GENERAL APPROACH TO EVALUATE HEALTHCARE FACILITIES FOR AIRBORNE INFECTION PREVENTION AND CONTROL

INTRODUCTION:

Administrative Controls reduce risk of exposure, infection, and disease through policies and practices. A critical component of Administrative Controls is **the evaluation of the airborne infection prevention and control plan and its implementation.**

The development of the approaches to evaluate healthcare facilities with an emphasis on prevention and control of airborne infections is intended to help identify **the strengths and weaknesses** of healthcare facilities in prevention and control of infections in healthcare facilities, both indoors and outdoors, which may be of low, medium, or high complexity.

It is important to mention that this information can be used in training of healthcare workers who, in their daily work routine, would be permanent evaluators. The healthcare workers can become technical advisors for the institutions they represent or other health institutions to which they may be called upon as evaluators, supervisors, or inspectors, developing their skills at the national or international level.

Formalities have also been described when presenting themselves before health authorities for the purpose of carrying out a productive evaluation intervention. The attitude and respect that an evaluator has in the face of an evaluation of a healthcare facility in infection prevention and control, determines the success or failure of the intervention. Identifying the lack of maintenance is an important task in prevention, allowing the management of the control of infections transmitted by air.

One of the most effective ways to reduce the risk of contamination by airborne diseases in health establishments is through administrative controls, to have categorized and safe health establishments.

Administrative controls ensure maintenance of ventilation equipment is performed and that ensures the appropriate air exchange rates for dilution and removal of airborne bacteria and viruses.

Periodic training in prevention and control of airborne infections as well as to carrying out monitoring and evaluation of the facilities IPC efforts ensure management awareness of the status of disease transmission and effectiveness of airborne IPC interventions.

AIM

Contribute to a proper evaluation in healthcare facilities for airborne infection prevention and control.

OVERALL OBJECTIVE

Conduct an evaluation in healthcare facilities for airborne infection prevention and control within the technical and regulatory framework.

SPECIFIC OBJECTIVE

Set criteria for evaluation in healthcare facilities for airborne infection prevention and control.

SCOPE OF APPLICATION

The provisions contained in this document will apply to staff in healthcare facilities that require an evaluation for airborne infection prevention and control.

LEGAL BASIS

Current technical regulations in the countries that require evaluation and those set out by the World Health Organization, Pan American Health Organization, et al, and those to which these organizations refer.

GENERAL PROVISIONS

After selecting the healthcare facility to be evaluated, the preliminary evaluation of healthcare facility for the prevention and control of airborne infections is scheduled, generally by teleconference, with the heads of the health sector and the healthcare facilities.

Many national, regional, and international regulations, guides, manuals address airborne IPC and biosafety/biosecurity in health establishments. Additional resources and URLs can be found on page 13.

Figure 1. Selected publications on airborne IPC guidance

Upon arrival at the healthcare facility, contact with the most senior manager to inform them about the work to be conducted and confirm the permissions required to conduct an efficient evaluation in healthcare facilities for airborne infection prevention and control. A personal identification document (personal cards or a letter of introduction as IPC evaluators in healthcare facilities should be taken to this meeting.

A visit report should be completed, and the evaluation team should inform the management when they are leaving at the end of the visit.

When beginning the evaluation and providing technical assistance in healthcare facilities for airborne infection prevention and control, it is important to have knowledge of the technical and legal rules in force in the country and to be familiar with the country's language, currency, habits, economy, and traditions.

SPECIFIC PROVISIONS

Identify the flow through which patients with respiratory diseases transit, as well as the health/disease units that congregate these patients, identify whether they have ventilated waiting rooms or perform the segregation of patients with respiratory diseases.
Identify what type of ventilation is being evaluated, whether it is natural or mechanical ventilation, in order to propose the recommendations required to assure optimal natural or mechanical ventilation.

■ Administrative controls

In the example below, the creators of the design of this outpatient clinic/health center, due to their lack of knowledge of IPC, organized the consulting rooms in alphabetical order and put them together:

Figure 2. Dermatology and COPD

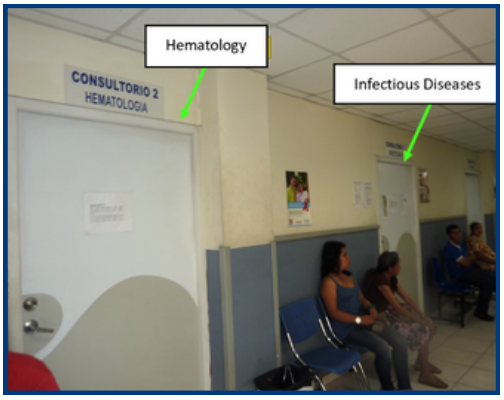


Figure 3. Hematology and Infectious Diseases

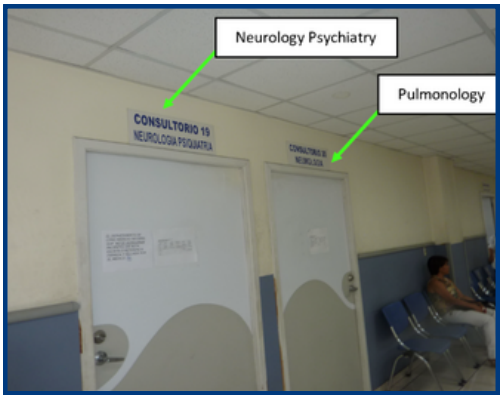


Figure 4. Pulmonology and Neurology / Psychiatry

In this example you can identify a hospital that operates with natural ventilation and after the renovation the windows were removed. Now, there is little-to-no natural ventilation in this ward.

Figure 5. Hospital Patient Ward before renovation

Figure 6. Hospital Patient Ward after renovation

Healthcare facility complexity

It is important to identify the level of care provided at the healthcare facility visited. This will set the evaluation guidelines.

Primary care: treats outpatients and low complexity patients.

Secondary and tertiary care: treat medium and high complexity inpatients.

For Example: There are countries which divide complexity into four levels of care; however, the subgroups correspond to outpatients and inpatients.

Primary care facilities consist of:

- Outpatient clinics
- Imaging services
- Bronchoscopy
- Clinical and pathology laboratories - Biosafety Level I (low TB risk)

> **Administrative controls, environmental controls, and respiratory protection must be applied in a sustainable manner.**

For example, one might start with various policies and practices, such as separation of patients. In a temperate environment, natural ventilation in a properly designed building is sustainable. When the risk still needs to be reduced, respiratory protection and cough etiquette are instituted.

Figure 7. Pulmonology Exam Room.

Note the open window for limited natural ventilation, the physician wearing an N95 respirator, and the patient covering his mouth with a cloth.

Figure 8. DOTS and DOTS Plus Room.

Note the limited natural ventilation due to closed windows and the nurse wearing an N95 respirator.

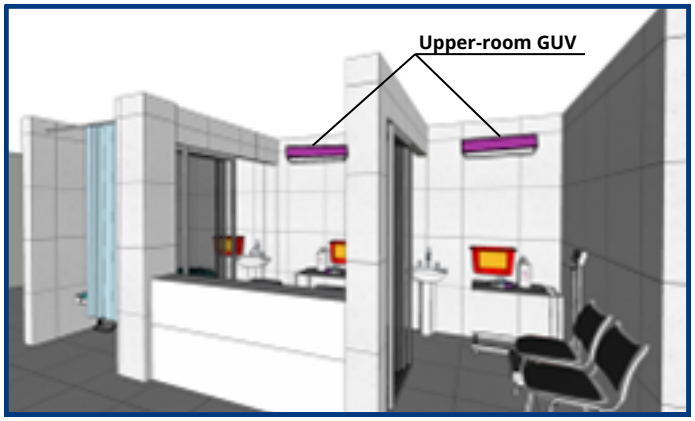


Figure 9. Triage Area.

Note no mechanical or natural ventilation. Upper-room ultraviolet germicidal fixtures were used to inactivate airborne microorganisms.

Figure 10. Waiting Area and dedicated toilets.
This area was used to separate known and presumptive TB patients from the general OPD.

Case Study

Figure 11. Extra beds were placed in the recently renovated patient room.

Here is an example of renovation in which the mechanical ventilation system was repaired. Because of demand, more beds were placed in the patient room than were on the approved project and plans.

How would this change affect the operation of the ventilation system?

Figure 12. Patient's side table and cabinet preventing air from exhausting from the room.

Note the smoke not going into the exhaust grille.

Figure 13. The patient's side table and cabinet were moved about 20 cm (8 in).

Note the smoke going into the exhaust grille.

Renovations must consider the size of the room, the equipment, and the furniture, to ensure nothing obstructs or hinders the functionality for which they were designed. After any renovation or major repair, it is critical to ensure all patient care and IPC controls are working properly.

Secondary and Tertiary care facilities consist of:

- Specialist outpatient clinics
- Specialist imaging services
- Clinical and pathology laboratories - Biosafety Level II and III (moderate and high TB risk)
- Emergency units
- Obstetric and surgical units
- Specialized Intensive Care Units as applicable

The level of care provided by the healthcare facility will set parameters for evaluating and identifying the features required by each unit. Below are two examples of the application of environmental controls for Trauma Shock Emergency Room and Emergency Procedure Room.

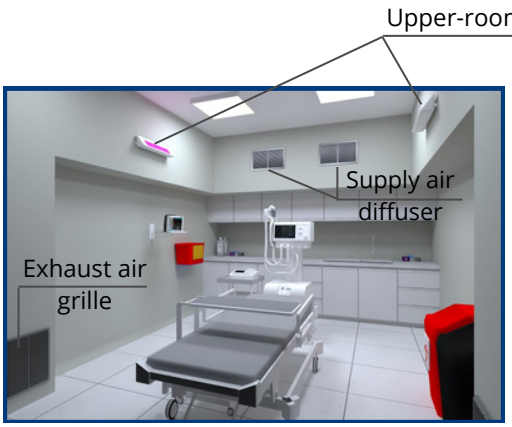
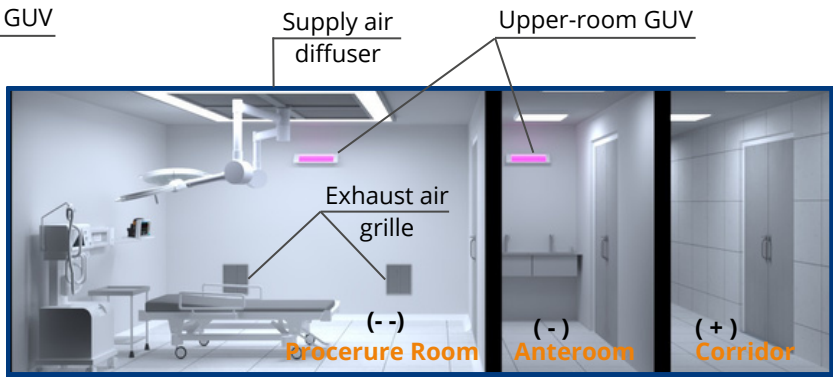


Figure 14. Trauma Shock Emergency Room with mechanical ventilation and upper-room GUV.



the courtesy of Bruno Trejo Herrera

Figure 15. Procedure Room in Emergency Department with mechanical ventilation, negative pressure, HEPA filter and upper-room GUV.

Evaluation in healthcare facilities for airborne infection prevention and control is initiated according to what the level of care determines.

1. Checks at the secondary care level for airborne infections control and prevention:

   ■ The surface area (>10 m2 [>110 ft2]) and height of rooms (>3m [>10 ft]) should be sufficient for providing safe care.

   ■ The air circulation should be in accordance with standards, avoiding stagnant air, and ensuring minimum air changes per hour, as needed.

   ■ Examples of some ventilation recommendations for selected spaces (Note: See *Mechanical Ventilation to reduce TB, COVID-19, and other airborne infections in Healthcare Facilities* for additional details. Local, national, and international guidelines may differ. Upper-Room (UR) GUV may be used to supplement natural and mechanical ventilation deficiencies):

   - Outpatient offices should have minimum: >6 ACH, supplement with UR GUV
   - Unit Intensive Care: >12 ACH, supplement with UR GUV
   - Imaging Services: >6 ACH, supplement with UR GUV
   - Bronchoscopy rooms: >12 ACH, supplement with UR GUV
   - Laboratory Biosafety Level III (high TB risk): 12-20 ACH, supplement with UR GUV
   - Sterilization Unit: > 6 ACH, positive pressure, supplement with UR GUV
   - Additional areas:

     ▪ Waiting room (separate patients), toilet facilities, DOTS and DOTS Plus treatment areas (separate entrance), and sputum sample collection rooms: Natural ventilation or mechanical ventilation system should be in accordance with standards, separated from the other rooms as they are a means of transmission, supplement with UR GUV if possible.
     ▪ Admission, corridors, and enclosed areas: Ventilation and lighting (artificial) should be in accordance with standards, supplement with UR GUV, as needed.

2. Checks at the secondary and tertiary level of care for airborne infection prevention and control: same as for primary care with additional measures.

   ■ Outpatient clinics for airborne diseases. It is advisable to have separates areas for the waiting room and toilet facilities (separate from the rest of the clinic).

   ■ Rooms for specialized diagnostic imaging for respiratory diseases, x-ray and tomography are temperature controlled for the equipment; therefore, it is important to ensure sufficient ACH (mechanical ventilation systems), in accordance with standards (includes nuclear energy).

   ■ Clinical and pathology laboratories, Biosafety Levels II and III (moderate and high TB risk). These laboratories should ensure containment by using mechanical ventilation systems; hence, ventilation systems and UR GUV need to be checked or installation recommended.

■ Emergency units: to maintain airborne infection prevention and control in emergency department areas, it is important to have isolation in separation areas (with ventilation system, possibly supplemented with UR GUV system).

■ Obstetric and surgical units: Check the ventilation system, in accordance with standards. Check the "Upper-room GUV irradiation" guidance for recommended installation and maintenance program for all UR GUV equipment of the healthcare facility, in accordance with standards.

■ Intensive Care Units. It is advisable to have areas for respiratory isolation (according to the specialization). Check the ventilation system (filters, ducts, equipment, ventilation supply and exhaust cleaning, etc.). UR GUV should be checked or recommended for the installation.

■ Sterilization Units should have good mechanical ventilation and UR GUV, in accordance with standards.

■ Inpatient Departments. According to standards, the hospitalization unit has natural ventilation, however, in cases of airborne diseases it is advisable to have respiratory isolation rooms in proportion to demand, mechanical ventilation systems and UR GUV systems, in accordance with standards.

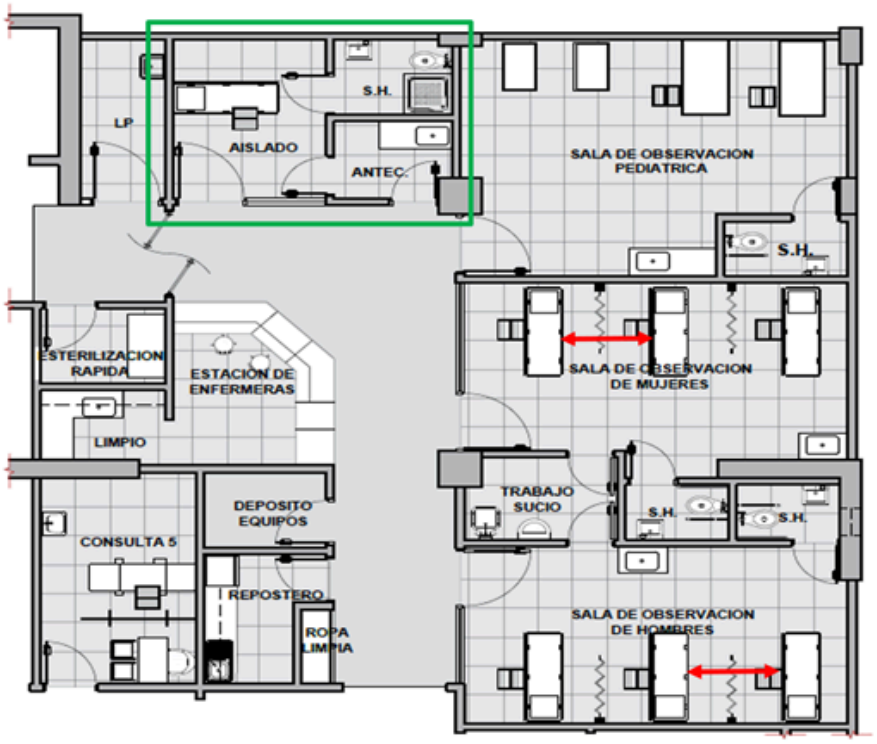


Figure 16. Inpatient Infectious Disease Ward (airborne precautions). The rooms are separated by life stages and by sex, beds must be separated by at least 1.5 m. It also has a respiratory isolation room with a private bathroom (in green).

For general inpatient rooms, maintain a minimum of 1.50 m (5 ft) between hospital beds and a maximum of 5 beds in a room (note: per Peru norms). Ideally, there should be single-patient rooms when infectious TB or presumptive TB patients are isolated from the general healthcare facility. Consider accessibility to toilets, handwashing sinks, ventilation (mechanical or natural), and UR GUV.

Case Study

Below is an example of the repurposing of a room to a waiting room with an outside entrance. The major environmental control was natural ventilation.

The design permitted health workers to adjust windows with limited training and education on natural ventilation and the importance of unimpeded air movement. Additional administrative controls are needed to ensure proper maintenance of windows as they must be functional in order to open as well as assure the adequate flow of air (wind).

Figure 17. Naturally ventilated space before repurposing as a waiting room.

Note the configuration and openable area of the windows.

Figure 18. Naturally ventilated waiting room after renovation of space.

Note the configuration and openable area of the new windows, which has become significantly smaller.

EVALUATION VISIT EQUIPMENT

The following equipment is needed to conduct a good evaluation in healthcare facilities for airborne infections prevention and control:

- UVC 254 meter (radiometer)
- Distance meter or tape measure
- Digital anemometer (velocity meter)
- Smoke tubes
- Swinging vane anemometer (Vaneometer™)
- Flashlight
- Photographic camera or mobile phone
- Notebook, pencils, etc.
- For personal protection: N95 or FFP2 respirator (one for replacement if necessary), sunscreen, alcohol gel, eye protection.

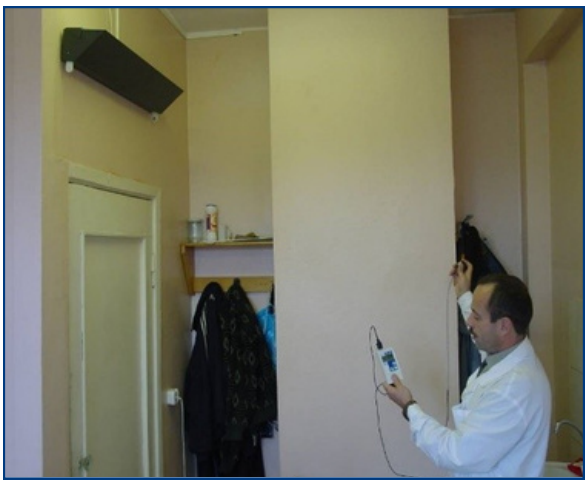


Figure 19. Measuring Upper-room germicidal ultraviolet to ensure the fixtures are emitting high levels of germicidal ultraviolet light in the upper room and lower/safe levels in the occupied space.

Figure 20. Tape ruler to measure ventilation grilles as well as room dimensions.

Figure 21. Anemometer to measure the velocity of air being exhausted from the room.

Figure 22. Technician using both a commercial smoke generating tube and a swinging vane anemometer to verify that air is moving into the room. In addition, the anemometer can be used to measure the speed of the air coming into the room. Knowing the area of the grille and the speed of the air, the volumetric airflow rate into the room can be calculated.

Figure 23. Smoke generated tube in order to visually the movement of air.

Figure 24. Swinging vane anemometer used to visualize air moving underneath a door.

Figure 25. IPC staff performing a qualitative fit test to ensure the proper fit and subsequent protection of an N95 or FFP2 respirator on a health worker.

Figure 26. Health worker just completed and passed a quantitative fit test to ensure proper fit.

Case Study

What's wrong with this photo?
How much air will go through that window?
Obviously, no air due to the brick wall behind the windows.

Figure 27. An example of a renovation where a window was bricked up.

It is critical to consider the positive and negative effect(s) of changing procedures and structures on airborne IPC.

PROCEDURE

■ You must be careful where you walk and what you touch. You must report any incidents that occur during your evaluation visit to the management of the healthcare facility (for example, needle sticks, cuts from glass, and contact with bodily fluids).

■ When entering a room, it is advisable to do a visual recognition, where are people located and activities, where furniture and medical equipment are located, smell or odors that are concentrated in the environment relative to other spaces, where the air comes from, thus beginning a preliminary evaluation of the place being evaluated.

■ It is important to ask room occupants for permission to take photos. Remember that you cannot infringe on the privacy of the patients.

■ Making a list of administrative, managerial and respiratory controls measures, questions relevant to the area of use, it will give the evaluator a broader picture of the users, for example:

- Those which have an up-to-date or existing infection prevention and control plan.
- The number of patients seen daily.
- The number of patients seen last year.
- The length of time for which patients are seen.
- Whether patients attend alone or accompanied.
- Epidemiology of patients.
- The patient route from the entrance to the care area.
- The healthcare workers have training in the use of respirators and masks.
- The healthcare workers have gone through the respirator fit test.
- Ask if they have a budget for the maintenance of collective protection equipment, such as biological safety cabinets (BSCs), ventilation (natural and mechanical) or UR GUV fixtures (if present).

■ Observe the area and take notes of what you see during your visit, for example:

- If the windows were closed, why were they closed?
- If the waiting area was overcrowded.
- If the waiting room areas are separated and each one has toilets.
- Use the smoke tube to visualize the wind flow in windows, doors and ventilation system ducts.
- If there were patients from other areas.
- If the staff were using the correct respiratory protection and whether it was in good condition.
- Whether environmental control equipment (mechanical ventilation and/or GUV systems) was turned on, turned off or damaged.
- Observe respiratory controls, verify whether patients and health workers use their respiratory protection correctly.

■ Draw a diagram (floor plan) of the area being evaluated, annotating it with:

- Measurements (width, length, and height).
- Location and measurements of doors and windows.
- Location of ventilation systems, diffusers, and grilles (if there were any).
- Location of extraction and mixing fans.
- Location of GUV fixtures (if there was one).
- Location and placement of furniture.
- Air flow diagram.

■ Calculate the volume of the room.

■ Calculate the air flow rate (in windows or ventilation ducts).

■ Calculate air changes per hour (ACH) in the area.

■ Evaluate the GUV irradiation on the upper room and near the room's workstations.

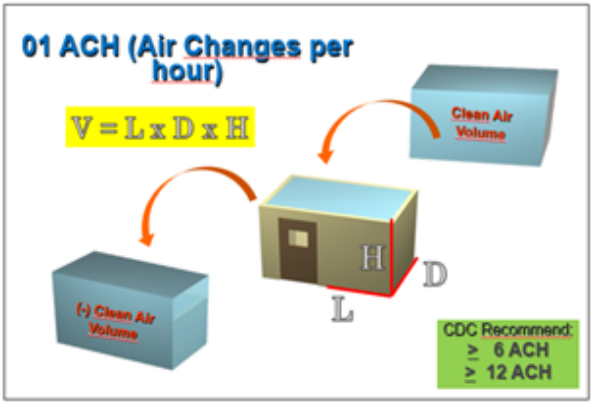


Figure 27. Calculation of ACH in the room

■ Identify air flow short circuits and make recommendations to ensure optimal air flow for entire room space.

Figure 28. The patient room has mixed ventilation. Fresh air enters through an open window and is removed through a nearby mechanical exhaust ventilation system.

■ Review the maintenance plans for mechanical ventilation systems. How are ACHs defined for each service? How are they evaluated? Is there documentation?

The information gathered will be used to propose the best solution(s) for improving and optimizing the airborne infection prevention and control.

RECOMMENDATIONS

■ For corridors and stairways with little natural ventilation, analyze the possibility of installing UR GUV and mechanical ventilation to circulate the air inside the building. Where there is UR GUV, fixtures should be checked to see how well they working and how much UV irradiation is coming from it. The safety of anyone in the area (health workers, inpatients, outpatients) should also be checked, See *Disinfecting room air with upper-room (UR) GERMICIDAL UV (GUV) systems* for additional details.

■ It is important that any UR GUV fixtures be installed **by qualified professionals** using **standardized equipment and protocols** that meets current regulations, to ensure and support the safety of internal and external personnel exposed to GUV in that health facility.

■ **Routine, preventive, and corrective maintenance** of UR GUV fixtures and GUV lamps. It is suggested to make measurements of the ultraviolet irradiance in upper and occupied room space after installation and further on regular basis.

■ **Training**: If, during the evaluation of healthcare facility it becomes apparent that staff need training on infection prevention and control, the topics where training is needed should be identified and recorded in the monitoring report so that this can be included in the technical report recommendations.

■ At the end of the evaluation of the healthcare facility for the prevention and control of airborne diseases, you should meet with the healthcare facility management to **finalize and give the feedback**. Leave the visit record which all involved parties to sign. The assessor will use this document to draw up a technical report containing the relevant conclusions and recommendations to give to the management of the healthcare facility, before leaving the area/region/country. The initial draft report should be delivered within two days of completion of the evaluation. This will give the facility management time to review and ensure that they:

- Understand the findings and recommendations.
- Correct any technical errors or misunderstandings.
- Discuss future actions and/or activities.

FURTHER READING

1. The End TB Transmission Initiative (ETTi) https://www.stoptb.org/who-we-are/stop-tb-working-groups/end-tb-transmission-initiative/etti-technical-readings
2. The World Health Organization (WHO) https://www.who.int/health-topics/tuberculosis#tab=tab_1
3. Centers for Disease Control and Prevention (CDC) https://www.cdc.gov/tb-healthcare-settings/hcp/facility-risk-assessment/index.html
4. The Curry International Tuberculosis Center (CITC) https://www.currytbcenter.ucsf.edu/products/view/tuberculosis-infection-control-practical-manual-preventing-tb

The information sheet was originally developed in Spanish by ETTi core group member Isabel Milagros Ochoa Delgado, Architect, Master in Public Health, Lima, Peru.
This information sheet was funded by the Stop TB Partnership with funds from the U.S. Agency for International Development in support of End TB Transmission Initiative - Powering Airborne IPC (ETTi).

The End TB Transmission Initiative (ETTi) is a working group of the Stop TB Partnership that supports the global fight against TB by focusing its efforts on preventing and controlling the transmission of TB.

The ETTi's vision is to provide leadership in ending TB transmission in institutional and community settings worldwide thereby preventing TB infection and disease. To achieve its vision, the collective initiative advocates for and leads implementation of effective TB infection prevention and control.

To learn more about ETTi and to keep up to date on ETTi activities, please join to receive our newsletter: https://www.stoptb.org/end-tb-transmission-initiative/etti-newsletters-social-media.

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