ORIGINAL ARTICLE

Evaluation of Tuberculosis Infection Control Strategies at the Philippine General Hospital

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ABSTRACT

Background. Nosocomial TB transmission adversely affects inpatients and healthcare workers (HCWs). HCWs have a higher risk of tuberculosis and MDR-TB compared to the general population. Nosocomial TB outbreaks have occurred among patients with HIV/AIDS. Hospitals need to examine TB infection control measures in order to address this growing concern.

Objective. This study aimed to evaluate the TB infection control strategies in the adult service wards of the Philippine General Hospital (PGH).

Methods. This descriptive study was conducted on adult inpatients with bacteriologically-confirmed PTB admitted in April-August 2016. A data collection tool based on Center for Disease Control (CDC) guidelines was utilized for chart review. Baseline characteristics, diagnosis, treatment, and isolation intervals were obtained and compared between areas. In-hospital TB infection control practices were reviewed using the CDC TB Risk Assessment Worksheet with data from the TB-DOTS, UP Health Service, PGH Hospital Infection Control Unit, and PGH Department of Laboratories.

Results. Of the 95 patients with bacteriologically-confirmed PTB, data from 72 medical records were available and included in the analysis. Majority were Medicine patients (55.6%) with a diagnosis of pneumonia (52.8%). Only 61.1% were PTB suspects on admission. The mean diagnosis interval was 5.82 days±5.473, the mean treatment interval was 0.77 days±2.941, and the mean isolation interval was 8.23 days±6.372. Only 41.7% were successfully isolated. The most common reasons for isolation failure/delay were lack of vacancy (ER, Medicine wards) and lack of isolation room (Surgical wards). Treatment initiation rate was 66.7% while TB-DOTS inpatient referral rate was 55.6%. The hospital is classified as having potential ongoing transmission of PTB.

Conclusion. In this study, TB treatment was promptly started but there were delays in diagnosis and isolation. Gaps included 1) lack of recognition of a PTB case, 2) limited isolation rooms, and 3) inadequate utilization of TB-DOTS. TB infection control measures need to be strengthened in order to prevent nosocomial transmission of PTB.

Key Words: tuberculosis, infection control, nosocomial infection

INTRODUCTION

Tuberculosis (TB) is one of the world's deadliest infectious diseases despite the fact that most deaths from this disease are preventable.[1] Transmission of *Mycobacterium tuberculosis* occurs through inhalation of droplet nuclei. Droplet concentration and the length of exposure to an infectious person determines likelihood of infection.[2] Healthcare-associated transmission of TB has been reported in treatments that induce coughing or sputum induction, aerosol-generating procedures (eg, bronchoscopy, endotracheal intubation, suctioning), open abscess irrigation, and autopsy, among others.[2]

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In high-prevalence, low-income countries, national TB programs generally focus on early diagnosis and appropriate treatment by strengthening the TB-DOTS services. Hospital infection control is imperative as well since transmission in healthcare settings can adversely affect other patients and healthcare workers and may result to loss of personnel.[3] Several studies have documented this nosocomial transmission.[4,5,6] Four studies in Asia have documented higher rates of latent tuberculosis infection (LTBI) among healthcare workers compared to the general population.[7,8,9,10]

Increased transmission of *M. tuberculosis* in the hospital setting

In 2006, a systematic review of 51 studies conducted in low-income and middle-income countries showed that among healthcare workers (HCWs), the prevalence (33-79%) and incidence (0.5-14.3% per year) of LTBI are high.[11] Higher risk of disease acquisition was observed in certain locations (inpatient TB facility, laboratories, internal medicine, emergency facilities) and in several occupational categories (nurses, patient and ward attendants, paramedics, radiology technicians, and clinical officers).[11]

The concern for nosocomial transmission of tuberculosis is growing especially in the settings of immunodeficiency and resistance to current anti-TB treatment regimens.[12,13] Among high-burden countries like the Philippines, the risk of nosocomial transmission is likely to be augmented especially with the advances in the treatment of HIV/AIDS. The World Health Organization (WHO) estimates that 3.3% of new TB cases and 20% of previously treated cases have multidrug-resistant TB (MDR-TB).[14] Worldwide, nosocomial MDR-TB outbreaks among inpatients have been reported and most of the infected patients have HIV.[15,16,17,18] HCWs are also more likely than non-HCWs to have MDR-TB and HCWs with HIV have a higher risk of contracting TB disease.[12,15,16,19]

Gaps in tuberculosis infection control

Delays in diagnosis, treatment, and isolation contribute to the increased risk for nosocomial transmission. A study in a large tertiary hospital in Taiwan showed that these delays are significantly higher for patients in non-pulmonary wards compared to those in pulmonary and infectious wards. These delays contribute to the institutional risk of TB transmission.[20] A study of 17 acute care hospitals in Canada identified older age and the absence of cough to be associated with missed diagnosis, delayed treatment, and increased mortality.[21]

Current guidelines

The Center for Disease Control and Prevention (CDC) and the WHO released recommendations for prevention of nosocomial transmission using three levels of control, namely, administrative, environmental, and respiratory-protection controls.[2,3] The administrative controls are considered the most important because they are necessary for the implementation of environmental and personal respiratory protection controls.

Administrative controls reduce the exposure of patients and HCWs to patients with PTB and include the assessment of risk of transmission within the institution, the development, implementation, and evaluation of an infection control plan, adequate training of HCWs, and education of the patients and the community.[2,3,12] CDC guidelines recommend the utilization of Airborne Infection Isolation (AII) room for all patients with suspected or confirmed TB. The CDC recommends that for a hospital with 120 beds, a minimum of one AII room is needed.[2] An additional AII room is recommended for every 200 patient-days of cases with either suspected or confirmed TB disease.[2] Emergency rooms and intensive care units catering to a high volume of TB patients should have at least one isolation room.[2] Currently, there are no recommendations that provide a specified time frame to reach a diagnosis, provide treatment, and transfer a patient to isolation. However, guidelines continue to reiterate the prompt need for these management goals.

Environmental controls such as modification of ventilation, High Efficiency Particulate Air (HEPA) filtration and Ultraviolet Germicidal Irradiation (UVGI), are needed to reduce the concentration of infectious particles in the air.[2,3,22] In low income settings, natural and mechanical ventilation should be optimized.[3,12,22]

Respiratory protection controls include the use of protective equipment to protect the HCWs from inhaling infectious droplet nuclei.[3,22] While effective, the major disadvantages include usage for a limited time and the low likelihood for use when attending to patients with undiagnosed infectious TB.[12]

OBJECTIVES

This study aimed to evaluate the existing TB infection control practices in the service areas of University of the Philippines-Philippine General Hospital (UP-PGH). Specifically, the study aimed:

1. To describe the baseline demographic and clinical characteristics of the patients diagnosed with PTB admitted to the UP-PGH service areas;
2. To identify the current TB infection control measures of UP-PGH;
3. To assess compliance to the three-level hierarchy of controls (administrative, environmental, respiratory protection) recommended in the WHO and CDC guidelines;
4. To compare the intervals to diagnosis, treatment, and isolation for TB patients in medicine and non-medicine wards of UP-PGH and to identify the reasons for delayed or missed isolation; and
5. To evaluate the inpatient utilization of TB-DOTS.

METHODS

Selection and description of participants

This descriptive study was done in the Philippine General Hospital (PGH), the national university hospital. It has a total of 1,388 beds, with 950 beds in the service wards and intensive care units, 790 of which are for adult patients. It has a wide and comprehensive range of medical and surgical specialties.

All adult patients admitted to the service areas (ER, ICUs, Medical Wards, Surgical Wards) of PGH between April to August 2016 whose sputum specimens were positive for Direct Sputum Smear Microscopy (DSSM) or Sputum Tuberculosis Polymerase Chain Reaction (TB PCR) were included in the study. Patients with PTB who were already undergoing treatment for more than or equal to 2 weeks *and* have negative surveillance AFB smears or were determined to be non-infectious by the attending physician were excluded from the study.

Technical information

The registry of submitted specimens for sputum AFB or TB GeneXpert were reviewed periodically. The data collection sheet (Appendix A) was used to gather data from inpatient charts. The baseline demographic and clinical characteristics of included patients together with the clinical signs and symptoms that prompted suspicion or diagnosis of PTB were gathered.

Data on the following parameters were recorded: time interval from admission to bacteriologic confirmation of PTB for patients who are suspected of having PTB (Diagnosis Interval), time interval from request and submission of sputum specimens to release of result, time interval from admission to transfer to an isolation room (Isolation Interval), time interval from bacteriologic confirmation of diagnosis to initiation of treatment (Treatment Interval), response to request for isolation (success or failure) and reason for failure to isolate, length of stay of in an isolation room, total length of stay inside the hospital, referral rate of patients with confirmed pulmonary TB to the TB-DOTS, and final disposition (discharged, transferred, home against advice, mortality). Comparison of the data between different areas (medical wards, non-medical wards, ER) was done.

The PGH Infection Control Manual[23] was reviewed. Interviews with personnel of the Hospital Infection Control Unit (HICU), UP Health Service (UPHS), and TB-DOTS were done in order to evaluate the existing hospital infection control strategies of the hospital. Data from census of these units, including the number of healthcare personnel diagnosed with PTB over the past 3 years, the level of compliance of healthcare personnel to TB screening, and the numbers and characteristics of isolation rooms in the hospital, were obtained and used to complete the TB Risk Assessment Worksheet (Appendix B) recommended by the CDC.[2] Existing in-hospital TB infection control practices were reviewed according to the WHO and CDC guidelines.

Patient confidentiality was ensured by assigning patient code numbers. The Declaration Upon Admission Form signed by the patient and/or legal relative covers the sharing of knowledge and information, allowing the documentation and preservation of the patient's ailment in the name of research. Only patient records were perused and no interaction with the patient occurred and no intervention was made during the entire duration. Only the investigators and the UP Manila Research and Ethics Board (UPMREB) were allowed to access this database to ensure confidentiality and anonymity. Approval from the UPMREB was obtained prior to the start of the study.

Statistics

Data analyses were performed using SPSS 23.0. The baseline characteristics of patients in the different wards were gathered. Diagnosis, treatment, and isolation intervals were compared between the different wards. Means and standard deviations were calculated for continuous variables.

RESULTS

All patients whose sputum was submitted for DSSM and TB PCR were screened. Ninety-five (95) patients satisfied our inclusion criteria, with ages ranging from 20 to 91 years and mean age of 44 years. However, during the duration of our data collection (April-August 2016), 23 inpatient charts were not available for review (ER-17, Medical Wards-1, Surgical Ward-2, Cancer Institute -1). Hence, only 72 patients were included in our analyses. Of these patients, 42 (58.3%) were male and 30 (41.7%) were female. Most patients were located in the Medical Wards (40, 55.6%), followed by the Emergency Room (19, 26.4%), and Surgical Wards (12, 16.7%).

As shown in Table 1, of the 72 patients, majority had primary pulmonary diagnoses (n=38, 52.8%). The most common was pneumonia (n=26, 36.1%), followed by hemoptysis (n=4, 5.6%), pleural effusion (n=3, 4.2%), and pneumothorax or pneumohydrothorax (n=4, 5.6%). Infectious diseases and gastrointestinal diseases were the second most common primary diagnoses, followed by oncologic/hematologic diseases and renal diseases. Pulmonary comorbidities, such as chronic obstructive pulmonary disease (COPD) and bronchial asthma, were present in 33.3% of the patients. Eight patients (11.1%) had a previous history of PTB treatment. Cardiovascular comorbidities were present in 26.4% of patients, of which the most common was hypertension (n=10, 13.9%), followed by heart failure (n=6, 8.3%). Renal comorbidities were present in 27.8% of patients, most commonly acute kidney injury (n=11, 15.3%). Twenty-one (29.2%) patients had an endocrine comorbidity, mostly Type 2 diabetes mellitus (n=18, 25%). Sixteen patients were suspected of having HIV/AIDS and ELISA screening was ordered. Other comorbidities included cancers (19.4%), anemias (6.9%), neurologic diseases (6.9%), and infectious diseases such as viral hepatitis, oral candidiasis, and herpes zoster (12.5%).

Table 1. Baseline characteristics

		Mean N (%)
Age (years)		44 (20-91)
Sex	Male	42 (58.3%)
	Female	30 (41.7%)
Ward	Emergency Medicine	19 (26.4%)
	Medicine	40 (55.6%)
	Surgery	12 (16.7%)
	Neuro-Psych	1 (1.4%)
Primary diagnosis - Categories	Pulmonary	38 (52.8%)
	Cardiovascular	2 (2.8%)
	Gastrointestinal	7 (9.7%)
	Renal	6 (8.3%)
	Endocrine	1 (1.4%)
	Oncologic/Hematologic	6 (8.3%)
	Neurologic	4 (5.6%)
	Rheumatologic	1 (1.4%)
	Infectious	7 (9.7%)
Comorbidities	Pulmonary	24 (33.3%)
	Cardiac	19 (26.4%)
	Gastrointestinal	10 (13.9%)
	Renal	20 (27.8%)
	Endocrine	21 (21.8%)
	HIV/AIDS	
	Suspect	16 (22.2%)
	ELISA reactive	4 (5.6%)
	ELISA non-reactive	4 (5.6%)
	Oncologic	14 (19.4%)
	Neurologic	5 (6.9%)
	Infectious diseases	9 (12.5%)
	Others	6 (8.3%)
Symptoms of PTB Present	Chronic cough	44 (61.1%)
	Dyspnea	27 (37.5%)
	Weight loss	28 (38.9%)
	Fever	25 (34.7%)
	Night sweats	0
	Hemoptysis	4 (5.6%)

As Table 2 shows, out of the 72 patients eventually proven to have positive sputum tests, 30.6% were not initially suspected of having PTB; hence, testing was not done upon admission. During the hospital stay of these patients, specimens were eventually sent for PTB testing due to development of respiratory symptoms or due to suspicious findings on chest radiography. In contrast, 61.1% of patients had a diagnosis of "presumptive PTB" or "PTB suspect". The rest of the patients (8.3%) were already diagnosed with PTB prior to admission but respiratory specimens were submitted in order to determine infectiousness.

Table 2. Clinical suspicion by physician on admission of 72 bacteriologically-confirmed cases

PTB status on admission*	n (%)
Not suspected	22 (30.6%)
Presumptive/suspect	44 (61.1%)
Confirmed	6 (8.3%)
Total	72 (100.0%)

**As indicated in the chart*

Diagnosis Interval (time from admission to the bacteriologic confirmation of a TB case), has 3 components: the interval between admission and request for testing (Request Interval), the interval between the request to the submission of specimen (Submission Interval), and the interval between the submission of the specimen to the release of the result (Result Interval).

As shown in Table 3, the mean Diagnosis Interval for all included patients was 5.82 days (SD 5.474 days). The mean Request Interval was 1 day for patients at the ER (range 0-7 days), 2 days for patients at the medical wards (range 0-17 days), and 3 days for patients at the surgical wards (range 0-11 days). The mean Submission Interval was similar for the medical and surgical wards (4 days) compared to the ER (2 days). The average Result Interval was 1 day for the medical wards and 0 for the rest of the service wards.

Table 4 shows the outcomes of the isolation requests in different wards. Among the 72 patients who had bacteriologically-confirmed PTB (detailed results shown in Appendix C), isolation was requested for 49 patients (68.05%). In the ER, 12 of 19 isolation requests were fulfilled. In the medical wards, 23 of 28 isolation requests were fulfilled. In the surgical and neuropsychiatric wards, all isolation requests were not fulfilled.

As shown in Table 5, the most common reason for isolation failure in the Emergency Medicine and Medicine areas was the occupancy of the existing isolation rooms at the

Table 3. Diagnosis intervals (in days)

	All wards mean (in days), SD	Emergency Medicine	Medicine	Surgery	Neuro-Psych
Diagnosis interval	5.82, SD 5.473	4	6	7	5
Request Interval	1.76, SD 3.142	1	2	3	3
Submission Interval	3.32, SD 4.160	2	4	4	1
Result Interval	0.74, SD 1.492	0	1	1	5

Table 4. Isolation requests, failures, and delays

	All wards n (% of 72)	Emergency Medicine	Medicine	Surgery	Neuro-Psych
Positive sputum AFB/GeneXpert	72 (100%)	19 (26.4%)	40 (55.6%)	12 (16.7%)	1 (1.4%)
Isolation requests	49 (68.05%)	12 (16.7%)	28 (38.9%)	9 (12.5%)	0
Isolated within 24 hours	12 (16.7%)	6 (8.3%)	6 (8.3%)	0	0
Isolation delays	17 (23.6%)	0	17 (23.6%)	0	0
Isolation failures	20 (27.8%)	0 6 (11.1%)	5 (6.9%)	9 (12.5%)	1 (1.4%)

Table 5. Reasons for isolation failures/delays

	All wards n (% of 72)	Emergency Medicine n (% of requests)	Medicine n (% of requests)	Surgery n (% of requests)	Neuro-Psych n (% of requests)
No isolation room in ward	9 (12.5%)	0	0	9 (100%)	0
Isolation room occupied	30 (41.7%)	7 (100%)	23 (95.8%)	0	0
Isolation room being cleaned/refurbished	1 (1.4%)	0	1 (4.2%)	0	0

Table 6. Comparison of diagnosis, treatment and isolation intervals among different wards

	All wards Mean (days), SD	Emergency Medicine Mean (days), SD	Medicine Mean (days), SD	Surgery Mean (days), SD	Neuro-Psych Mean (days), SD
Diagnosis Interval	9 (12.5%)	0	0	9 (100%)	0
Treatment Interval	30 (41.7%)	7 (100%)	23 (95.8%)	0	0
Isolation Interval (from admission)	1 (1.4%)	0	1 (4.2%)	0	0

Table 7. Duration of isolation

	All Wards with Isolation Rooms Mean (days), SD	Emergency Medicine Mean (days), SD	Medicine Mean (days), SD
Duration of isolation	10.05, 7.520	5, 4	10, 7
Length of hospital stay	13.49, 10.759	8, 6	15, 12

Table 8. Treatment initiation rates

	Emergency Medicine n (% of 72)	Medicine n (% of 72)	Surgery n (% of 72)	Neuro-Psych n (% of 72)	Total n (% of 72)
Inpatient treatment initiated	11 (57.9%)	28 (70.0%)	9 (81.8%)	0	48 (66.7%)

Table 9. TB-DOTS inpatient referral rates

	Emergency Medicine (% of 19)	Medicine (% of 19)	Surgery (% of 19)	Neuro-Psych (% of 19)	Total (% of 19)
Referred to TB-DOTS	8 (42.1%)	25 (62.5%)	8 (66.7%)	0	41 (56.9%)

Table 10. Final outcomes

	Total n (% of Total)	Inpatient treatment initiated n	Referred to TB-DOTS n
Discharged	47 (65.3%)	35	31
Mortality	15 (20.8%)	7	5
Home against advice	9 (12.5%)	5	4
Still admitted	1 (1.4%)	1	1
Total	72 (100.0%)	48 (66.7%)	41 (56.9%)

time of request. In contrast, the reason for isolation failure among patients under the Surgical Services was the lack of isolation room in the surgical wards.

Comparison of the different intervals of interest (Table 6) showed that the mean Diagnosis Interval was shortest for patients at the Emergency Medicine areas (4 days). The mean Treatment Interval was shortest for patients at the medical wards (0) and was longest for patients at the surgical wards (2 days). In terms of duration of isolation, the average Isolation Interval was longer for the medical wards (9 days) compared to the Emergency Medicine areas (5 days).

Among the patients who were successfully isolated, the mean duration of isolation was 10.05 days (Table 7). In the ER, the mean duration was 5 days while in the wards, the mean duration was 10 days.

Treatment was initiated (first dose of medication given) prior to discharge in only 66.7% with bacteriologically-confirmed PTB (Table 8) despite written orders in the chart to start anti-TB medications. To explore the reason for the failure to initiate treatment, we investigated the inpatient referral rate to TB-DOTS (Table 9). Only 56.9% of the bacteriologically-confirmed PTB cases were referred on an inpatient basis to TB-DOTS. The highest referral rate was at the surgical wards and lowest at the ER.

As shown in Table 10, at the end of the data collection period, 65.3% of patients were discharged while 1 patient was still admitted. Among the 72 sputum-positive patients, 20.8% expired while still admitted. Of the 47 discharged patients, only 31 were referred to TB-DOTS. Nine out of 72 patients (12.5%) went home against advice and 5 of them were not referred to TB-DOTS. Patients were not followed up thereafter.

TB risk assessment for UP-PGH

The TB Risk Assessment Worksheet (Appendix B) was accomplished using the available data from infection control manuals, records, laboratory data, and other databases from different units of the hospital, including the HICU, the

Department of Laboratories, TB-DOTS, and the UPHS. The incidence of PTB among clinical and non-clinical personnel of UP Manila and PGH were gathered and are shown in Appendix D.

On review, there is no annual hospital census for bacteriologically-confirmed PTB cases, hence, the actual incidence of PTB in hospital cannot be determined. Surrogate data were derived from the referrals received by the TB-DOTS and the cases diagnosed and treated by the UPHS.

As shown in Appendix B, TB-DOTS received more outpatient referrals rather than inpatient referrals from 2010 to 2012. A total of 705 cases of both pulmonary and extra-pulmonary tuberculosis were referred in 2015 but the sources of these referrals were not recorded. As of this writing, it already received 1,141 referrals but these are not limited to in-hospital referrals since the clinic also caters to patients referred by other institutions. TB-DOTS did not have data for 2014 and 2015.

From the UPHS data (Appendix D), the number of physicians and nurses diagnosed with PTB increased from 2013 to 2015. A clustering of PTB cases was noted among the personnel belonging to the hospital's Support Services in 2014. It could not be fully determined whether these trends were due to in-hospital transmission since tuberculin skin test (TST) conversion and genetic testing of TB strains are not being done in the hospital.

The PGH Infection Control Manual identifies suspected or diagnosed of having pulmonary tuberculosis and laryngeal tuberculosis to be among those needing airborne precaution in addition to standard precautions and identifies specific administrative control strategies (Appendix E).[23] For HCWs who have close contact with patients with active TB, baseline chest X-ray and baseline sputum AFB are recommended.[23] Repeat CXR and sputum AFB studies are recommended 3 months after exposure even if there are no symptoms. Presently, the HICU detects lapses in infection control through surveillance methods, directly through the employees' annual physical examinations, and indirectly through the census of Infectious Diseases specialists within the hospital.

Environmental controls within the hospital are not compliant to CDC standards. Only 5 rooms are designated as source isolation rooms (medical wards - 4; ER - 1). None conform to the requirements of an Airborne Infection Isolation (AII) room. No data is available regarding air changes per hour (ACH).

HCWs are advised the use of N95 masks when handling patients with airborne infections. However, the utilization of these masks are dependent on their availability and the awareness of the healthcare workers regarding the infectious state of the patient.

Given the number of inpatients and outpatients being referred to TB-DOTS and the gaps in the implementation of TB infection controls, we classified PGH as having potential ongoing TB transmission.

DISCUSSION

Multiple gaps in TB infection control implementation exist. Gaps in administrative controls identified include delays in diagnosis, initiation of treatment, and isolation of bacteriologically-confirmed PTB cases. There are no strong surveillance systems for identifying bacteriologically-confirmed PTB cases and rapid notification systems for healthcare workers in contact with these cases.

HCWs do not appear to be actively engaged in the prevention of in-hospital TB transmission. All regular employees are required to undergo annual screening; however, compliance is low. There is no documentation of compliance to annual screening and there are no sanctions or incentives. Contract staff, including janitorial and security services, are not included in this program. Additionally, HCWs who are exposed to PTB cases do not regularly comply with post-exposure screening. Conversion rates are not tallied and incidence per area is also not documented precluding an analysis.

Diagnosis delays

The mean Diagnosis Interval was 5.82 days ± 5.473. Delays were observed in 3 successive phases. First, a high index of suspicion for TB is encouraged in the TB infection control strategies of the hospital but as shown in our results, 30.6% of bacteriologically-confirmed PTB patients were initially not suspected of having the disease. This physician-dependent delay in the recognition of the disease leads to prolonged exposure of patients and healthcare personnel and potentially increases the risk of TB transmission in-hospital.

Second, a prolonged Submission Interval also contributes to delay in diagnosis. In our study, the Submission Interval was the longest component of the Diagnosis Interval (2-4 days). Factors which are both staff and patient-dependent contribute to the prolonged Submission Interval and include the following: 1) submission of ward specimens by bulk instead of immediate submission post-collection, 2) submission of specimen occasionally delegated to the patient's watcher, and 3) inability or difficulty of the patient to expectorate.

The third component of the Diagnosis Interval is the Result Interval. Based on laboratory data, results are released within 24 hours (0-1 days) from submission. A discrepancy between the Result Interval and the expected response to a positive result (eg, initiation of treatment, isolation request, referral to TB-DOTS) indicate that a substantial number of laboratory results are not received or relayed in a timely manner to the physician.

Of the 72 patients included in this study, 33.3% of patients were suspected to have HIV/AIDS. However, HIV/AIDS screening was not routinely done in these patients, which ideally should be done in all patients with tuberculosis as recommended in guidelines[4].

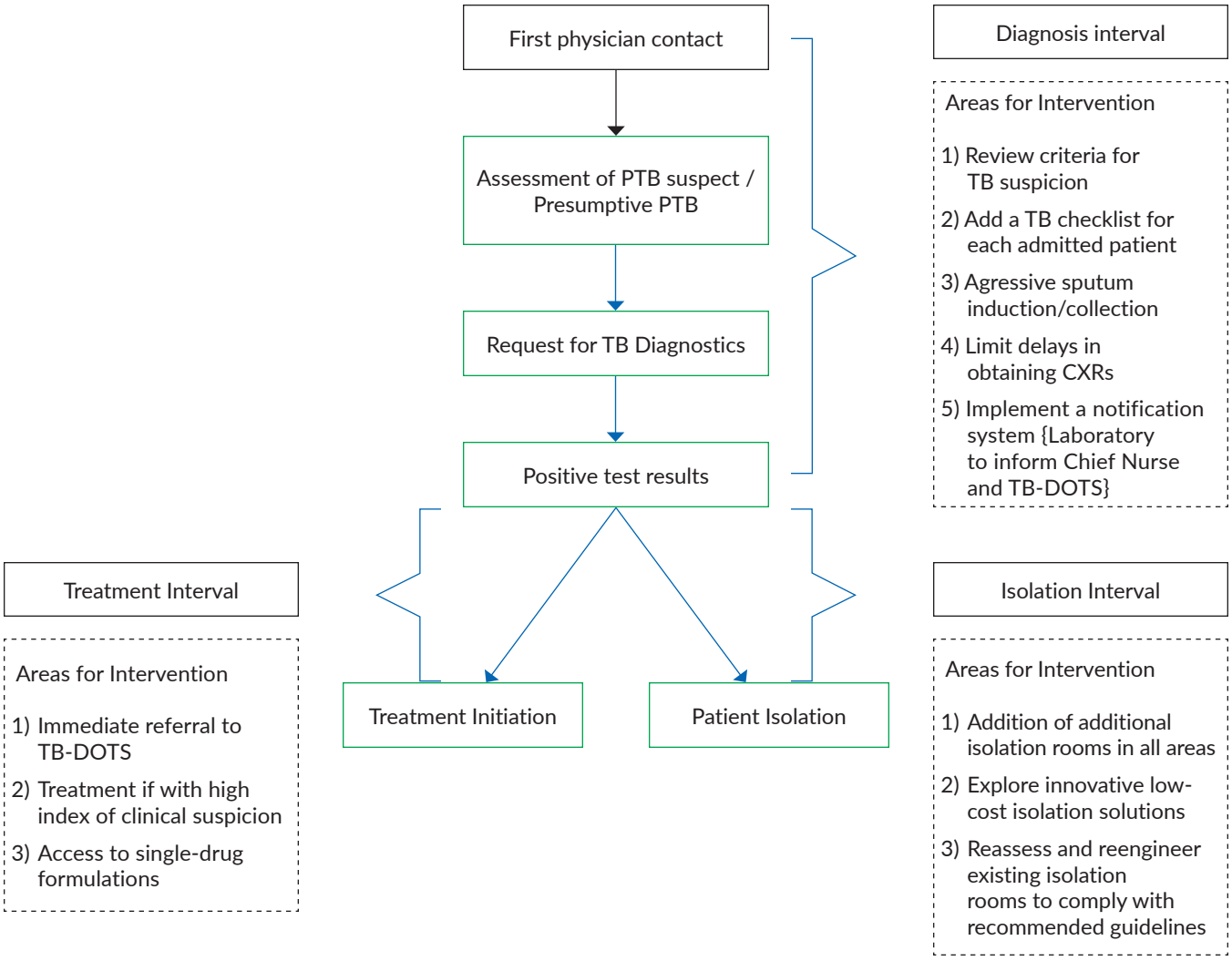

Figure 1. Recommendations for TB infection control strategies.

Treatment delays

Another component of the PGH TB Infection Control Program is early initiation of adequate anti-TB medications. One-third (33.3%) of the 72 bacteriologically-confirmed PTB patients in this study were not started on anti-TB medications as indicated in their inpatient therapeutic sheets despite written physician orders in the chart. Factors that contributed to treatment delays included: 1) lack of awareness of the bacteriologic confirmation of PTB, 2) low inpatient referral rate to TB-DOTS (56.9%), 3) lack of single-drug medications for patients with contraindications to fixed-drug combinations, and 4) inefficient nursing care. Treatment delays lead to prolonged infectiousness of the patient especially when coupled with delays in isolation.

Additionally, failure to initiate treatment among inpatients make them at highest risk of becoming index cases for PTB transmission to household members, which impacts community health.

Isolation delays and failures

Physicians ordered isolation for 68.05% of 72 bacteriologically-confirmed PTB cases. However, 40.8% of isolation requests were isolation failures. Isolation delays and failures occurred due to two major reasons: 1) the occupancy of the isolation room at the time of request and 2) the lack of an isolation room in a given ward. The CDC recommends that one airborne infection isolation room is needed for every 120 hospital beds[2]; therefore, at least 7 rooms are needed in the service areas of the hospital. However, an additional AII room is needed for every 200 patient-days of cases with either suspected or confirmed TB disease[2]. Based on the data gathered for 72 patients with an average LOS of 13.49 days, additional 5 isolation rooms are needed. Hence, at least 12 isolation rooms should be available within the service areas of PGH. However, this is still an underestimate since the duration of our study was only 5 months.

The existing isolation rooms are not AII rooms with a designed single-pass or recirculation system. Instead, UVGI and local exhaust ventilations are used to clean the air. Cohorting of smear-positive TB patients is done in high-risk areas such as the medical wards. However, these patients are still at risk of transmitting TB to the adjacent patients and HCWs.

Inefficient referral to TB-DOTS

Data from the UP-PRIME TB-DOTS Clinic revealed a yearly average of 300 suspected pulmonary TB inpatients and 646 outpatients. Ideally, all inpatients with tuberculosis should be referred to TB-DOTS but only 56.9% were referred in our study. Factors that contributed to failure of referral to TB-DOTS included the lack of recognition of a TB case by the physician, delayed diagnosis, and the multi-step process of referring. Referral forms are not available in the service wards and are obtained in the outpatient clinics, which are only open on weekdays. Since the patients' caregivers or relatives are the ones who deliver these referral forms to the TB-DOTS clinic, the forms occasionally get lost in transit. Conversely, the TB-DOTS Clinic only has 1 nursing staff and is not open on weekends, which also contributes to failure of referral.

CONCLUSIONS AND RECOMMENDATIONS

TB infection control strategies are present within PGH and have been established in writing since 2007. However, the results of this study show that there are gaps between actual and recommended TB infection control strategies. Given that the hospital is also an HIV treatment hub and a cancer center catering to immunocompromised patients, there is an urgent need to strengthen detection and surveillance, treatment, and infection control.

Administrative controls (early diagnosis, treatment, and isolation) are the most important components of TB infection control strategies. Hence, our major recommendations focus on these aspects of TB infection control. Figure 1 shows the current flow of TB diagnosis, treatment, and isolation in PGH and summarizes our key recommendations.

For early diagnosis, the availability of a checklist in the patient record sheets may be useful for first-contact physicians. Aggressive sputum induction should be emphasized and CXRs to augment strength of diagnosis must be performed in a timely manner.

The decision to initiate treatment is dependent on clinical suspicion and awareness of a positive smear or PCR result. Physicians may start treatment for PTB based on a clinical decision while awaiting bacteriologic and/or radiologic confirmation provided that these tests are done as soon as possible. In our hospital, lack of awareness of a positive result due to missing printed results or lack of access to the online laboratory records, is an important cause of delay.

We recommend a rapid notification system that originates from the Department of Laboratories and directed towards the Chief Nurse of the concerned area and the HICU to coordinate infection control measures. This system change will then cascade down to activate referral to the TB DOTS Clinic. The expected end result is the provision of immediate access to medications and recommendations for isolation. We also recommend that all physicians facilitate retrieval of the TB tests results (smears and/or GeneXpert) prior to discharge. Knowledge of the results will greatly help the physician educate the patient on treatment adherence and prevention of community transmission.

For improvements on isolation, the hospital's infrastructure needs to be re-evaluated. Re-engineering to ensure compliance to Airborne Infection Isolation (AII) standards is needed. We recommend the addition of another isolation room in the Emergency Room, in each of the Medicine wards, and one each in all other departments. Innovative low-cost isolation solutions should also be explored in the setting of financial and spatial limitations.

Based on literature review, this is the first study in the Philippines that attempted to explore existing inpatient TB infection control strategies. One of the PhilPACT's strategies is to encourage the participation of both public and private health care providers in TB control measures in order to scale up and sustain the coverage of DOTS.[24] In order to achieve this, hospitals like PGH need to strengthen TB infection control procedures and empower both HCWs and patients. Additionally, in-hospital TB-DOTS referral systems need to be intensified. Hospitals should ensure that all inpatients admitted and diagnosed with PTB are referred to TB-DOTS while they are still admitted. Finally, the national TB-DOTS program should integrate hospital TB data into its surveillance parameters, monitor the outcomes of patients who are started on TB treatment as inpatients, and compare these data with the outcomes of patients who are started on treatment as outpatients. Ideally, the TB epidemic should be addressed thoroughly in both inpatient and outpatient settings.

The limitations of this descriptive study included the small number of included patients, the short observation period, and the lack of in-depth investigation on the reasons for delays. Additional studies of longer duration on tuberculosis infection control in high-prevalence, low-resource settings such as ours are needed and can help investigate 1) the challenges in TB diagnosis, treatment and isolation, 2) the effect of system changes on increasing the effectiveness of infection control strategies, and 3) the efficacy of innovative isolation strategies.

Statement of Authorship

All authors have approved the final version submitted.

Author Disclosure

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APPENDICES

Appendix A. Data Collection Sheet

Patient Code Number: _____
Date admitted:_____ Date discharged: _____
1. Age: _____
2. Sex:
- ☐ 0 Male
- ☐ 1 Female

3. Primary diagnosis: _____
4. Comorbidities
- ☐ None
- ☐ 1 Pulmonary (e.g. COPD, BA, etc.) _____
- ☐ 2 Cardiac (e.g. CHF, CAD, RHD, etc.) _____
- ☐ 3 Gastrointestinal (e.g. PUD, CLD, etc.)_____
- ☐ 4 Renal (e.g. CKD, AKI, etc.) _____
- ☐ 5 Endocrine (e.g. T2DM) _____
- ☐ 6 HIV/AIDS_____
- ☐ 7 Oncologic (e.g. Leukemia, Lung Cancer, GI cancer) _____
- ☐ 8 Neurologic _____
- ☐ 9 Others _____

5. TB status on admission
- ☐ 0 Not suspected
- ☐ 1 Presumptive/suspect
- ☐ 2 Confirmed

6. If with Presumptive PTB/PTB suspect, clinical symptoms of TB present:
- ☐ 0 None
- ☐ 1 Chronic cough
- ☐ 2 Dyspnea
- ☐ 3 Weight loss
- ☐ 4 Fever
- ☐ 5 Night sweats

7. HIV Status throughout admission
- ☐ 0 Negative
- ☐ 1 Positive
- ☐ 2 Not Tested

8. TB diagnostics done
- ☐ 0 CXR Date requested _____ Date done _____
- ☐ 1 Direct sputum smear microscopy/Sputum AFB
  Specimen 1 Date requested _____ Date done _____ Date released _____
  Specimen 2 Date requested _____ Date done _____ Date released _____
- ☐ 3 Xpert/ MTB/Rif
  Date requested _____ Date done _____ Date released _____

9. Was isolation requested?
- ☐ 0 No
- ☐ 1 Yes
  Date requested _____ Date isolated _____ Date transferred out _____
  Number of days in isolation _____

10. If isolation was requested but patient was not isolated, what was the reason for failure to isolate?
- ☐ 0 No isolation room in ward
- ☐ 1 Isolation room occupied
- ☐ 2 Isolation room being cleaned/refurbished
- ☐ 3 Medical staff not aware of need to isolate
- ☐ 4 Others _____

11. Was treatment initiated as inpatient?
- ☐ 0 No
- ☐ 1 Yes Date started on Anti-TB meds _____

12. Was the patient referred to TB-DOTS while still admitted?
- ☐ 0 No
- ☐ 1 Yes Date referred _____ Date approved _____

13. Final outcome
- ☐ 0 Discharged
- ☐ 1 Mortality
- ☐ Home against advice
- ☐ Transfer

Appendix B. TB Risk Assessment Worksheet[2]

According to the CDC[2], this model worksheet should be considered for use in performing TB risk assessments for health-care facilities and nontraditional facility-based settings. Facilities with more than one type of setting will need to apply this table to each setting. The CDC headquarters is at 1600 Clifton Road Atlanta, GA 30329-4027 USA.

Scoring √ or Y = Yes	X or N = No	NA = Not Applicable

1. Incidence of TB

What is the incidence of TB in your community (county or region served by the health-care setting), and how does it compare with the state and national average? What is the incidence of TB in your facility and specific settings and how do those rates compare? (Incidence is the number of TB cases in your community the previous year. A rate of TB cases per 100,000 persons should be obtained for comparison.)* This information can be obtained from the state or local health department.	National rate 290,000 Facility rate unknown
Are patients with suspected or confirmed TB disease encountered in your setting (inpatient and outpatient)?	(Yes) No
If yes, how many patients with suspected and confirmed TB disease are treated in your health-care setting in 1 year (inpatient and outpatient)? Review laboratory data, infection-control records, and databases containing discharge diagnoses.	Data from UP PRIME TB DOTS Clinic

Year	Inpatient		Outpatient	
	S	C	S	C
2010*	181	NA	244	NA
2011	431	NA	889	NA
2012*	245	NA	608	NA
2013	Not available			
2014	Not available			
2015	705			
2016	Not yet available			

* - partial counts

If no, does your health-care setting have a plan for the triage of patients with suspected or confirmed TB disease?	(Yes) No
Currently, does your health-care setting have a cluster of persons with confirmed TB disease that might be a result of ongoing transmission of *Mycobacterium tuberculosis* within your setting (inpatient and outpatient)?	Yes (No)

2. Risk Classification

Inpatient settings	
How many inpatient beds are in your inpatient setting?	**1,300 total, 790 for adult service patients**
How many patients with TB disease are encountered in the inpatient setting in 1 year? Review laboratory data, infection-control records, and databases containing discharge diagnoses.	Previous year 705 total (inpatients, outpatients and out-of-hospital referrals) 5 years ago 431
Depending on the number of beds and TB patients encountered in 1 year, what is the risk classification for your inpatient setting? (See Appendix C.)	o Low risk o Medium risk ☑ Potential ongoing transmission
Does your health-care setting have a plan for the triage of patients with suspected or confirmed TB disease?	(Yes) No
Outpatient settings	
How many TB patients are evaluated at your outpatient setting in 1 year? Review laboratory data, infection-control records, and databases containing discharge diagnoses.	Previous year 705 total 5 years ago 889
Is your health-care setting a TB clinic? (If yes, a classification of at least medium risk is recommended.)	(Yes) No
Does evidence exist that a high incidence of TB disease has been observed in the community that the health-care setting serves?	(Yes) No The Philippines is considered a high-burden country by the WHO
Does evidence exist of person-to-person transmission of *M. tuberculosis* in the health-care setting? (Use information from case reports. Determine if any tuberculin skin test [TST] or blood assay for *M. tuberculosis* [BAMT] conversions have occurred among health-care workers [HCWs]).	Yes (No) Clustering of persons with TB noted in a certain area of the hospital in 2014
Does evidence exist that ongoing or unresolved health-care–associatedtransmission has occurred in the health-care setting (based on case reports)?	Yes (No)
Is there a high incidence of immunocompromised patients or HCWs in the health-care setting?	(Yes) No

Have patients with drug-resistant TB disease been encountered in your health-care setting within the previous 5 years?	(Yes) No
When was the first time a risk classification was done for your health-care setting?	**Data not available**
Considering the items above, would your health-care setting need a higher risk classification?	Yes (No)
Depending on the number of TB patients evaluated in 1 year, what is the risk classification for your outpatient setting? (See Appendix C)	o Low risk o Medium risk ☑ Potential ongoing transmission
Does your health-care setting have a plan for the triage of patients with suspected or confirmed TB disease?	(Yes) No
Nontraditional facility-based settings	
How many TB patients are encountered at your setting in 1 year?	**Not applicable**
Does evidence exist that a high incidence of TB disease has been observed in the community that the setting serves?	**Not applicable**
Does evidence exist of person-to-person transmission of *M. tuberculosis* in the setting?	**Not applicable**
Have any recent TST or BAMT conversions occurred among staff or clients?	**Not applicable**
Is there a high incidence of immunocompromised patients or HCWs in the setting?	**Not applicable**
Have patients with drug-resistant TB disease been encountered in your health-care setting within the previous 5 years?	**Not applicable**
When was the first time a risk classification was done for your setting?	**Not applicable**
Considering the items above, would your setting require a higher risk classification?	**Not applicable**
Does your setting have a plan for the triage of patients with suspected or confirmed TB disease?	**Not applicable**
Depending on the number of patients with TB disease who are encountered in a nontraditional setting in 1 year, what is the risk classification for your setting? (See Appendix C)	**Not applicable**

3. Screening of HCWs for *M. tuberculosis* Infection

Does the health-care setting have a TB screening program for HCWs?	(Yes) No
If yes, which HCWs are included in the TB screening program? (Check all that apply.) ☑ Physicians o Mid-level practitioners (nurse practitioners [NP] and physician's assistants [PA]) ☑ Nurses ☑ Administrators ☑ Laboratory workers ☑ Respiratory therapists ☑ Physical therapists o Contract staff o Construction or renovation workers	 o Service workers o Janitorial staff ☑ Maintenance or engineering staff ☑ Transportation staff ☑ Dietary staff ☑ Receptionists ☑ Trainees and students o Volunteers o Others _____
Is baseline skin testing performed with two-step TST for HCWs?	Yes (No)
Is baseline testing performed with QFT or other BAMT for HCWs?	Yes (No)
How frequently are HCWs tested for *M. tuberculosis* infection?	Ideally, every employee should have an annual medical evaluation which includes a chest x-ray. Compliance among the employees is highly variable. Actual numbers are not available but according to the UP Health Service, most health care workers, particularly physicians and nurses, are non-compliant.
Are the *M. tuberculosis* infection test records maintained for HCWs?	(Yes) No
Where are the *M. tuberculosis* infection test records for HCWs maintained? Who maintains the records?	**Records are maintained at the U.P. Health Service.**
If the setting has a serial TB screening program for HCWs to test for *M. tuberculosis* infection, what are the conversion rates for the previous years? †	**Data not available**
Has the test conversion rate for *M. tuberculosis* infection been increasing or decreasing, or has it remained the same over the previous 5 years? (check one)	o Increasing o Decreasing o No change **Data not available**
Do any areas of the health-care setting (e.g., waiting rooms or clinics) or any group of HCWs (e.g., lab workers, emergency department staff, respiratory therapists, and HCWs who attend bronchoscopies) have a test conversion rate for *M. tuberculosis* infection that exceeds the health-care setting's annual average?	Yes No If yes, list _____ _____ _____ **Data not available – no active surveillance done.**
For HCWs who have positive test results for *M. tuberculosis* infection and who leave employment at the health setting, are efforts made to communicate test results and recommend follow-up of latent TB infection (LTBI) treatment with the local health department or their primary physician?	Yes (No) Not applicable

4. TB Infection-Control Program

Does the health-care setting have a written TB infection-control plan?	(Yes) No
Who is responsible for the infection-control program?	Hospital Infection Control Unit
When was the TB infection-control plan first written?	2007
When was the TB infection-control plan last reviewed or updated?	2008 Awaiting publication of latest updates
Does the written infection-control plan need to be updated based on the timing of the previous update (i.e., >1 year, changing TB epidemiology of the community or setting, the occurrence of a TB outbreak, change in state or local TB policy, or other factors related to a change in risk for transmission of *M. tuberculosis*)?	(Yes) No
Does the health-care setting have an infection-control committee (or another committee with infection control responsibilities)?	(Yes) No
If yes, which groups are represented on the infection-control committee? (Check all that apply.) ☑ Physicians ☑ Nurses o Epidemiologists ☑ Engineers ☑ Pharmacists ☑ Laboratory personnel ☑ Health and safety staff ☑ Administrator ☑ Risk assessment ☑ Quality control (QC) o Others (specify) _____	
If no, what committee is responsible for infection control in the setting?	

5. Implementation of TB Infection-Control Plan Based on Review by Infection-Control Committee

Has a person been designated to be responsible for implementing an infection-control plan in your health-care setting? If yes, list the name: _____	(Yes) No
Based on a review of the medical records, what is the average number of days for the following: Presentation of patient until collection of specimen Specimen collection until receipt by laboratory Receipt of specimen by laboratory until smear results are provided to health-care provider Diagnosis until initiation of standard antituberculosis treatment Receipt of specimen by laboratory until culture results are provided to health-care provider Receipt of specimen by laboratory until drug-susceptibility results are provided to health-care provider Receipt of drug-susceptibility results until adjustment of antituberculosis treatment, if indicated Admission of patient to hospital until placement in airborne infection isolation (AII) ^*Based on the data gathered from our study*	 **1.76, SD 3.142^** **3.32, SD 4.160^** **0.74, SD 1.49^** **0.77, SD 2.941^** **NA** **NA** **NA** **8.23, SD 6.372^**
Through what means (e.g., review of TST or BAMT conversion rates, patient medical records, and time analysis) are lapses in infection control recognized?	Surveillance methods through annual physical examinations, census of Infectious Disease specialists.
What mechanisms are in place to correct lapses in infection control?	Targeted active surveillance for documented outbreaks.
Based on measurement in routine QC exercises, is the infection-control plan being properly implemented?	(Yes) No
Is ongoing training and education regarding TB infection-control practices provided for HCWs?	(Yes) No

6. Laboratory Processing of TB-Related Specimens, Tests, and Results Based on Laboratory Review

Which of the following tests are either conducted in-house at your health-care setting's laboratory or sent out to a reference laboratory?	In-house	Sent out
Acid-fast bacilli (AFB) smears	☑	
Culture using liquid media (e.g., Bactec and MB-BacT)	☑	
Culture using solid media		
Drug-susceptibility testing	☑ but currently without reagents	
Nucleic acid amplification (NAA) testing	☑	
What is the usual transport time for specimens to reach the laboratory for the following tests? AFB smears — Less than 24 hours Culture using liquid media (e.g., Bactec, MB-BacT) — Less than 24 hours Culture using solid media — Less than 24 hours Drug-susceptibility testing — Less than 24 hours Other (specify) — _____ NAA testing — Less than 24 hours		
Does the laboratory at your health-care setting or the reference laboratory used by your health-care setting report AFB smear results for all patients within 24 hours of receipt of specimen? What is the procedure for weekends?	**Yes** No Usually within 24 hours however delays occur when the staff is on leave.	

7. Environmental Controls

Which environmental controls are in place in your health-care setting? (Check all that apply and describe) Environmental control — Description o All rooms ☑ Local exhaust ventilation (enclosing devices and exterior devices) — Enclosed rooms in select wards. o General ventilation (e.g., single-pass system, recirculation system.) ☑ Air-cleaning methods (e.g., high-efficiency particulate air [HEPA] filtration and ultraviolet germicidal irradiation [UVGI]) — UVGI only. HEPA filtration not available.	
What are the actual air changes per hour (ACH) and design for various rooms in the setting?	**Not known**
Which of the following local exterior or enclosing devices such as exhaust ventilation devices are used in your health-care setting? (Check all that apply) ☑ Laboratory hoods o Booths for sputum induction o Tents or hoods for enclosing patient or procedure	
What general ventilation systems are used in your health-care setting? (Check all that apply) ☑ Single-pass system o Variable air volume (VAV) o Constant air volume (CAV) o Recirculation system o Other _____	
What air-cleaning methods are used in your health-care setting? (Check all that apply) HEPA filtration o Fixed room-air recirculation systems o Portable room-air recirculation systems ☑ UVGI o Duct irradiation o Upper-air irradiation ☑ Portable room-air cleaners	
How many AII rooms are in the health-care setting?	**None**
What ventilation methods are used for AII rooms? (Check all that apply) Primary (general ventilation): o Single-pass heating, ventilating, and air conditioning (HVAC) o Recirculating HVAC systems Secondary (methods to increase equivalent ACH): o Fixed room recirculating units o HEPA filtration ☑ UVGI o Other (specify) _____	
Does your health-care setting employ, have access to, or collaborate with an environmental engineer (e.g., professional engineer) or other professional with appropriate expertise (e.g., certified industrial hygienist) for consultation on design specifications, installation, maintenance, and evaluation of environmental controls?	Yes **(No)**
Are environmental controls regularly checked and maintained with results recorded in maintenance logs?	**Not applicable**
Are AII rooms checked daily for negative pressure when in use?	**Not applicable**
Is the directional airflow in AII rooms checked daily when in use with smoke tubes or visual checks?	**Not applicable**
Are these results readily available?	**Not applicable**
What procedures are in place if the AII room pressure is not negative?	Regular isolation rooms
Do AII rooms meet the recommended pressure differential of 0.01-inch water column negative to surrounding structures?	**Not applicable**

8. Respiratory-Protection Program

Does your health-care setting have a written respiratory-protection program?	(Yes) No
Which HCWs are included in the respiratory protection program? (Check all that apply) ☑ Physicians o Mid-level practitioners (NPs and PAs) ☑ Nurses ☑ Administrators ☑ Laboratory personnel o Contract staff o Construction or renovation staff ☑ Service personnel o Janitorial staff ☑ Maintenance or engineering staff ☑ Transportation staff ☑ Dietary staff ☑ Students o Others (specify) _____	
Are respirators used in this setting for HCWs working with TB patients? If yes, include manufacturer, model, and specific application (e.g., ABC model 1234 for bronchoscopy and DEF model 5678 for routine contact with infectious TB patients). Manufacturer Model Specific application _____ _____ _____	
Is annual respiratory-protection training for HCWs performed by a person with advanced training in respiratory protection?	Yes (No)
Does your health-care setting provide initial fit testing for HCWs? If yes, when is it conducted? _____	Yes (No)
Does your health-care setting provide periodic fit testing for HCWs? If yes, when and how frequently is it conducted? _____	Yes (No)
What method of fit testing is used? Describe. _____ _____	
Is qualitative fit testing used?	**Not applicable**
Is quantitative fit testing used?	**Not applicable**

9. Reassessment of TB risk

How frequently is the TB risk assessment conducted or updated in the health-care setting?	**Data not available**
When was the last TB risk assessment conducted?	**Data not available**
What problems were identified during the previous TB risk assessment?	**Data not available**
What actions were taken to address the problems identified during the previous TB risk assessment?	**Data not available**
Did the risk classification need to be revised as a result of the last TB risk assessment?	Yes No

** If the population served by the health-care facility is not representative of the community in which the facility is located, an alternate comparison population might be appropriate.*

† Test conversion rate is calculated by dividing the number of conversions among HCWs by the number of HCWs who were tested and had prior negative results during a certain period (see Supplement, Surveillance and Detection of M. tuberculosis infections in Health-Care Settings).

Appendix C. Results Of AFB And GeneXpert among Adult Service Patients of PGH (April – August 2016)

		Emergency Medicine		Medicine		Surgery		Neuro-Psych	
AFB D1 Result	Negative	1	5.9%	8	21.6%	5	41.7%	1	100.0%
	1-29	7	41.2%	13	35.1%	2	16.7%	0	0.0%
	1+	3	17.6%	8	21.6%	1	8.3%	0	0.0%
	2+	2	11.8%	2	5.4%	2	16.7%	0	0.0%
	3+	4	23.5%	6	16.2%	2	16.7%	0	0.0%
	Total	17	100.0%	37	100.0%	12	100.0%	1	100.0%
AFB D2 Result	Negative	4	44.4%	7	30.4%	5	55.6%	0	0.0%
	1-29	1	11.1%	8	34.8%	1	11.1%	0	0.0%
	1+	1	11.1%	2	8.7%	2	22.2%	0	0.0%
	2+	1	11.1%	3	13.0%	1	11.1%	0	0.0%
	3+	2	22.2%	3	13.0%	0	0.0%	1	100.0%
	Total	9	100.0%	23	100.0%	9	100.0%	1	100.0%
Xpert/Rif Result	Not detected	1	11.1%	2	8.3%	0	0.0%	0	0.0%
	Very low	5	55.6%	5	20.8%	2	33.3%	0	0.0%
	Low	0	0.0%	8	33.3%	1	16.7%	0	0.0%
	Medium	0	0.0%	2	8.3%	1	16.7%	0	0.0%
	High	3	33.3%	7	29.2%	2	33.3%	0	0.0%
	Total	9	100.0%	24	100.0%	6	100.0%	0	0.0%
Rifampicin Resistance	Not detected	7	87.5%	20	90.9%	5	83.3%	0	0.0%
	Resistance detected	0	0.0%	0	0.0%	1	16.7%	0	0.0%
	Indeterminate	1	12.5%	2	9.1%	0	0.0%	0	0.0%
	Total	8	100.0%	22	100.0%	6	100.0%	0	0.0%

Appendix D. Incidence of PTB among UP Manila and UP PGH Personnel (Based on UP Health Service Census)

	Personnel	2013	2014	2015
Clinical	Medical (physicians, nurses)	5	8	11
	Paramedical (Nursing attendants, Utility workers, Medical technologists, Radiologic technologists)	8	9	5
Non-clinical	Support Services	3	11	4
	UP Manila Staff	0	1	0
	UP Manila Students	5	10	11
Total		21	39	31

Appendix E. Selected Guidelines in the PGH Infection Control Manual[23]

Management of patients needing airborne precautions

1) placement of patient in a source isolation room
2) hand hygiene
3) use of respiratory protection using an N95 mask
4) limiting visitors
5) limiting patient movement and transport

Administrative Control Strategies for Patients with TB

1) early detection through low threshold of suspicion for a possible diagnosis of TB 2) early initiation of TB diagnostic work-up and efficient release of results
3) early initiation of adequate anti-TB medications
4) isolation of suspected or confirmed TB for at least 1 week in patients not suspected of MDR-TB and until discharge or until conversion of Sputum AFB to negative in patients suspected of MDR-TB
5) properly ventilated isolation rooms
6) and proper use of N95 masks by healthcare personnel exposed to patients with active TB