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(Original Article)

Evaluation of Isolation Criteria and Operating Room Design for COVID-19 and Other Epidemics in Khartoum State Hospitals, Sudan

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A B S T R A C T

Background: Healthcare facilities struggle to treat patients with suspected or confirmed HIDs. Indeed, particular efforts should be implemented to reduce disease transmission. These methods include infection control and patient isolation in technical rooms. These illnesses (SARS, COVID-19, influenza) require isolation facilities.

Objective: Evaluation of Isolation Criteria and Operating Room Design for COVID-19 and Other Epidemics in Khartoum State Hospitals, Sudan

Methods: The evaluation of isolation center data and papers, as well as the research conducted in isolation centers at hospitals in Khartoum, Sudan, and other countries, was a collaborative effort. A cross-sectional questionnaire survey, a one-time or short-term study, was conducted, involving 45 isolation center engineers, nurses, and physicians.

Results: The findings reveal that there is significant room for improvement in isolation standards. Currently, only 48.89% of isolation rooms/wards meet negative pressure class N standards, and 44.44% have infection control measures and schedule maintenance and sterilization. Only 24.44% of isolation facilities use telemedicine to provide clinical assistance without patient contact, indicating a potential area for improvement.

Conclusion: Infection control procedures in hospitals depend on the physical form of the building. Therefore, early coordination between the architect and biomedical engineer minimizes problems. Development of structural and mechanical systems for isolation system control and personal protection is recommended.

1. INTRODUCTION

Coronaviruses, with their distinctive crown-shaped-enveloped-RNA structure, are among the major viruses responsible for severe respiratory infections. They are capable of infecting a wide range of hosts, including humans and other mammals.[SarayuKrishnamoorthy, Basudev Swain, Verma & Sachin,Gunthe,2020].

The confirmation of an active coronavirus infection requires a specialized diagnostic test, often conducted by a clinician who takes a swab

of the patient's nose or uses a saliva sample. The sample is then checked for the virus's genetic material (PCR test) or specific viral proteins (antigen test). This process underscores the crucial role of healthcare professionals in the control of coronavirus.[Harvard Health Publishing,2021]

The key to controlling the disease lies in the early identification of suspect cases and their immediate isolation, coupled with meticulous infection control measures. The ongoing development of sensitive and specific rapid diagnostic tests is a proactive step towards this goal. [Simon James Fong , Nilanjan Dey ,and Jyotismita Chaki , 2020]

An isolation facility is designed to control the airflow in the room, reducing the number of airborne infectious particles to a level that minimizes the risk of cross-infection within a healthcare facility.[.World Health Organization. 2020].

In conclusion, the construction of centralized isolation facilities for emergency response, the issuance of regulations by health authorities, and the establishment of a multidisciplinary administration team are all crucial steps. Equally important is the encouragement of in-depth studies and international collaboration on the centralized isolation policy, which will foster a sense of global unity in the fight against coronaviruses.[Xianliang Wang,Jiao Wang, Jin Shen and others ,2021]

Isolation rooms have relatively high air exchange rates relative to other patient areas. This applies to both ventilation air supply and exhaust flow rates. Potential draughts within the patient room can result. Therefore, the patient's thermal comfort needs special attention. Consideration should be given to installing individual thermostats and filters in each room so that air temperature and relative humidity can be controlled from within the room. [.International Health Facility Guidelines .2022]

The aim of this study is to assess the current situation of isolation room specification and setup, with a focus on infection control. We will analyze the current infection control setup in isolation centers, assess HVAC, and affirm Criteria for the design and operation of rooms and isolation centers for Corona and other epidemics.

World Health Organization (WHO) conducted a study on 19 March 2020 on infection prevention and Control of the pandemics. The WHO recommended that each hospital must follow these three measures

1. Early recognition and Control.
2. Administrative controls.
3. Environmental controls [Design Guideline for COVID-19 ISOLATION CENTER, 2020]

Other criteria discussed by International Health Facility Guidelines that an isolation facility aims to control the airflow in the room so that the number of airborne infectious particles is reduced to a level that ensures cross-infection of other people within a healthcare facility is highly unlikely. This may achieved by Controlling the quantity and quality of intake or exhaust air, maintaining different air pressures between adjacent areas, designing airflow patterns for specific clinical procedures, diluting infectious particles with large air volumes and Air filtration – HEPA filters, etc.

Isolation facilities include the following types: (i) Neutral or standard room air pressure, for example, standard air conditioning, also known as Class S.(ii) Positive room air pressure where an immune-compromised patient is protected from airborne transmission of any infection, Class P, including an Anteroom.(iii) Negative room air pressure, where others are protected from any airborne transmission from a patient who may be an infection risk, Class N, including an Anteroom, and (iv) Negative room air pressure with additional barriers, including an Anteroom, also known as Class Q for quarantine isolation.[.International Health Facility Guidelines,2022].

2. MATERIALS AND METHODS

2.1. Kobo toolbox

The Kobo toolbox was used. Kobo Toolbox is a free, open-source tool for mobile data collection. Available to all. It allows data to be collected using mobile devices such as mobile phones or tablets, paper, or computers. After completing the fieldwork in all the selected areas and collecting data, the Kobo toolbox analyzed the data. This analysis involved specific steps shown in Figure 1. The questionnaire was

designed in English form and divided into 11 parts: HCF Preparedness to manage major Epidemics and Pandemics, Triage, Space management, workflow consideration and isolation facility room setup, call center and outbreak response, Patient acquisition, Patient Transport, Layout of center and other department, Pressure and ventilation in isolation center, Staff and Oxygen supply, associated devices, and quality control, Infection Prevention and Control Practices and Contamination control technique occupational safety and hygiene and Biomedical Waste Management (BMWM). The questionnaire was reviewed and judged. Validity confirmation was done and data collection took place.

2.2. Data collection

The survey was conducted using the Kobo Toolbox, a unique suite of tools designed for field data collection in challenging environments. This free and open-source platform operates both online and offline, making it a versatile and reliable choice for data collection.Participants were encouraged to be honest about their answers. By giving them more than one option in the questions, including (I don't know) if the participant does not know the answer and Participants are not forced to answer any question so that they can bypass any question, they do not want to answer for whatever reason.

Features of kobo toolbox

i. Faster. Data must not be transcribed from paper to computers to be analyzed. Some analyses can be applied within minutes of the data being collected.

ii. Accurate. Enumeration errors are minimized because data validation can occur in real-time as data is collected. Transcription errors are eliminated

iii. Optimized for humanitarian work. It works offline, is easy to use (requires no technical knowledge to manage, and enumerators can be trained within minutes), and can be rolled out rapidly in even the harshest of remotest situations. If all else fails, paper forms can be used as a backup and integrated with other data.

iv. Based on Open Data Kit (ODK).

Recognizing that many agencies already use ODK, a de facto open-source standard for mobile data collection, Kobo Toolbox is fully compatible and interchangeable with ODK. This compatibility ensures that your existing tools are not only valued but also seamlessly integrated with Kobo Toolbox, enhancing your data collection experience.

v. Reliable support. The implementing partners are dedicated to providing comprehensive support for the platform. This includes not only assisting with usage and bug fixes but also continuing its development and regularly adding new features, including those suggested by users.

vi. Free. All humanitarian actors can create accounts on the dedicated server and use them without limitations on data or time. Organizations can also install it on their servers or directly contribute to further development.

vii. User-friendly. Kobo Toolbox supports the entire data collection cycle, from form design to data collection and analysis, in a straightforward and intuitive manner.[World Health Organization, 2020]

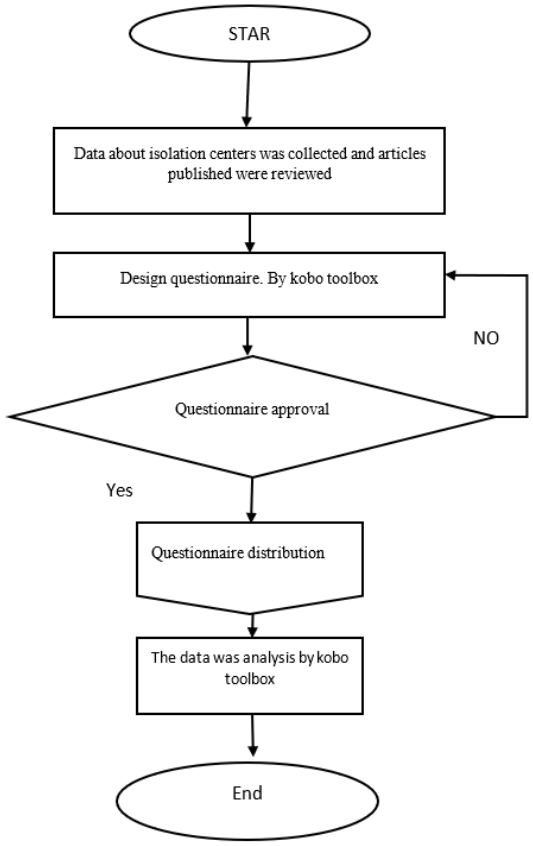

Figure 1. Flow Chart of Methodology

3. RESULTS:

Forty-five responses were received during the study period. Data were obtained from isolation centers in Sudan and other countries and reflected the extent of application of standard measures in isolation centers. A complete survey of these facilities was performed, ensuring a thorough understanding of their adherence to standard measures. The analysis is explained below.

Data analysis

1. The healthcare facility (HCF)

A wide range of healthcare facilities, including public, private, and military, participated in the questionnaire, providing a comprehensive view of the healthcare landscape.

Figure 2. Core Emergency Response / Rapid Response Team for outbreak management identified? A public hospital is a government hospital, while onothers means a hospital endowed by a specific person or hospitals based on public donations.)

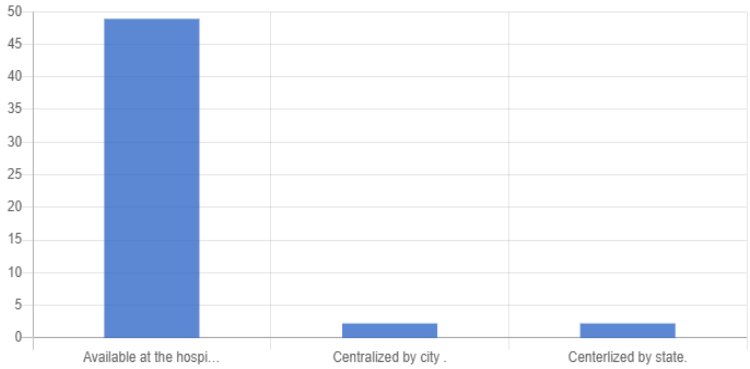

Fig 3: Emergency response team

3.Monitoring and managing Health Care Personnel (HCP)?

There are written public health policies/procedures for monitoring and managing HCP with potential for exposure to COVID-19

Table 1: Public health policies procedures

Value	Frequency	Percentage
Guideline.	16	35.56
Full procedure	9	20
Photo illustrated procedure	3	6.67
No dedicated document available.	1	2.22

4.Training for Healthcare Personnel (HCP)a) Education and job-specific training to HCP?

Table 2: Training of HCP

Value	Frequency	Percentage
No dedicated training is available.	10	22.22
update monthly.	8	17.78
Weekly update.	6	13.33
update monthly.	1	2.22

b/ is there standard and national medical record for staff a

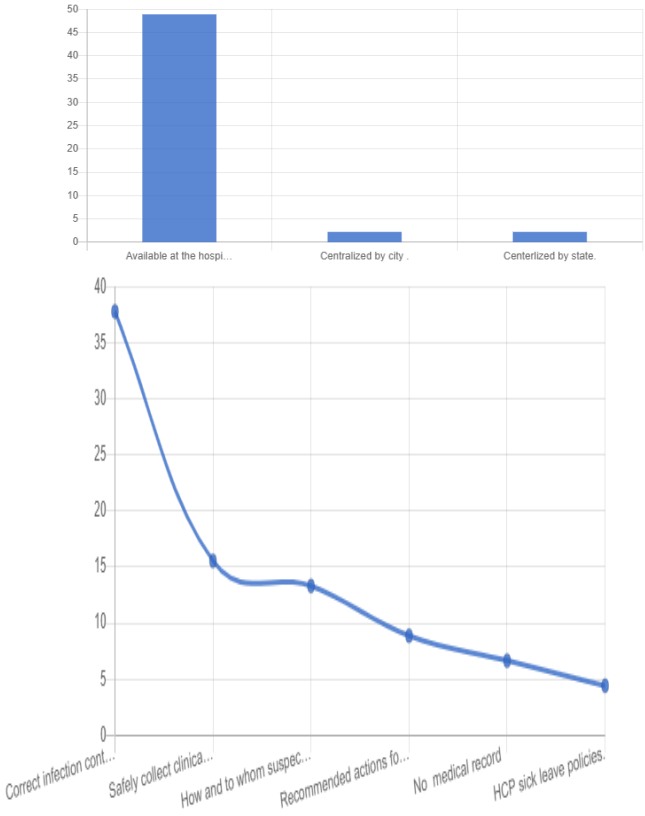

Fig 4: Medical record for staff and patient

5. Type of isolation Facility.?

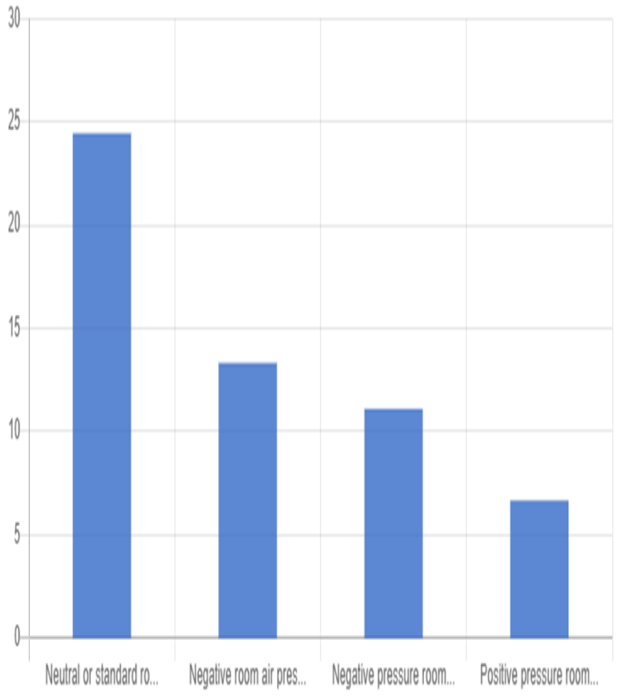

Fig 5: Type of isolation Facility

6. Do they have non-contact Infra-Red thermometer available near the registration desk and with the triage staff?

Table 3: Non-contact Infra-Red thermometer		
Value	Frequency	Percentage
Available 1-2 portable device.	10	22.22
device portable 3-5	6	13.33
1 fixed device	5	11.11
No device available	4	8.89

The facility has a meticulous process for conducting symptom and temperature checks prior to the start of the duty shift for HCPs, all persons, 12% for staff, and 25% for patients. This thorough screening process instills confidence in the safety of the facility. In each isolation center, Physical barriers (glass or plastic screens) at reception areas are used to limit close contact between triage staff and potentially infectious patients, thereby preventing the spread of infection. Additionally, there must be a single room for examination. Forty percent of the centers have applied these measures.

7. The proximity of the isolation facility to OPD/IPD/another crowded area is a crucial factor in preventing the spread of infection. Is the isolation facility located near such areas?

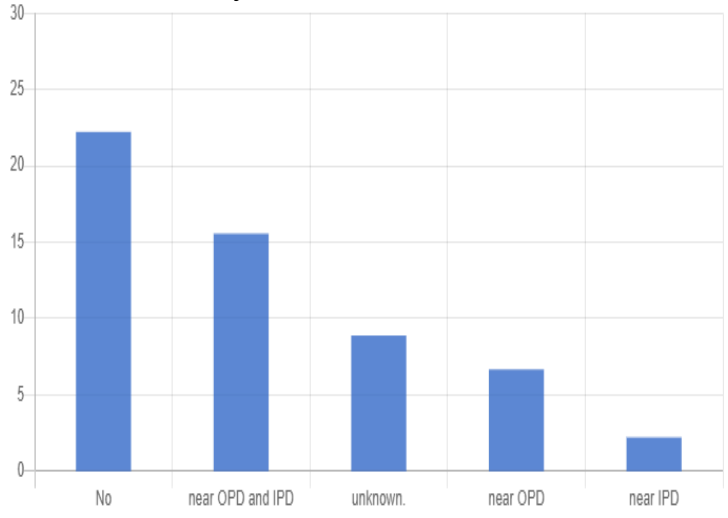

Fig 6: Isolation facility place

30% make separate entry and exit with self-closing devices on room and put signage directing to triage area and signage to instruct patients to alert staff if they have symptoms of COVID-19.

8.Is the distance between two beds in isolation wards/rooms more than 1 meter?

TYPE: "SELECT_ONE". 25 out of 45 respondents answered this question. (20 were without data.)

Table 4: Distance between two beds		
Value	Frequency	Percentage
more than 1 meter.	19	42.22
less than 1 meter.	3	6.67
Unknown	3	6. 67

9. Is there an easy possibility of access to health care at any time?

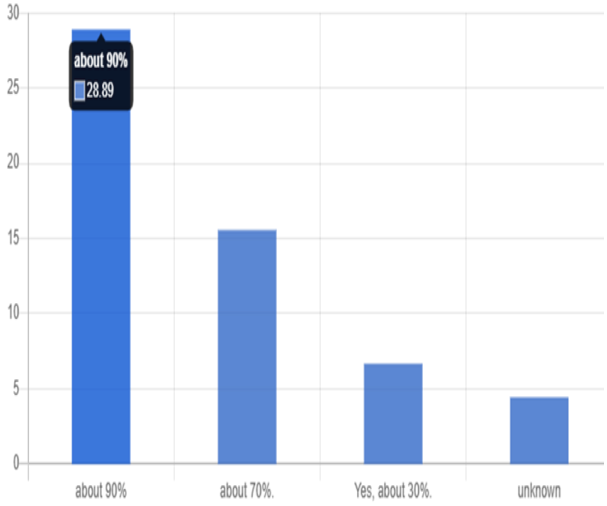

Fig 7: Access to health care at any time easily

Telemedicine facility is important as a way to provide clinical support without direct interaction with the patient. 33% OF the rooms have physiological monitoring, linked to the centrally monitored .45% have establishment of sustainable Infection Prevention and Control (IPC) infrastructures and activities.

10. Are the staff trained in handling dead bodies and wearing PPE?

Table 5: Staff trained in handling dead bodies and wearing PPE		
Value	Frequency	Percentage
90% of Staff.	14	31.11
70% of Staff.	5	11.11
Yes 30% of Staff.	4	8.89
Unknown	2	4.44

11. isolation staff trained on revised COVID19 case definition and identify suspected cases?

Table 6: Isolation staff trained on revised COVID19 case		
Value	Frequency	Percentage
Daily update.	8	17.78
Weekly update.	7	15.56
Unknown	5	11.11
No update available.	3	6.67
Monthly update	2	4.44

Just 30% of patients and health care providers have timely and continued access to high-quality medical devices to respond effectively and 35% have strategy for optimizing the device supply PPE. 20% contingency plan for covering for a core team member who is absent. 32% have strategy for optimizing the PPE supply only for health workers 20% all patients and visitors

12. While transporting patients are specific routes used to minimize contact with other patients and staff?

50%of the hospital limits the movement of patients in the isolation facility outside for medically necessary purposes only. If a patient leaves their room for medical purposes, they are provided face mask. And 5% make their movement free.

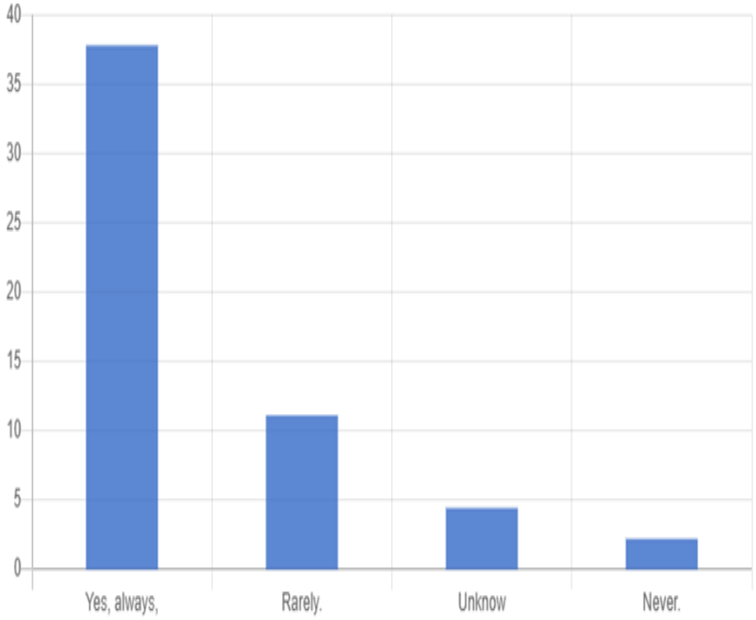

Fig 8: Specific routes used

40% of centers perform chest X-rays for patients with suspected/confirmed COVID-19 in rooms with portable machines (as much as possible) to limit patient transportation, which may increase the risk of transmission of infection.

13. use audible and visual alarms to warn staff when pressurization is changed.?

Table 7: Using alarm to warn change		
Value	Frequency	Percentage
audible and visual alarm	9	20
Unknown	6	13.33
No alarm	5	11.11
audible alarm	4	8.89
visual alarm	1	2.22

14. Are these isolation rooms/wards satisfying the negative pressure class N criteria?

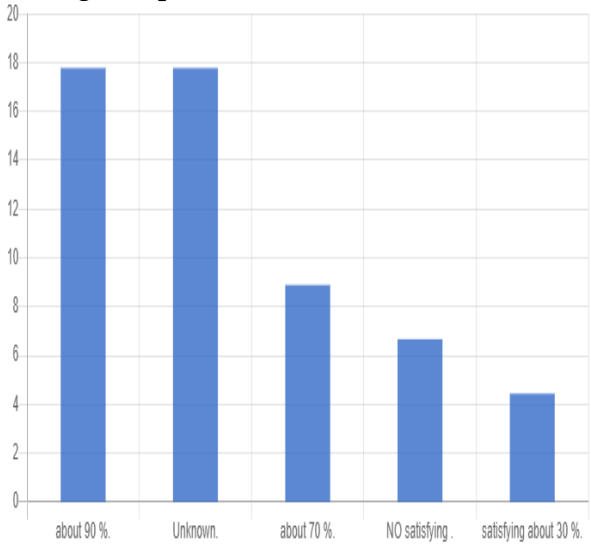

Fig 9: Negative pressure class N

The negative pressure room is used to protect clinical staff and the broader hospital from infectious diseases, but 23% of them use a HEPA1 filter, and 33% use cross ventilation.

15. Schedule available maintenance tasks, sterilization, and disinfection process for devices and accessories.

Table 8: Schedule of Maintenance /Sterilization and disinfection		
Value	Frequency	Percentage
Daily	**20**	**44.44**
Weekly	**3**	**6.67**
Monthly	**1**	**2.22**
Other	**1**	**2.22**

50% use infection control protocols/guidelines and disinfect the rooms with an approved disinfectant frequently (at least daily) and when visibly soiled.

16. What is the method of disposing of biomedical wastes?

Table 9: Method of disposing biomedical wastes		
Value	Frequency	Percentage
Unknown	**20**	**44.44**
Incineration	**4**	**8.89**
CWTF	**3**	**6.67**
Deep burial	**1**	**2.22**

40% have standard operating procedures (SOP) for managing biomedical waste (BMW), and posters reinforce hand washing and PPE at hand washing stations.

Discussion:

Isolation centers are separate rooms that isolate patients suffering from highly transmitting infectious diseases [Pan American Health Organization, 2020]. The study evaluates Standard measures for isolation centers and the availability of personal protective equipment (PPE) and other equipment necessary for maintaining isolation precautions. Isolation of infected patients is the most effective way to fight against COVID-19. This isolation of centers will reduce virus transmission. This will reduce the contamination of medical personnel from the patient. The patient also has an opportunity to cure quickly, as continuous inhalation of virus particles is minimized. This will reduce the death rate and help people recover much faster.

In Sudan, they have not followed all the criteria of isolation rooms. Isolation rooms have Neutral or standard room air pressure (Class S). In Sudan, they do not use negative pressure rooms yet. There are single examination rooms dedicated to the Triage area. Selected hospitals in the Kingdom of Saudi Arabia have been designated to treat coronavirus patients by international standards. Ministry of Health (MOH) hospitals have 1,449 negative pressure isolation rooms equipped with an air-conditioning system using lower air pressure to receive patients with severe symptoms. It is designed to prevent the transmission of diseases from one patient to another or hospital workers. There are single examination rooms dedicated to the Triage area. All rooms have self-closing devices on exit doors.

They follow standard operation procedures for biomedical waste. There is a daily schedule for the Sterilization and disinfection process for devices and accessories. Weekly update on education and job-specific training for HCP. Telemedicine facilities are available to provide clinical support without direct interaction with the patient. Also, available Infection control protocols and guidelines

Conclusion:

Data collection with smartphones supported by the KoBoCollect application contributed to conducting research more effectively and efficiently.

As infectious respiratory diseases such as COVID-19, SARS, and MERS occur frequently, the importance of hospital isolation rooms to treat respiratory diseases and prevent their further spread is increasing. This study focused on the importance of isolation centers and the standard criteria for designing them. It conducted a questionnaire survey in isolation centers and then analyzed the results. The analysis shows the extent to which the isolation centers follow and implement standard measures in the design of rooms to contribute to future hospital construction plans.

In summary, evidence shows an association between the architectural design of healthcare facilities and infection control. To minimize the spread of the COVID-19 coronavirus, Isolation center design may help prevent the spread of infection within healthcare facilities. All levels of control in an isolation system (administrative controls, environmental and engineering controls, and personal protection) are essential and should be considered when designing an isolation center.

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All authors contributed equally to this work

Conflicts of Interest:

The authors declare no conflicts of interest.

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