exponentially, now it is considered being the epicenter of the pandemic. In South America, the first case was recorded in Argentina in February 2020, and the most affected countries in this part of the continent are currently Brazil, Peru and Mexico.[6] On March 11, 2020, the first three imported cases of the disease from Italy were reported in Cuba, detected in Trinidad municipality, in Sancti Spíritus province.[7]

One of the aspects that has been a real challenge for the health systems all over the world is the transmissibility of SARS-CoV-2 in asymptomatic patients that could infect others and make the detection of new cases very complex, which promotes the *"hidden"* propagation and perpetuation of the COVID-19.[8]

This is why this disease has activated all the forces of the National Health System, through the plans of the Government since January 2020, which promoted the organization and involvement of all the factors in the fight against the pandemic.[9,10,11]

The system of work that is currently applied in Cuba to face this pandemic follows the same approach used against epidemics in the country, such as dengue and neuropathy. [12, 13] For this purpose, epidemiological and mathematical techniques as instruments in the analysis and to achieve the best capacity in the administration and management of the epidemic were applied. The surveillance of events and adverse situations related to the problems of the epidemics is an important process, which allows the identification, action strategies, monitoring and control of them.[14]

Mobile technologies and networked applications, computer systems, among others, are tools for the design of communication, knowledge, self-survey and research of the disease, as well as the collection, processing and data analysis. Several applications have been designed for this purpose by the University of Computer Science (UCI), GeoCuba Enterprise Group and CineSoft.[15]

COVID-19 in Cuba has tested the capacity of both the government and the health system to find effective decision-making to control the disease. One of the measures taken is the creation of isolation centers for the care of COVID-19 suspected and confirmed positive patients. This decision contributes to more effectively detect if someone presents respiratory symptoms. This is the case of those who have been in close contact with positive cases, have come to the nation from other countries or are patients who present some symptoms that may be related to the disease.

In Pinar del Río, all isolation centers opened to deal with the pandemic must record the information of patients and accompanying persons admitted. Daily reports are issued to the Provincial Administrative Headquarter of Public Health, the Provincial Direction of Hygiene, Epidemiology and Microbiology, and the Provincial Defense Council for the analysis of clinical, epidemiological, logistic, etc. aspects related to the disease in Vueltabajo.

The information obtained from the epidemiological surveys, clinical histories and the physical examination of the patients, generate large volumes of information, which are filled in manually, with the consequent possible human error and time, given the evident existence of methods or tools provided by information and communication technologies, which would support the management and storage of data with more quality in its collection. To process all the information manually recorded would cause loss or deterioration of information, possible errors in the information collected as well as inaccuracies in data analysis.

These aspects led to raise the scientific problem of, how to contribute to the information management process that is generated and demanded in the isolation centers created in Pinar del Río to face the COVID-2019? The scientific novelty was based on the deployment of a web application that allows managing the information of patients and companions that are admitted in the isolation centers created in Pinar del Río to cope with this terrible disease.

The general objective is to develop a web application for information management taken from the isolation centers opened to face COVID-2019 in Pinar del Río province.

## METHODS

During the development of this research, theoretical and empirical methods were applied, among which are: historical-logical, inductive-deductive, analytical-synthetic, documentary analysis and interviews that allowed to deepen in the processes that are carried out in the isolation centers for the collection of information, as well as to carry out an efficient engineering of requirements to achieve the satisfaction of the needs of the users.

In addition, the Modeling approach was used to build a Domain Model that relates all the concepts carried out in this service, for a better understanding of it by the entire team of development. The Data Model was built to define the structure of the database to store the managed information.

For the design and implementation of *GICA-Covid*, the creativity of the designer from the Pinar del Río University was taken into account in the creation of the logo of the application, based on the reference of designs already developed for other products, also related to COVID-2019. Within the implementation point of view, several technologies, tools and programming languages to be used were taken into account, which led to a detailed study of the most feasible ones, taking into account advantages and disadvantages in their use. It was decided to use the XP Development Methodology (Extreme Programming), which is characterized by the use of different rules with a high degree of simplicity and by its focus on practical sense, which is vital for the successful development of the application proposed.

These rules are specifically oriented to test driven development, planning strategy, *in-situ* user, pair programming (as a golden rule for successful projects), small deliveries, simple design and collective ownership of the code.

In addition, UML (Unified Modeling Language) was used as a modeling language and the Case EA Tool (Enterprise Architect) for the construction of the artifacts proposed by the methodology. The implementation was developed using Laravel as a development Framework since it allows the use of a refined and expressive syntax to create code in a simple way and allowing a large number of functions and MySQL as a database manager.

## RESULTS

*GICA-Covid* was created, a web application in charge of managing all the information registered in the isolation centers opened in the province to fight Coronavirus. It is an application that records the data of patients, the accompanying persons; the isolation centers themselves according to their type, as well as generating reports and providing graphs that enrich the statistics that follow the behavior of the disease in Vueltabajo.

To access the application, the user must employ his/her access credentials (username and password). The roles handled during the development of the system were: Administrator and Statistician. It is valid to emphasize that the management of users is made only by the administrator of the system, with which to be able to create the Statistical user of an isolation center, firstly it must be requested to the administrator. In addition, a statistician will only have access to the information of the isolation center in which s/he works. (Fig. 1)


**Fig. 1** Main interface *GICA-Covid. 2020*

Within the most important functional requirements of the system we can mention: Management of Isolation Centers, Management of Patients and Companions. Below there is an explanation of each of them.

The functional requirement for the **management of isolation centers** records the following data: name of the center, entity that manages it, municipality, province, address, telephone, total capacity and type of center. This last characteristic is related to the condition of the people who are admitted to the center, which can be contacts of confirmed positive patients, travelers or symptomatic people. In addition, this function has the ability to Insert, Modify or Delete an isolation center. (Fig. 2)

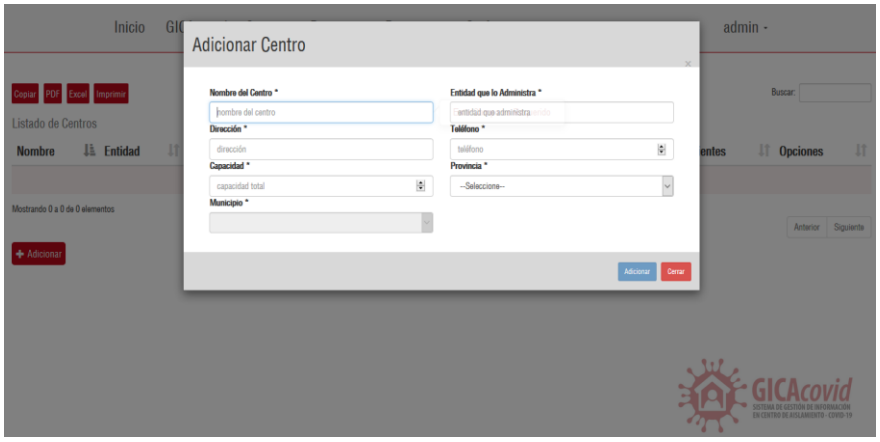


**Fig. 2** Interface to add the Isolation Center

In the case of **managing patients**, the statistician must initially access the information corresponding to the isolation center to which he or she belongs and once there, access the option of adding a new patient. This function also gives the possibility to Add, Modify or Delete the data of a patient. The information recorded in this functional requirement is the following: name and surname, identity card, age, sex, home address, municipality, province, health area, people's council, bed number, room, date of admission, date of nasal swab sample for COVID-19 testing, date of result, result (positive or negative) and date of discharge. (Fig. 3)

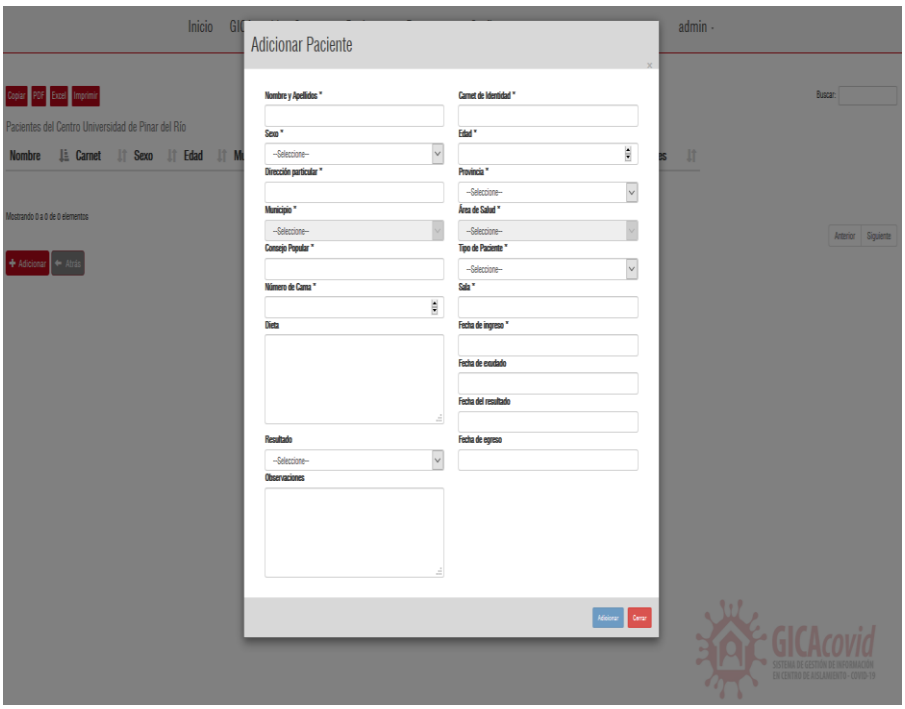


**Fig. 3** Interface to add a new patient

Other data of patients is related to their type, and is given specifically because it can be of three different types: Travelers, Confirmed Positive or Symptomatic Case Contacts. Therefore, the system has been validated so that, depending on the previous characteristic, new data such as these can be recorded:

- If the patient is a Traveler, the system will require the user to enter the country that was visited by the patient.
- If the patient is a Contact, the user must enter in the system the name and surname of the person who tested positive for COVID-2019.
- If the patient is Symptomatic, the system will provide the option for the user to enter the symptoms the patient presents and for s/he needs to be isolated.

In the case of Diet, it is also possible to enter a brief description in the case of patients with dietary restrictions, for example: diabetic patient, milk intolerance in the case of children, or other diseases that do not allow them to eat certain food. The field Observations gives the doctor the possibility to describe some additional information, for example: if the patient was transferred to another hospital, isolation center or other changes during his/her stay.

For the option of **Management of Companions**, once all the processes within the isolation center were analyzed, it was possible to verify that there are patients who require companions, in children cases. The data of the companions that should be entered into the system are the following: name and surname, identity card, sex, age, home address, municipality, province, patient they represent, bed number, room and diet (the same as for patients). This option of the application also allows to Add, Modify or Delete a companion.

For all the previous cases, the system has validated that no erroneous data is entered into the application, as well as not leaving attributes blank by specifying the required fields at all times. And in the case of companions, there cannot be more than one companion per patient.

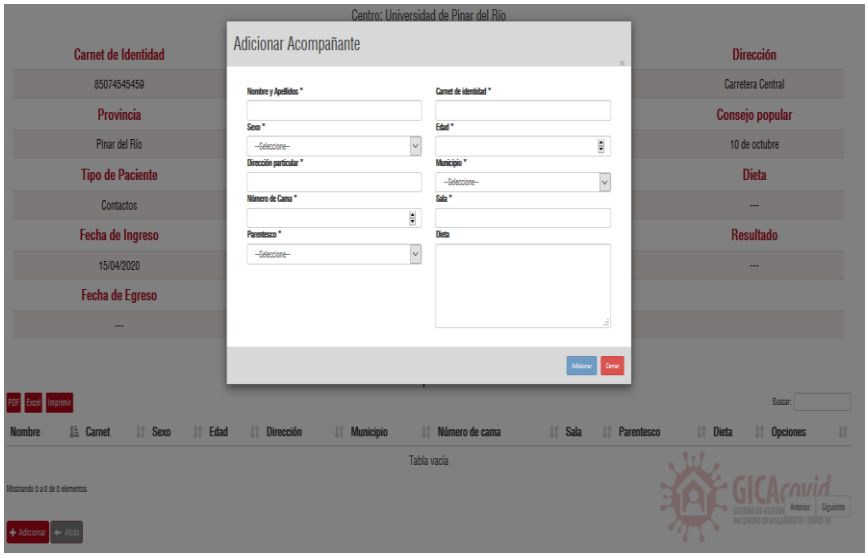


**Fig. 4** Interface to add the companions

## Reports generated

The reports generated from the application correspond to information that must be provided daily and weekly to the Provincial Administrative Headquarter of Public Health, the Provincial Defense Council and the Provincial Direction of Hygiene, Epidemiology and Microbiology, which are related to:

1. Number of available beds.
2. Patients by age group.
3. Number of children by sex.
4. Number of adults by sex.
5. List of patients and companions with dietary restrictions.
6. List of patients discharged from the isolation center.
7. List of accompanying mothers with children under 18 years old.
8. List of accompanying mothers with two or more children admitted.
9. List of general patients or for a specific isolation center.
10. List of patients by municipality.
11. List of patients by province.
12. List of patients by health area.
13. Listing patients by people's council.
14. List of patients and their companions.

## Graphics generated

The graphics generated by the application allow representing the information stored in the database. These are accessible through the Graphics Menu of the *GICA-Covid* application, and among the most relevant are: availability of beds in isolation centers, behavior of the disease according to age group and behavior of admissions and discharges according to a given date. (Fig. 5)


**Fig.5** Graph of admissions and discharges according to a given date.

## DISCUSSION

In the current battle that Cuba faces to fight this terrible pandemic, a great number of mathematical models and computer applications have been developed, which contribute to identify the magnitude and dissemination of the epidemic, its risk, the planning of the resources of the national health system to face it and the analysis of the epidemiological situation of Cuba in the international context.[14] The mathematical models are focused on the prognosis and monitoring of the situation, for the epidemiological adjustment of the course of the epidemic; as information to support a better decision-making in the Government, national health system and other sectors of society.

Among the analysis models developed, the following stand out: predictive model based on Artificial Intelligence for the analysis of the epidemic, Mathematical model SIR (Susceptible, Infected, Recovered) to study the behavior of the disease in Cuba, research system with the support of information and communication technologies (ICT) and Andariego System of GeoCuba Group, which facilitates the work from the health area, with geospatial data, and geographically referenced information, for the detection of outbreaks, monitoring and epidemiological analysis. An advantage of these methods is that they provide a global vision of the epidemic duration, of the hospital peaks; as well as, they help to know the number of beds and other health resources needed in each stage. As a disadvantage of these models there is that they require solving systems of differential equations that depend on parameters that are necessary to estimate from the data obtained, hence it was essential to obtain real information of the behavior of the disease from local environments for a complete study of the behavior of the disease.

And this is precisely the reason why it was decided to develop *GICA-covid*, since it allows managing all the information of the patients and companions that are admitted in the isolation centers of Pinar del Río province, and in this way to have real data of the behavior of the disease in the province.

*GICA-Covid* is an application developed with free languages and tools, so it can be used and deployed without any difficulty. In addition, it allows to process information faster, it gives answers to tasks that in a manual way required a lot of time. It can handle large volumes of information, due to the speed of data processing. At the same time, this application allows the creation of reports and the generation of graphs that show the behavior of the disease on a daily basis. It also allows reducing other costs such as personnel and resources, since many activities previously managed by a member of the center are now generated directly by the computer system.

*GICA-Covid*, in itself, is a social impact, because it is one more step in the fight against this terrible epidemic that affects humanity today. Having this tool is essential today for doctors, nurses, specialists, epidemiologists, scientists, etc., who study the behavior of the disease to reverse this situation that we all are facing. The reports, the graphs generated and the information stored in the database help in the analysis of the risk groups, the most vulnerable communities, more affected patients with pathological and personal antecedents, among other indicators of interest.

## CONCLUSIONS

A web application called *GICA-covid* was achieved, which allows the management of all the information registered in the isolation centers located in the province and contributes to the analysis of the statistics of the territory in its constant battle against this terrible disease. It was developed with tools and technologies of free access that respond to the demands of its user from an intuitive and completely friendly interface. This application is one more contribution that allows adopting intelligent health strategies in Pinar del Río.

### Conflict of interests
The authors declare that there is no conflict of interest.

### Author's contribution
Alejandro Peláez Batista, with 70% was in charge of developing the web application described in this article.
Raymari Reyes Chirino, with 20% was responsible for analyzing the application, with a survey of functional requirements with the user and the definition of the entire stage of the service according to the development methodology applied.
Jesús A. Gorgoy Lugo, with 10% was the main user of the application, providing at all times the essential elements to develop it. He participated in the system testing stage.

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## BIBLIOGRAPHIC REFERENCES

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet [Internet]. 2020 [Citado 20/05/2020]; 395(10223):497-506. Disponible en: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30183-5/fulltext

2. Lu R, Zhao X, Li J, et al. Genomic characterization and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet [Internet]. 2020 [Citado 20/05/2020]; 395(10224):565-574. Disponible en: https://www.thelancet.com/article/S0140-6736(20)30251-8/fulltext

3. Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med [Internet]. 2020 [Citado 20/05/2020]; 382: 727-733. Disponible en: https://www.nejm.org/doi/full/10.1056/nejmoa2001017

4. Guzmán-Del Giudice O, Lucchesi-Vásquez E, Trelles-De Belaúnde M, Pinedo-Gonzales R, Camere-Torrealva M , Daly A y Pichilingue-Chagray J. Características clínicas y epidemiológicas de 25 casos de COVID-19 atendidos en la Clínica Delgado de Lima. Revista De La Sociedad Peruana De Medicina Interna [Internet]. 2020 [Citado 20/05/2020]; 33(1):15-24. Disponible en: https://doi.org/10.36393/spmi.v33i1.506

5. OMS Informe de situación COVID-19, n.7 (11/05/2020). 2020. Disponible en: https://iris.paho.org/handle/10665.2/52425

6. Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First Case of 2019 Novel Coronavirus in the United States. N Engl J Med [Internet]. 2020 [Citado 20/05/2020]; 382(10):929-36. Disponible en: https://www.nejm.org/doi/full/10.1056/NEJMoa2001191

7. ACN. Cronología sobre la COVID-19 en Cuba [Internet]. 2020 [citado 30/04/2020]. Disponible en: http://www.acn.cu/cuba/63214-cronologia-sobre-la-covid-19-en-cuba-dossier

8. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, et al. SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. N Engl J Med [Internet]. 2020 [Citado 20/05/2020]; 382(12):1177-9. Disponible en: https://www.nejm.org/doi/full/10.1056/nejmc2001737

9. CUBADEBATE. COVID-19: Cuba entró en fase de transmisión autóctona limitada; 2020. Disponible en: http://www.cubadebate.cu/noticias/2020/04/07/cuba-en-fase-detransmision-autoctona-limitada/#.XqxBqM3NtXw

10. Infomed. Infecciones por coronavirus. COVID-19. Temas de Salud. Infomed. 2020 [citado 05/05/2020]. Disponible en: https://temas.sld.cu/coronavirus/covid-19/

11. MINSAP. Coronavirus en Cuba. Ministerio de Salud Pública de la República de Cuba. 2020 [citado 05/05/2020]. Disponible en: https://salud.msp.gob.cu/?p=5100

12. Guzman MG. Dengue. La Habana: Editorial Ciencias Médicas. 2016 [citado 05/05/2020]:512 p. Disponible en: http://www.bvs.sld.cu/libros/dengue/dengue_completo.pdf

13. MINSAP y OPS/OMS. Neuropatía epidémica en Cuba. 1992-1994. La Habana: Editorial de Ciencias Médicas; 1995.

14. Más Bermejo P, Vidal Ledo MJ, Baldoquín Rodríguez W, Seuc Jo AH, Guinovart Díaz R, Noriega Bravo V, Pérez Rodríguez N, et al. Organización de la investigación epidemiológica para la lucha antiepidémica contra la COVID-19 en Cuba. INFODIR [Internet]. 2020 [citado 16/02/2021];(32):[aprox. 0 p.]. Disponible en: http://revinfodir.sld.cu/index.php/infodir/article/view/831

15. Gavilondo Mariño X, Vialart Vidal MN. Salud Móvil: retos y perspectivas de aplicación en Cuba. Rev Cubana Enferm [Internet]. 2016 [Citado 06/05/2020]; 32(1): [aprox. 13p.]. Disponible en: http://revenfermeria.sld.cu/index.php/enf/article/view/657