

Designing for Middle East Respiratory Syndrome (MERS)— Airborne Infectious Isolation Patient Facilities: A Case Study

Ministry of Health
Dammam Medical Complex
Dammam, Kingdom of Saudi Arabia



Design of MERS Airborne Infectious Isolation (A.I.I.) Facilities



The Middle East Respiratory Syndrome (MERS) virus first appeared in Saudi Arabia in April 2012, and while found throughout the Arabian Peninsula, 85% of the cases identified have been in Saudi Arabia. Of these, 67% have been in the Al-Ahsa region of the Eastern Province, in which the city of Dammam is located. In addition to MERS, tuberculosis is also not uncommon in the region. The travel in and out of the area by the large population of foreign workers who come to the oil fields of the Eastern Province has the potential to rapidly spread MERS to all parts of the globe.

When selected by the Ministry of Health to design a new Inpatient Tower and a new Emergency Department and Ambulatory Services Facilities in a shelled building on the campus of Dammam Central Hospital (DCH) in the Eastern Province of Saudi Arabia, we soon learned the Ministry was also about to begin another project on the campus. The Ministry had identified DCH as one of three facilities in the Kingdom designated to treat patients with MERS and had plans to construct a MERS isolation unit within the existing hospital building, which had been constructed in 2005. Given the condition of the existing HVAC system and its questionable capacity to handle the additional loads from an airborne infectious isolation unit, the degree of difficulty to route the required exhaust ductwork through the existing structure and poor access and adjacencies to the proposed location, KMD recommended that the unit instead be designed as part of the new inpatient tower.

In view of the high number of patients with infectious diseases being admitted to Dammam Central Hospital and the 36% fatality rate of MERS, it appeared crucial that consideration be given to providing greater capacity for treating patients with infectious diseases. In addition to the Acute Care MERS Airborne Isolation Unit, we were to design a greater number of A.I.I. rooms in all new nursing units, as well as provide the necessary facilities for rapid response in early diagnosis, isolation and treatment of these diseases in the new Emergency Department.

The Ministry of Health determined that the new facilities were to be designed to include:

For Acute Care Patients:

- A new Acute Care MERS Airborne Infectious Isolation Nursing Unit of twelve (12) A.I.I. beds.
- Six (6) A.I.I. rooms and one (1) P.E. room in each of the four new 24-bed Medical/Surgical Units.

For Intensive Care Patients:

- Eight (8) A.I.I. Rooms, four (4) of which are designated for patients with MERS in a 20-Bed Intensive Care Unit.
- Four (4) A.I.I. rooms and one (1) P.E. room in each of the two additional 20-bed Intensive Care Units.

In the new Emergency Department:

- A separate suite of eight (8) Airborne infectious Isolation (A.I.I.) Treatment Rooms adjacent to the Triage/Reception area.



Figure 1: Dammam Medical Complex | Central Hospital Expansion | Level Four

The Acute Care MERS Airborne Infectious Isolation (A.I.I.) Unit

The Centers for Disease Control and Prevention (CDC) and the Facilities Guidelines Institute for the Design and Construction of Healthcare Facilities (FGI) served as the basis of design for the A.I.I. Rooms and for a number of the design strategies employed to support infection control when planning the unit.

A key aspect of the unit design was control of those entering the unit to minimize the potential of disease transmission. The public waiting, toilet and consultation rooms are located outside the perimeter of the unit which allows visitors a place to wait and space to be trained in the proper procedures for the use of personal protection equipment (PPE), hand hygiene and other policies in accordance with the facility's infection control protocols, prior to being permitted to enter the patient unit.

Typical of all the new inpatient units, public elevators and visitor entrances to the nursing unit are separated from staff/patient/service elevators and entrances which reduces the chances of the public crossing paths with an infectious patient during transport to the isolation unit. Airlock vestibules that provide a secondary level of airborne isolation protection are provided at both the visitor and staff entrances to the units and are adjacent to a Nurse Station or Health Unit Coordinator station to provide visual monitoring of everyone entering and exiting the unit.

To eliminate the chance of cross contamination through the use of shared anterooms, each patient room has its own anteroom for the donning and doffing of personal protection equipment (PPE). All anterooms include a hand-wash sink, cabinets for storage of gowns and PPE, a wall-mounted fold-down bench and a pressure monitor. The anteroom can also be used as a place where visitors can view and speak to the patient via intercom if facility policy or patient condition prevents visitors from entering the patient room.

In addition to the waiting area outside the unit perimeter, a family respite area is provided within the patient unit to permit visitors a place to rest without having to exit the unit and repeat the entrance protocol.

Hand hygiene plays a vital role in the prevention of disease transmission and the placement of handwash sinks not only within the patient rooms and ante rooms, but also throughout the inpatient unit was carefully considered to maximize their use in following handwashing protocol.

To simplify HVAC distribution, the negative pressure A.I.I. patient rooms, all with low wall returns, are grouped together in one HVAC zone and support spaces are served by a separate HVAC system. Within each A.I.I. patient room, the low wall returns are placed near the patient headwall to facilitate air flow across the patient zone and away from the staff zone near the room entry.

Shelled space, located adjacent to the MERS unit, has separate access to the public waiting area and its own HVAC zone thereby affording the flexibility to be designed either as a 10-bed expansion of the isolation unit or a different type of nursing unit.

Robust finishes in all isolation rooms, ante rooms and patient toilet rooms include monolithic flooring with integral base as well as monolithic, washable wall and ceiling finishes. Interior windows have integral blinds and exterior windows are fitted with washable roll down blinds for sun control and privacy. All hand-wash sinks are composed of integral solid surface material with infrared sensor-controlled faucets. The family respite area provides a comfortable place to spend extended hours in the patient unit, but the culture of privacy and gender separation in the region prevent it from being used overnight unless occupied by one family. This is a departure from the typical design of the family zone within the patient room in that a sleeper chair or sofa often included, is eliminated in these rooms.



Figure 2: Level Four | 12-Bed MERS Airborne Infectious Isolation Unit

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|--------------------------------|--------------------------------------|
| 1. Public Elevators | 6. Public Waiting |
| 2. Public Corridor | 7. Staff Offices |
| 3. Patient & Service Elevators | 8. Support |
| 4. Patient & Service Corridor | 9. Airlock Entry (Patient & Service) |
| 5. Airlock Entry (Public) | 10. Airlock Entry (Staff) |

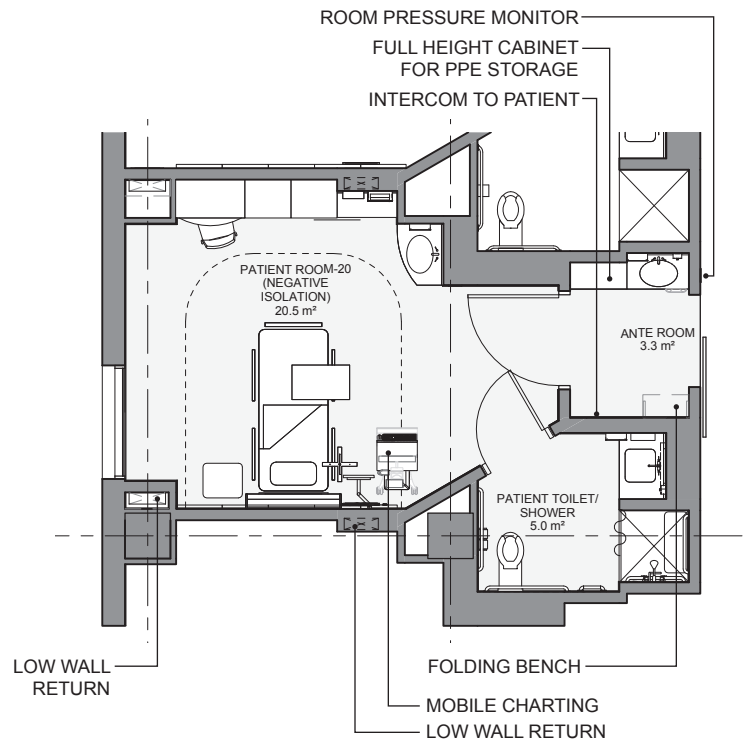


Figure 3: Typical Acute Care MERS A.I.I. Patient Room

Intensive Care MERS Airborne Infectious Isolation (A.I.I.) Rooms

During the course of programming, it became apparent there was a need for A.I.I. rooms for critically ill patients with MERS. Staff training and the different environment of care required for intensive care patients precluded these rooms being part of the acute care unit. Staff believed there was not a need for a dedicated ICU for MERS patients as there was for the acute patients, but the need was significantly larger than the percentage of ICU isolation beds typically provided. As a result, one of the three new 20-bed ICU units planned for the new inpatient tower was designed to include eight A.I.I. rooms, four of which are designated for MERS patients.

While the basic requirements of the A.I.I. rooms for the acute care and intensive care patient rooms are the

same, the different nursing ratio and greater need for visualization of the patient in the ICU rooms resulted in an anteroom arrangement quite different from that of the acute care rooms. In the acute care MERS A.I.I. rooms (see figure 3), due to the 'inboard' toilets (adjacent to the nursing corridor) and lesser need for direct sightlines to the patient, the anteroom serves as both the entry into the room as well as the ante room function. In the ICU A.I.I. rooms (see figure 5), toilets are placed along the exterior wall to provide greater opportunity for patient visualization by staff, the anteroom is to one side, a sub-nurse station to the other provides sightlines into the adjacent room as well. A door directly from the corridor is located between them for the movement of the patient and large equipment.



Figure 4: Damman Medical Complex | New Inpatient Tower

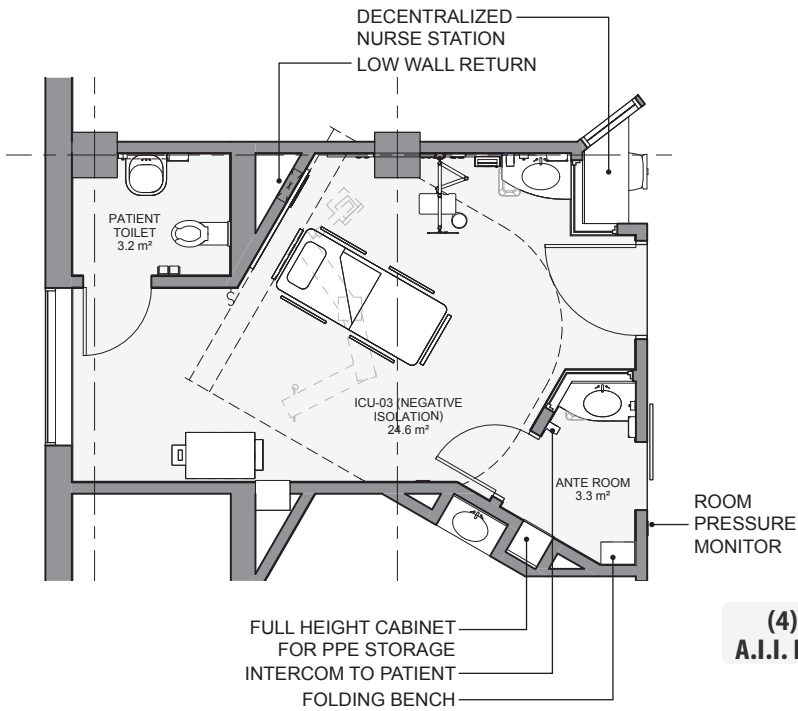


Figure 5: Typical ICU MERS A.I.I. Room



Figure 6: Level Four | 20-Bed Intensive Care Unit

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|--------------------------------|--------------------------------------|
| 1. Public Elevators | 6. Public Waiting |
| 2. Public Corridor | 7. Staff Offices |
| 3. Patient & Service Elevators | 8. Support |
| 4. Patient & Service Corridor | 9. Airlock Entry (Patient & Service) |
| 5. Airlock Entry (Public) | 10. Airlock Entry (Staff) |

Airborne Infectious Isolation (A.I.I.) Treatment Rooms in the Emergency Department

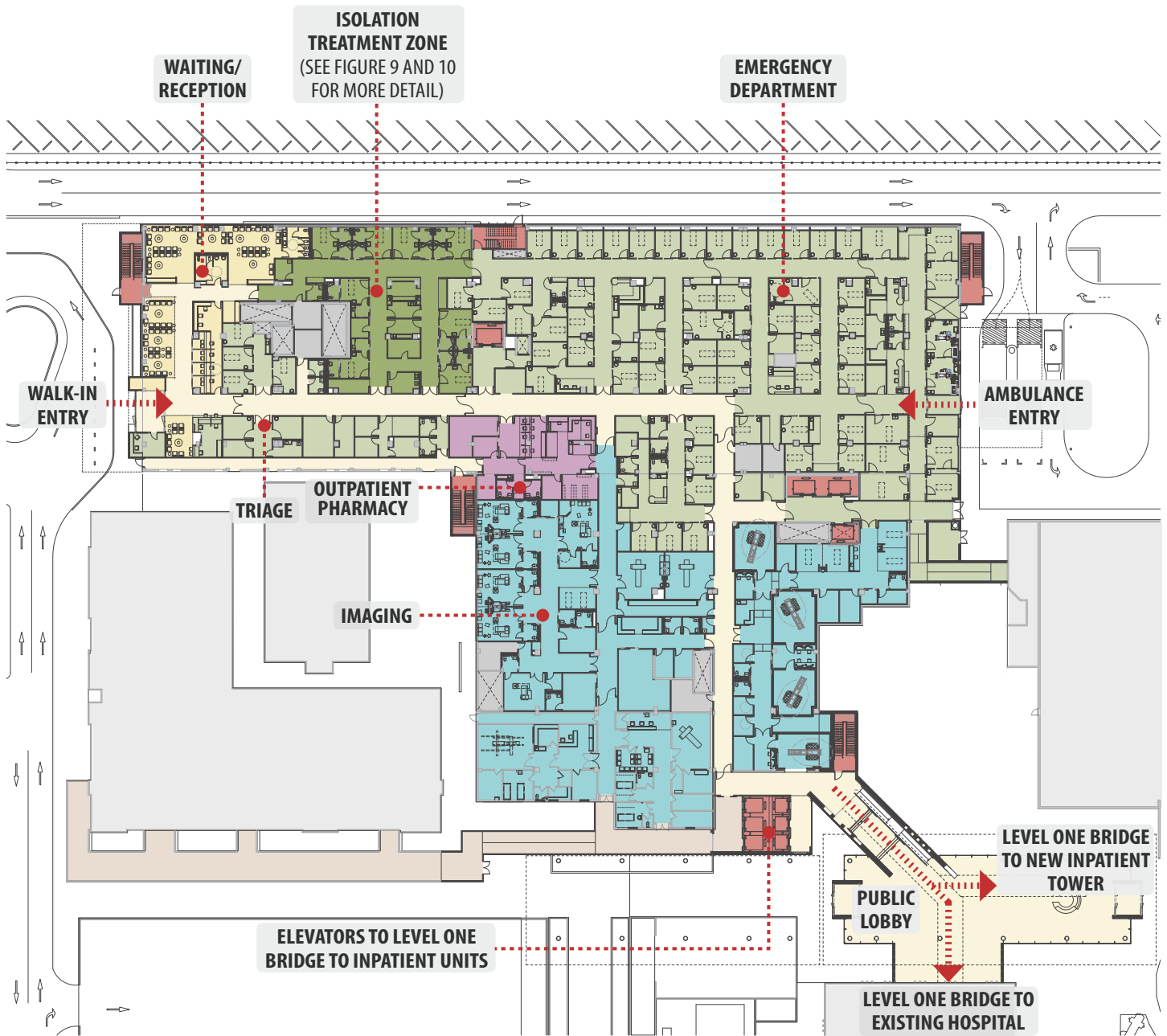


Figure 7: Dammam Medical Complex | Emergency Services Building | Ground Level

Airborne Infectious Isolation (A.I.I.) Treatment Rooms in the Emergency Department

With Emergency Rooms in Saudi Arabia being used to address nearly every healthcare issue, regardless of acuity or urgency, the resulting enormous patient volumes bring a corresponding higher number of infectious patients as well as the greater potential for adverse events involving patients with infectious diseases. To address this, early assessment, identification and isolation of patients with MERS or other infectious diseases is crucial to limit the spread of pathogens and to protect vulnerable patient populations.

Initial Emergency Department programming and conceptual planning accounted for A.I.I.s distributed throughout the department's various treatment areas for Men, Women, Fast Track and Observation. After further discussion with staff, the design team determined all Emergency Services A.I.I. rooms should be consolidated in a designated isolation treatment zone area near Triage so infectious patients could be quickly moved into an A.I.I. room. Emergency staff for this area would be trained specifically to deal with the airborne and contact precaution protocols. When centralized, there is greater flexibility in the assignment of A.I.I. rooms since it reduces the chances of a room being unavailable because

it was in the wrong treatment zone for the patient gender or acuity level.

The design of the A.I.I.'s in the Emergency department is similar in design to those in the inpatient units in that each has its own anteroom. Like the ICU MERS A.I.I. rooms, the anteroom is to the side of the patient room with a door from the corridor directly into the room rather than the acute care arrangement, which uses the ante room for all entries and exits to and from the room.. The ante rooms similarly have a hand wash sink, storage for gowns and personal protection equipment and a fixed bench for donning and doffing PPEs.

One of the primary differences in the design of the ED A.I.I.'s is that the door to the treatment room is a sliding breakaway ICU type door, which for isolation room requirements includes door seals, sweeps and self-closing hardware. The interior finishes are the same monolithic flooring with integral base and monolithic wall and ceiling finishes. Interior windows have integral blinds and all handwashing sinks are integral and composed of solid surface material with infrared sensor-operated faucets.



Figure 8: Dammam Medical Complex | Emergency and Ambulatory Services Building

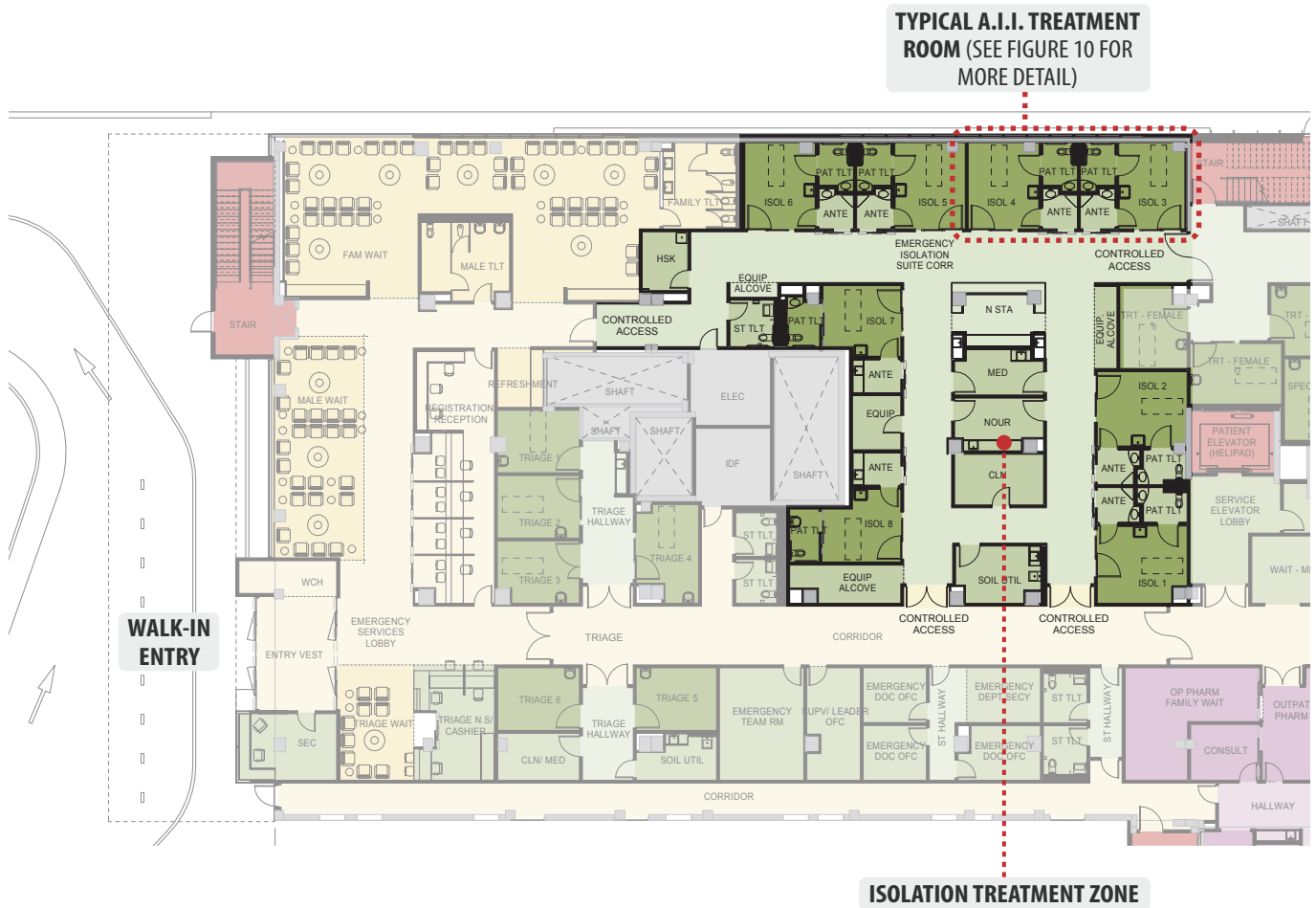


Figure 9: Emergency and Ambulatory Services Building | Ground Level | A.I.I. Treatment Zone

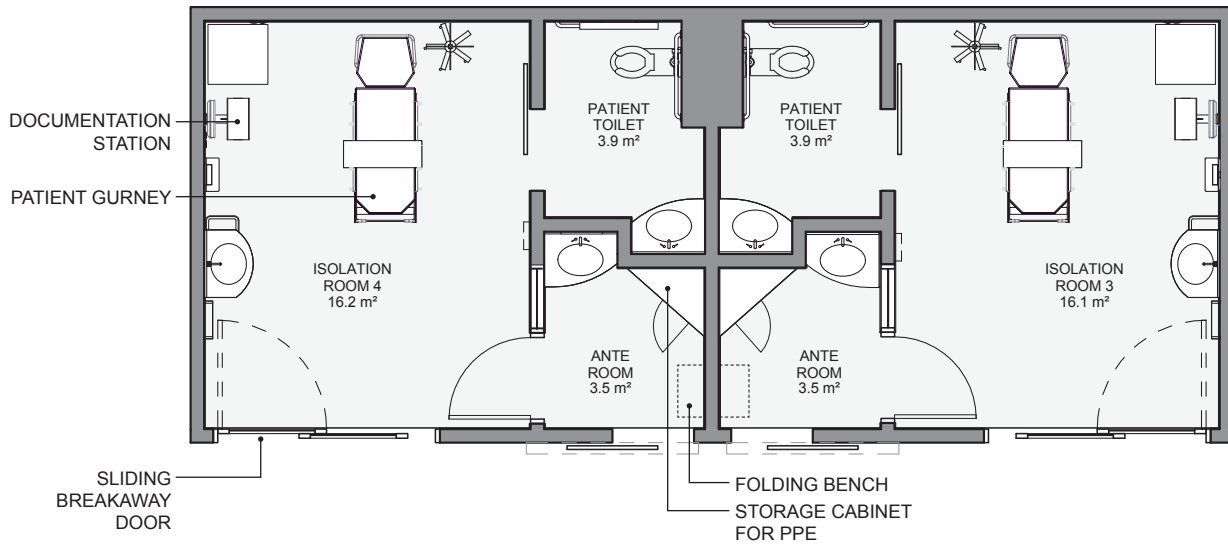


Figure 10: Typical A.I.I. Treatment Room

Conclusion

While the requirements for MERS Airborne Infectious Isolation Rooms are not different from those for many other infectious diseases such as TB, nor as stringent as for the deadly Ebola virus, its fatality rate and opportunity for transmission to regions outside the Eastern Province due to the transient foreign worker population necessitated a broader multi-faceted response when designing the new facilities at Dammam Central Hospital.

First, the Emergency Department as the gateway to the hospital for a majority of patients supports the rapid identification and isolation of infectious patients upon arrival at the hospital. Second, the MERS Isolation Unit provides a consolidated specialized location for treating the significant number of MERS patients in the area, further supported by the ICU with MERS A.I.I.s. Lastly, the greater numbers of isolation rooms designed throughout the facility allows the hospital to accommodate the larger numbers of patients with infectious diseases other than MERS on a regular basis but with the flexibility to respond to an increase in MERS-related cases by assigning isolation rooms in other acute care or ICU units to MERS patients as needed.

References

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