Designing an Isolation Center for Respiratory Diseases

Mohammed Elmujtaba Yahia, Rawan fadul amin, Wud abudhobby mohammed, Dina abdulghaffar, Dr. Eltahir mohammed hussein, and Mohammedyagoub esmail

Affiliation not available

October 31, 2023

Abstract

This scientific paper is focused on designing an isolation center for respiratory diseases that meets high standards of patient care while minimizing the risk of transmission of infectious viruses. The paper is based on a mixed-methods approach that includes a comprehensive review of existing literature on isolation centers and respiratory diseases, as well as visits to different facilities to gather data on best practices and equipment requirements. The resulting design incorporates feedback from experts in infection control and patient care to ensure that it meets high standards of patient care while minimizing the risk of transmission of infectious viruses. Key protocols for infection control were identified based on findings from the literature review and expert consultation. The paper provides valuable insights into best practices for designing and operating isolation centers treating respiratory diseases, and can help improve patient outcomes and reduce the spread of respiratory viruses in both high- and low-resource settings. The sources for this paper include a variety of references, including Bjørg Marit Andersen’s Background Information on Isolation Routines, the World Health Organization’s Infection Advice Center, the Centers for Disease Control and Prevention, the Royal College of Nursing’s Standards for Assessing, Measuring and Monitoring Vital Signs in Infants, Children and Young People, and the Design Guideline for COVID-19 Isolation Center Institute of Architects Bangladesh.
Designing an Isolation Center for Respiratory Diseases

Mohammed Elmujtaba Yahia  
Sudan University of Science and Technology  
Khartoum, Sudan  
mujtabyahia@gmail.com

Rawan Fadul Amin  
Sudan University of Science and Technology  
Khartoum, Sudan  
rwanfadal3@gmail.com

Dr. Eltahir Mohammed Hussein  
Sudan University of Science and Technology  
Department of Biomedical Engineering  
Khartoum, Sudan  
ahd984@gmail.com

Wud Abuobida Mohammed  
Sudan University of Science and Technology  
Khartoum, Sudan  
doodynajed123@gmail.com

Dina Abdulghaffar  
Sudan University of Science and Technology  
Khartoum, Sudan  
dinaabdulghaffar@gmail.com

Mohammed Yagoub Esmail  
Sudan University of Science and Technology  
Department of Biomedical Engineering  
Khartoum, Sudan  
mohammedyagou@sustec.edu.sd  
mohyagou@hotmail.com

Abstract—This research project aims to design an isolation center for respiratory diseases that meets the highest standards of patient care and infection control. The study involved a comprehensive review of existing literature on isolation centers and respiratory diseases, as well as visits to four different facilities to gather data on best practices and equipment requirements. The resulting design includes multiple departments, such as diagnostic radiology rooms, computed tomography, care centers, laboratories, restrooms and emergency rooms, all specifically equipped for the treatment of respiratory and pulmonary infections. The center is designed to provide patients with comfort and integrated care while minimizing the risk of transmission of infectious viruses. The study also identified key protocols for infection control that should be followed in any isolation center treating respiratory diseases. Overall, this research project provides valuable insights into the design and operation of isolation centers for respiratory diseases that can help improve patient outcomes and reduce the spread of infectious viruses.


I. INTRODUCTION

Respiratory diseases are a significant public health concern worldwide, with the potential to cause severe illness and death. The recent COVID-19 pandemic has highlighted the need for effective infection control measures to prevent the spread of respiratory viruses. One such measure is the use of isolation centers, which provide specialized care for patients with respiratory diseases while minimizing the risk of transmission to others. The design and operation of isolation centers are critical factors in ensuring patient safety and reducing the spread of infectious viruses. However, there is currently limited research on best practices for designing and operating these facilities, particularly in low-resource settings. This research project aims to address this gap by designing an isolation center for respiratory diseases that meets the highest standards of patient care and infection control[1]. The study will involve a comprehensive review of existing literature on isolation centers and respiratory diseases, as well as visits to different facilities to gather data on best practices and equipment requirements. The resulting design will be based on evidence-based guidelines for infection control and patient care, with a focus on providing patients with comfort and integrated care while minimizing the risk of transmission of infectious viruses. Overall, this research project has significant implications for improving patient outcomes and reducing the spread of infectious viruses in both high- and low-resource settings. By identifying key protocols for infection control and designing an effective isolation center model, this study can help inform future efforts to combat respiratory diseases worldwide. The literature review was an important part of the research endeavor since it gave a thorough overview of the body of information and recommended practices concerning isolation centers and respiratory illnesses. In order to conduct the research, relevant databases were thoroughly searched using keywords like “isolation center,” "respiratory disease,” “infection control,” and “patient care” from PubMed, Scopus, and Web of Science [2]. Several important themes regarding the layout and management of isolation centers for respiratory disorders were found in the literature research. Some of these themes were:

In isolation facilities treating respiratory disorders, the literature study identified a number of best practices and evidence-based recommendations for infection prevention and patient care. They included the utilization of negative pressure rooms, the accessibility of PPE, stringent guidelines for waste management and disinfection, and effective patient flow management. For efficient isolation centers treating respiratory disorders, the literature study highlighted major equipment needs. They included sophisticated diagnostic tools like CT scanners, HEPA filters, UV-C light disinfection systems, and specialized ventilation systems [3].


In isolation facilities treating respiratory disorders, the literature review emphasized the significance of staffing levels and experience in providing successful patient care. This required the use of PPE and specialized training in infection control procedures [4]. The literature evaluation also covered ethical problems, such as those involving patient autonomy, informed consent, and privacy, in relation to isolation facilities treating respiratory disorders [5].

II. METHODS AND MATERIALS

The research project utilized a mixed-methods approach to gather data on best practices and equipment requirements for designing an effective isolation center for respiratory diseases. The methods used included:

2.1 Site visits: Data was collected during site visits to different facilities, including hospitals with isolation departments, independent isolation centers, the ministry of health, and every location relevant to respiratory isolation. These visits provided valuable insights into existing equipment, staffing, and patient flow in different settings.

2.2 Expert consultation: Feedback from experts in infection control and patient care was incorporated into the design of the isolation center to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses.

2.3 Design development: The final design for the isolation center was developed using software such as REVIT 2017, LUMION AND 3D MAX. The design incorporated feedback from experts in infection control and patient care to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses [6].

The material used in this research project included existing literature on isolation centers and respiratory diseases, as well as data collected during site visits to different facilities. The final design for the isolation center incorporated feedback from experts in infection control and patient care to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses. The software used in developing the final design included REVIT 2017, LUMION AND 3D MAX which allowed for a detailed visualization of all aspects related to designing an effective isolation center for respiratory diseases. The design included multiple departments such as diagnostic radiology rooms, computed tomography rooms, care centers, laboratories, restrooms and emergency rooms all specifically equipped for the treatment of respiratory and pulmonary infections. Overall, the method and material used in this research project provided valuable insights into best practices for designing and operating isolation centers treating respiratory diseases [7]. By utilizing a mixed-methods approach that incorporated feedback from experts in infection control and patient care, this study can help improve patient outcomes and reduce the spread of respiratory viruses in both high- and low-resource settings.

A. Standards

Standard precautions are meant to reduce the risk of transmission of blood borne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control precautions which are to be used, as a minimum, in the care of all patients. Hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with health care. In addition to hand hygiene, the use of personal protective equipment should be guided by risk assessment and the extent of contact anticipated with blood and body fluids, or pathogens. In addition to practices carried out by health workers when providing care, all individuals (including patients and visitors) should comply with infection control practices in health-care settings. The control of spread of pathogens from the source is key to avoid transmission. Among source control measures, respiratory hygiene/cough etiquette, developed during the severe acute respiratory syndrome (SARS) outbreak, is now considered as part of standard precautions. Worldwide escalation of the use of standard precautions would reduce unnecessary risks associated with health care. Promotion of an institutional safety climate helps to improve conformity 17 with recommended measures and thus subsequent risk reduction. Provision of adequate staff and supplies, together with leadership and education of health workers, patients, and visitors, is critical for an enhanced safety climate in health-care setting [8].

Health Policy
a. Promote a safety climate.
b. Develop policies which facilitate the implementation of infection control measures.

d. Hand Hygiene
a. Perform hand hygiene by means of hand rubbing or hand washing (see overleaf for detailed indications).
b. Hands should always be washed with soap and water if hands are visibly soiled, or exposure to spore-forming organisms is proven or strongly suspected, or after using the restroom. For other indications, if resources permit, perform hand rubbing with an alcohol-based preparation.
c. Ensure availability of hand-washing facilities with clean running water.
d. Ensure availability of hand hygiene products (clean water, soap, single use clean towels, alcohol-based hand rub). Alcohol-based hand rubs should ideally be available at the point of care.

e. Personal Protective Equipment (PPE)
a. Assess to the risk of exposure to body substances or contaminated surfaces before any health care activity.
b. Select PPE based on the assessment of risk.
c. Clean non-sterile gloves.
d. Clean, non-sterile fluid-resistant gown.
e. Mask and eye protection or a face shield. Respiratory hygiene and cough etiquette
f. Education of health workers, patients and visitors.
g. Use of source control measures.
h. Hand hygiene after contact with respiratory secretions.
i. Spatial separation of persons with acute febrile respiratory symptoms.
B. Protocols

It is necessary to develop a clear and practical definition of suspected and confirmed cases of COVID-19 disease, and to work on diagnosing and isolating them as soon as possible, while identifying the places for their isolation and treatment. Identification and follow-up of contacts of confirmed cases, whether within the family or workplace, should be done immediately. Appropriate infection control procedures should be implemented at various levels of isolation to facilitate and expedite the taking of nasopharyngeal swabs and their access to laboratories for PCR examination.

Determine the categories for which laboratory examinations should be carried out. Isolate and treat confirmed cases in designated places according to the classification of cases mentioned in this protocol. Treat patients with the best available treatments for each patient and in proportion to the classification of the case according to the patient’s condition, and work to provide treatments that are not available, especially if clinical studies have shown positive results when using these treatments. Treat complications that can occur to patients, especially severe and critical cases, with the best methods and treatments available. Protecting health personnel by holding intensive courses by experts and those concerned with this subject and infection control offices by securing the best possible working conditions and ensuring that these protocols are strictly applied. Keeping abreast of all developments related to the treatment and management of COVID-19 patients, in a manner that does not conflict with the regulatory authorities related to medicines, medical devices, etc., and the need to update the treatment protocols as needed [9].

C. design criteria

The hospital departments should be isolated from each other, so it can be possible to control the infection. The infected departments must be separated from the clean ones. The best form for this hospital is a separated block. The hospital should divide into two zones – a staff area for health-care workers and a patients’ area. The patients’ area is further divided into three zones (mild and moderate, severe and critical) according to the medical conditions of the patient [6]. Avoid intersections of movement and adopt one-way movements. (Figure 1)

1) Location Criteria

- a. Ensure good access and guaranteed security for patients, visitors and staff.
- b. Avoid all flood areas and choose a site at least 30 m away from rivers or other bodies of water.
- c. Ensure proximity to the outbreak epicenter.
- d. Ensure proximity to existing health-care facilities to facilitate external referral pathways for people who test negative for COVID-19 but who require medical care for different medical conditions.
- e. Ensure the site is of sufficient size to extend the waiting room and triage area if necessary.
- f. The hospital should be far from active areas as much as possible.

2) Hospital Department

- a. Screening department.
- b. Laboratory department.
- c. Radiology department
- d. Isolating departments.
- e. Surgical department.
- f. ICU & CCU departments.
- g. Central sterilization.
- h. Central pharmacy.
- i. Gaze station.
- j. Central kitchen.
- k. Laundry.
- l. Storages.
- m. Workshops.
- n. General services (cafeteria, rest rooms etc.).

Medical services (Gaze station, changing room, nurse station, etc.).

- a. Technical services (workshops)
- b. Administration.

III. RESULTS

3.1 Best practices for infection control: The literature review and site visits revealed several best practices and evidence-based guidelines for infection control and patient care, including the use of negative pressure rooms, PPE availability, and strict protocols for disinfection and waste management.

3.2 Design of the isolation center: The final design incorporated feedback from experts in infection control and patient care to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses. The design included multiple departments such as diagnostic radiology rooms, computed tomography rooms, care centers, laboratories, restrooms and emergency rooms all specifically equipped for the treatment of respiratory and pulmonary infections.

3.3 Protocols for infection control: Key protocols for infection control were identified based on findings from the literature review and expert consultation. These protocols included strict hand hygiene practices, proper use of PPE, disinfection procedures, waste management protocols, and patient flow management.
3.4 Wireless network recommendation: One recommendation made in the study was to use a wireless network to link different departments within the isolation center to reduce contact between staff members and minimize the risk of transmission of infectious viruses.

3.5 Potential impact: By identifying key protocols for infection control and developing an effective isolation center model that meets high standards of patient care while minimizing the risk of transmission of infectious viruses, this study can help improve patient outcomes and reduce the spread of respiratory viruses in both high- and low-resource settings.

Overall, these results highlight the importance of effective infection control measures in isolation centers treating respiratory diseases. By incorporating best practices into design plans and implementing strict protocols for infection control, we can help protect public health worldwide.

IV. DISCUSSION

The results of this study highlight the importance of effective infection control measures in isolation centers treating respiratory diseases. The literature review and site visits revealed several best practices and evidence-based guidelines for infection control and patient care, including the use of negative pressure rooms, PPE availability, and strict protocols for disinfection and waste management. The design of the isolation center was based on these findings, with a focus on providing patients with comfort and integrated care while minimizing the risk of transmission of infectious viruses. The final design incorporated feedback from experts in infection control and patient care to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses. One key challenge identified during this study was the variability in equipment, staffing, and patient flow across different isolation centers. This highlights the need for standardized protocols for infection control and patient care that can be applied across different settings. Another challenge was ensuring that staff members were properly trained in infection control protocols and had access to adequate PPE. This requires ongoing training and education programs to ensure that staff members are up-to-date on the latest guidelines and best practices. Overall, this research project has significant implications for improving patient outcomes and reducing the spread of infectious viruses in both high- and low-resource settings. By identifying key protocols for infection control and developing an effective isolation center model that meets high standards of patient care while minimizing the risk of transmission of infectious viruses, this study can help inform future efforts to combat respiratory diseases worldwide.

Figure 1 An example of movement within the hospital
Figure 2: An example of the ground floor of a hospital

Figure 3: first & second plan
Figure 4: third, four & typical plans

Figure 5: exterior design

Table 1: Departments

<table>
<thead>
<tr>
<th>Departments</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation departments</td>
<td>6,654 m²</td>
</tr>
<tr>
<td>Surgical department</td>
<td>667.6 m²</td>
</tr>
<tr>
<td>ICU</td>
<td>1,314 m²</td>
</tr>
<tr>
<td>Laboratory</td>
<td>412 m²</td>
</tr>
<tr>
<td>Screening area</td>
<td>686.7 m²</td>
</tr>
<tr>
<td>Radiology department</td>
<td>848 m²</td>
</tr>
<tr>
<td>Follow up clinic depart</td>
<td>462 m²</td>
</tr>
<tr>
<td>Management</td>
<td>1,527 m²</td>
</tr>
<tr>
<td>Medical services</td>
<td>2,363 m²</td>
</tr>
<tr>
<td>General services</td>
<td>3,352.1 m²</td>
</tr>
<tr>
<td>Movement paths</td>
<td>768.48 m²</td>
</tr>
</tbody>
</table>
V. CONCLUSIONS

Respiratory diseases are a significant public health concern worldwide, with the potential to cause severe illness and death. The recent COVID-19 pandemic has highlighted the need for effective infection control measures to prevent the spread of respiratory viruses. One such measure is the use of isolation centers, which provide specialized care for patients with respiratory diseases while minimizing the risk of transmission to others. This research project aimed to design an isolation center for respiratory diseases that meets high standards of patient care while minimizing the risk of transmission of infectious viruses. The study involved a comprehensive review of existing literature on isolation centers and respiratory diseases, as well as visits to different facilities to gather data on best practices and equipment requirements. The resulting design incorporated feedback from experts in infection control and patient care to ensure that it met high standards of patient care while minimizing the risk of transmission of infectious viruses. Key protocols for infection control were identified based on findings from the literature review and expert consultation. Overall, this research project provides valuable insights into best practices for designing and operating isolation centers treating respiratory diseases. By identifying key protocols for infection control and developing an effective isolation center model that meets high standards of patient care while minimizing the risk of transmission of infectious viruses, this study can help improve patient outcomes and reduce the spread of respiratory viruses in both high- and low-resource settings. A wireless network can be used to link the center department to reduce contact between staff and to reduce the risk of the infection.

VI. RECOMMENDATIONS

A wireless network can be used to link the center department to reduce contact between staff and to reduce the risk of the infection.

REFERENCES

[4] Yong Dam Jeong1, 2, Keisuke Ejima3, Kwang Su Kim1, Shoya Iwanami1, Ana I Bento3, Yasuhisa Fujita1, Il Hyo Jung2, Kazuyuki Aihara4, Koichi Watashi5, 6, 7, Taiga Miyazaki8, 9, Takaji Wakiya10, 11, 12, 13, Marco Ajelli3, 14, Revisiting the guidelines for ending isolation for COVID-19 patients, Joshua T Schiffer, Fred Hutchinson Cancer Research Center, United States, 2021.