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Providing detailed information about latent tuberculosis and compliance with the PPD test among healthcare workers in Israel: A randomized controlled study

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KEYWORDS

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Abstract *Background:* The compliance of screening for latent tuberculosis (TB) with the tuberculin purified protein derivative (PPD) test is very low among healthcare workers (HCWs) in Israel.

Methods: This randomized controlled study uses the Health Belief Model (HBM) as a conceptual framework to examine whether providing more information about latent TB and the PPD test increases the response rate for PPD screening among HCWs. All candidate HCWs for latent TB screening were randomly allocated to one of the following two invitations to perform the PPD test: regular letter (control group, $n = 97$), and a letter with information about latent TB and the PPD test (intervention group, $n = 196$).

Results: 293 HCWs were included (185 nurses, and 108 physicians). Overall, 36 (12.3%) HCWs were compliant with the PPD test screening. Compliance with PPD testing in the intervention group was not statistically different from the control group, RR 0.87 (95% CI, 0.46–1.65).

Conclusions: Compliance for latent TB screening is low among HCWs in northeastern Israel. Providing detailed information about latent TB was not associated with

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increased test compliance. Understanding existing disparities in screening rates and potential barriers to latent TB screening among HCWs is important in order to move forward and successfully increase screening rates.

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1. Introduction

Tuberculosis (TB) infects about one third of the world's population, including roughly 9 million new diagnoses annually [1]. At present, TB is an emerging disease in Western countries, and the vast majority of TB cases occur in developing countries [2]. In the United States, the reported incidence of new TB cases was approximately 3.4 cases per 100,000 inhabitants [3]. Comparatively, in Israel, the incidence of active TB is around 5.8 per 100,000 inhabitants (about 425 new cases diagnosed annually), most of whom are foreign-born Israelis [4,5].

The risk of transmission of *Mycobacterium tuberculosis* is elevated among certain at-risk populations, including healthcare workers (HCWs) [1,6,7]. Patients with undiagnosed cases of active TB ultimately seek medical attention for their condition. Consequently, HCWs may come into contact with unknown and unsuspected cases of active TB [1,6,7]. They are then at an increased risk for acquiring latent TB, in which the immune system controls the *M. tuberculosis* bacteria, causing it to lie dormant in the body [6–8]. As a result, HCWs are also at an increased risk for developing active TB, which occurs when the immune system is no longer able to control the bacteria [6–8]. HCWs employed in certain departments (emergency room, intensive care, and internal medicine) are at an even greater risk of acquiring *M. tuberculosis* infection [6,7]. Given notable epidemiologic evidence that TB is a consequential occupational disease in the HCW population, the World Health Organization (WHO) recommends that HCWs with baseline negative test results should receive TB screening annually [9].

In Israel, TB screening tests are recommended for all new HCWs. Annual TB screening tests are recommended for HCWs who are at high risk of exposure to TB patients. Namely, HCWs employed in emergency rooms, intensive care units, internal medicine wards, radiology departments, and TB laboratories [6,7]. Annual testing is not recommended for HCWs with previously documented positive purified protein derivative (PPD) test. HCWs who are eligible for TB screening but refuse to be

tested are not suspended from their work or faced with other consequences. HCWs who test positive on the PPD test are referred to special TB clinics of the Ministry of Health for further investigation and treatment decisions [10].

The usual invitation letter for the PPD screening test at Ha'emek Medical Center of Afula consists of a single line inviting employees to be tested, followed by a statement of the screening clinic hours. Despite the convenience of at-work screening that is free of charge, compliance with the invitation among this population of HCWs is very low. According to the hospital registry, in the last few years only an average of 10% of eligible HCWs received a recommended Tuberculin skin test.

Previous research has demonstrated the value of initiatives such as personalized targeted mailing to increase screening rates among a range of audiences [11–14]. For instance, in a study looking at methods to increase mammography rates among women, participants were randomized into a two-step intervention group (physician letter and peer counseling call) or a control group. More women in the intervention group than in the control group obtained mammograms (38% vs. 16%) [11]. Another study offered a sample of HIV-infected adults either a food voucher incentive or a patient education program to encourage tuberculin skin test performance. Return rates for PPD readings were 35% for the control group, 48% for the food voucher group, and 61% for the food voucher and patient education group [12].

The present study examines whether providing additional information about latent TB and the PPD test to the TB screening invitation letter increases test compliance among HCWs in Israel.

2. Materials and methods

2.1. Study design

The study was conducted at Ha'emek Medical Center, located in the northeastern region of Israel and serving a population of over 500,000 persons. Based on data from the hospital registry, the incidence of active TB at Ha'emek Medical Center

was 26 cases per 100,000 hospitalizations during the year of the study.

The local institutional review board and ethics committee approved the study; informed consent was not required for this study because the HCW clinic routinely uses an invitation letter to invite HCWs to perform the PPD test.

Participating HCWs were those annually invited to get a PPD test. Once-positive PPD test results remain positive in subsequent testing independent of whether the subject with a positive test was, or was not, treated. Thus, repeated testing in these subjects is not helpful in terms of preventative treatment decision-making [10,15]. HCWs with a prior history of a positive skin test were therefore not invited for screening and were ineligible for the study. Candidate HCWs for the PPD test were randomly allocated with a 2:1 ratio into the intervention group and the control group. Random assignment to each treatment group was performed according to a computer-generated blocked randomization schedule using Research Randomizer. The schedule was prepared by an independent statistician who was not involved in the study. Participants were not informed that a study was taking place, and the investigators did not have contact with study participants during the study period.

The intervention group consisted of HCWs who were invited to perform the PPD test with a detailed letter explaining the severity of TB infection, the importance of the test for hospital employees, and the possibility of exposure to TB without immediate presence of symptoms. The control group consisted of HCWs who were invited to perform the PPD test with the usual invitation letter, which is a single-line letter without explanation.

According to the random allocation, each HCW ($n = 293$) received a letter inviting him or her to the PPD test. The letters were distributed during the workday through the inter-hospital post. All forms of the letter informed HCWs of the period during which they could get tested, as well as the days and times they could visit the screening clinic.

2.2. Theoretical framework

The Health Belief Model (HBM) was the theoretical framework used to guide the development of the detailed invitation letter in the study. The HBM is one of the most broadly used conceptual frameworks for understanding health behavior, including screening behaviors [16–19]. The framework of the HBM was chosen because of the substantial empirical support it has acquired over time and because of its application to this study [16]. The HBM is used

to assess individual motivations for adopting a health-related behavior, and to develop health-behavior interventions. The model is based on the understanding that a person will perform a behavior (e.g., get screened for TB) if they: perceive that a negative health condition (e.g., TB) can be avoided, believe that by taking a recommended action, they will avoid a health problem (e.g., getting screened for TB will effectively detect whether he or she has latent TB infection so they can prevent it from progressing to active TB), and believe that they can effectively take a recommended health action (e.g., they feel confident in their ability to get screened) [20].

The particular facts included in the detailed letter in this study reflect specific constructs from the HBM. The model includes six key constructs that influence health behaviors: perceived susceptibility (an individual's assessment of their risk of getting the disease), perceived severity (an individual's assessment of the seriousness of the disease and its possible consequences), perceived benefits (an individual's beliefs regarding the effectiveness of available action to reduce the threat of a given disease), perceived barriers (an individual's assessment of the obstacles in the way of adopting a behavior), cues to action (a signal that inspires an individual to take action), and self-efficacy (an individual's assessment of his or her ability to adopt a particular behavior) [16,20]. With existing evidence of the relationship between the HBM constructs and screening behavior [17–19], rather than assess which of these constructs was most effective in promoting TB screening, each construct was used to guide the development of the detailed letter. In this study, the detailed invitation letter included all six constructs, with a specific focus on perceived susceptibility, perceived severity and perceived benefits. These constructs were focused on in particular because of their relevance to this population of HCWs. It is believed that each individual's perceived susceptibility to TB, perceived severity of the consequences of acquiring TB, and the benefits of performing a screening test may be particularly influential in encouraging the uptake of a recommended screening test.

2.3. The PPD test

Skin testing was completed through intradermal injection using an insulin syringe of 0.1 ml purified protein derivative (PPD) on the interior of the forearm. HCWs were asked to return to the clinic after 72 h for reading and interpretation of the induration at the site of injection. The infectious disease

nurse who conducted the screening test recorded each compliant worker's name and test results. The HCW clinic nurse was blinded to the type of letter each HCW received. Since the nurse has limited contact with the HCWs, it is unlikely that the nurse had contact with participant HCWs prior to the study period. She was instructed not to inform participants about the study and not to contact them about PPD testing during the study period. The form of the letter each worker received was noted and later analyzed.

2.4. Statistical analysis

All of the 293 candidate HCWs for the annual PPD test were included in this study (197 in the

intervention group, and 96 in the control group). Considering the usual 10% compliance with the PPD test in our medical center, this sample size has a power of 80% to detect an absolute increase of 15% in the compliance for PPD testing in the intervention group. Hence, this small sample size does not have the power to detect a difference in the compliance of less than 15%. However, a small difference in compliance may still be clinically meaningful, especially with the use of an intervention that is easy to implement (e.g., the one used in the present study).

The relative risk (RR) along with a 95% confidence interval was calculated to estimate the association between the intervention and compliance

Table 1 Baseline characteristics of healthcare workers invited to perform the PPD test stratified by type of invitation, Ha'emek Medical Center, Israel ($n = 293$).

| Variable | All ($n = 293$) | Type of invitation letter for the PPD test | | P value |
|------------------------|----------------------|--|-------------------------------------|---------|
| | | Control group ($n = 97$) | Intervention group ($n = 196$) | |
| Gender | | | | 0.852 |
| Females | 176 (60.1%) | 59 (60.8%) | 117 (59.7%) | |
| Males | 117 (39.9%) | 38 (39.2%) | 79 (40.3%) | |
| Ethnicity | | | | 0.920 |
| Arabs | 119 (40.6%) | 39 (40.2%) | 80 (40.8%) | |
| Jews | 174 (59.4%) | 58 (59.8%) | 116 (59.2%) | |
| Profession | | | | 0.950 |
| Nurses | 185 (63.1%) | 61 (62.9%) | 124 (63.3%) | |
| Physicians | 108 (36.9%) | 36 (37.1%) | 72 (36.7%) | |
| Age (Mean \pm SD) | 38.6 \pm 10.5 | 38.3 \pm 10.3 | 39.1 \pm 10.6 | 0.512 |

Table 2 The association between intervention and compliance with PPD testing stratified by demographic subgroups, Ha'emek Medical Center, Israel ($n = 293$).

| Variable | Compliance with PPD testing | | RR (95% confidence interval)* |
|-------------|-----------------------------|-------------------|-------------------------------|
| | Intervention group (%) | Control group (%) | |
| Gender | | | |
| Females | 12.0 | 11.9 | 1.01 (0.43–2.36) |
| Males | 11.4 | 15.8 | 0.72 (0.28–1.88) |
| Ethnicity | | | |
| Arabs | 6.3 | 12.8 | 0.49 (0.15–1.58) |
| Jews | 15.5 | 13.8 | 1.12 (0.52–2.4) |
| Profession | | | |
| Nurses | 13.7 | 11.5 | 1.20 (0.52–2.72) |
| Physicians | 8.3 | 16.7 | 0.50 (0.17–1.44) |
| Age** | | | |
| <36 (years) | 11.2 | 12.5 | 0.90 (0.35–2.32) |
| >36 (years) | 12.1 | 14.3 | 0.85 (0.36–2.0) |

* The RR for performing the PPD test in the intervention group compared to the control group.

** This cut point represents the median age.

Table 3 Multivariate analysis for the association of healthcare worker characteristics with PPD testing, Ha'emek Medical Center, Israel ($n = 293$).

| Variable | OR (95% confidence interval) |
|--------------------|------------------------------|
| Gender | |
| Females | Reference |
| Males | 1.98 (0.80–4.87) |
| Ethnicity | |
| Arabs | Reference |
| Jews | 2.86 (1.07–7.62) |
| Profession | |
| Nurses | Reference |
| Physicians | 0.71 (0.31–1.65) |
| Age* | |
| <36 (years) | Reference |
| >36 (years) | 0.86 (0.38–1.96) |
| Study group | |
| Control group | Reference |
| Intervention group | 0.84 (0.40–1.76) |

* This cut point represents the median age.

to perform the PPD test. Multivariate logistic regression analyses were used to identify predictors for compliance with PPD testing based on age, gender, profession (physicians vs. nurses), and ethnicity (Jew vs. Arab).

A P -value of less than 0.05 for the two-tailed test was considered statistically significant. All statistical analyses were performed using SPSS 18.0 (SPSS Inc., Chicago).

3. Results

All candidate HCWs for the annual PPD test at Ha'emek Medical Center ($n = 293$) were approached by an invitation letter and were included in the study. None of the participants were lost to follow-up, and all enrollees continued to be employed by Ha'emek Medical Center at the end of the study.

Overall, the mean age was 38.6 ± 10.5 , 176 (60.1%) HCWs were female, 185 (63.1%) were nurses, and 108 (36.9%) were physicians. The comparison of the baseline characteristics between the three intervention groups is presented in Table 1. Of the invited HCWs, 36 (12.3%) were compliant and performed the PPD test, and 29 (80%) of them were tested during the first 2 weeks of the study, the period during which they were asked to come in for testing. All compliers returned to the HCW clinic for the follow-up reading and interpretation of the test.

The compliance with PPD testing was not statistically different among the intervention group

compared with controls, RR 0.87 (95% CI, 0.46–1.65). On stratified analyses by demographic subgroups, the compliance with PPD testing was not different between the intervention group and the control group within each subgroup (Table 2). As stratification was done with small sample sizes, the confidence intervals are large, which suggests imprecise estimates.

Through multivariate analyses to assess HCW characteristics that are independently associated with PPD screening compliance, age, gender, profession (physicians vs. nurses), ethnicity (Jew vs. Arab), and type of intervention were studied. Only ethnicity was associated with compliance. Compared to Arabs, Jews were more likely to be compliant with PPD screening; OR 2.86 (95% CI, 1.07–7.62) (Table 3).

4. Discussion

Based on the results of this study, detailed information provided to Israeli HCWs about latent tuberculosis and the utility of the PPD screening test does not show an increased compliance rate of at least 15% between the intervention and control groups. Compliance for TB skin testing among the population at large is adversely affected by factors including patient understanding of the importance of the test, patient understanding of the test procedure, and cost [12]. However, despite providing detailed information on both of these elements and the test being free of charge, screening rates remained low in this study. The results may be explained by the fact HCWs may still not understand TB epidemiology and pathogenesis and may not be conscious of the consequences of latent TB [21]. Research suggests that a low perceived risk of TB among healthcare professionals, a belief that TB testing may be harmful, and the voluntariness of screening tests might decrease PPD test adherence [22]. It is also the case that unlike screening tests such as mammography or cholesterol measurement, the PPD test requires a follow-up visit within 72 h of initial application of PPD for interpretation of the results. This acts as another possible barrier to latent TB screening in this study population.

Extant research shows that providing education around screening, or incentives for screening behavior increases screening adherence [11–14]. Compared with motivational education and usual encouragement, monetary or nonmonetary incentives (coupons) were associated with higher return rates for PPD reading among drug users [13]. Moreover, a study among African-American patients compared the efficacy of a computer-delivered

tailored intervention to increase colorectal cancer screening with non-tailored print material. Tailored messages were developed using HBM constructs, which were also examined as outcomes. The tailored group had a greater decrease in barriers to screening, increased knowledge, and improved health beliefs at post-intervention than the control group [14]. In a systematic review of tuberculosis interventions, researchers analyzed the results of 11 randomized controlled trials, and concluded that some evidence demonstrates the benefit of material incentives to improve return rates for TB diagnostic test results [23]. Finally, a relatively new area in the field of health research is mobile health (m-health) technology. Recent developments have explored the innovative approach of m-health as a method to promote TB control through improved communication, strategic action, and education [24]. Applications of m-health to increase HCW compliance with the PPD test have not yet been tested and this could be an interesting and valuable avenue to pursue. All of those who initially came in for testing in this study population returned to the HCW clinic for a follow-up reading and interpretation of the test, but some of the methods addressed in these studies may successfully encourage compliance for both parts of the TB screening test. Incentivizing the screening test, or encouraging adherence to the screening test in some other way, may be beneficial to consider for future research initiatives. Importantly, at present, the data on incentives for TB compliance are limited to subpopulations of drug users, the homeless, and prisoners in the United States.

Notably, researchers Joshi and colleagues present relatively strong evidence that healthcare-associated TB is a problem among HCWs, and that reduction of the risk for infection should be a priority [25]. The incidence of TB is likely to decrease once infection-control measures such as mandatory TB screenings and TB disease training and education are introduced. If HCWs are required by law to undergo annual screening for TB (or annual health evaluation for those who already have latent TB), and repercussions for noncompliance include suspension from work without payment, PPD compliance rates will improve [15]. To implement this, infection-control measures for preventing the transmission of TB in Israeli healthcare facilities must be modified to require TB screening and basic TB training among HCWs.

This study has several limitations that must be acknowledged. First, the sample of HCWs included in the study was small. Thus, the intervention may be associated with a smaller increase in the

compliance rate. Still, this sample size had a power of 80% to detect and an absolute increase of 15% in the compliance for PPD testing in the intervention group compared with the control group. Additionally, the researchers were aware of which individuals were in the control and intervention groups, which could have led to bias in the results. However, the HCW clinic nurse was blinded to the randomization assignment and neither the investigators nor the HCW clinic nurse were in contact with the study participants prior to the study period. It is therefore unlikely that the nurse could have influenced the participants' decision to take the test. Given these conditions, the presence of performance bias in the study was minimized. Moreover, the study was confined to one medical center, which adversely affects the external validity of the study. Finally, as it consisted of whether the enrollees were compliant with PPD testing, the investigated outcome in this study was highly robust, decreasing the possibility of detection bias. In addition, compliance for the PPD test was established only 12 weeks after distribution of the invitation letters. This relatively short time frame may underestimate HCW compliance. However, it is unlikely to have a large effect on the results given that 80% of compliers were tested during the first 2 weeks following the invitation.

5. Conclusions

In conclusion, the overall compliance for latent TB screening is low among HCWs in northeastern Israel. In the present study, the detailed invitation letter did not have any resulting advantage over the regular invitation letter. Merely providing information about latent TB and the screening test is not associated with increased compliance to perform the PPD test among HCWs. Thus, alternative efforts of encouraging HCWs to be screened for latent TB should be explored. One possibility would be to try a more in-depth face-to-face effort of encouraging HCWs to be screened for latent TB or to implement a more departmentally focused intervention. As previously mentioned, another possibility is to enact a more rigorous screening program that requires HCWs to be screened.

Moreover, compared with Arabs, Jews were more likely to be compliant with PPD testing. Understanding existing disparities in screening rates, namely, between the Arab population and the Jewish population, and the potential barriers to latent TB screening among HCWs is essential in order to move forward and successfully increase screening rates. In addition, it is important to

recognize Israeli HCWs' current beliefs and attitudes towards TB screening. This knowledge will allow for a greater insight into how prospective screening interventions can be designed to better engage HCWs and successfully encourage them to get screened.

Indeed, future studies are needed in order to develop more effective strategies to increase adherence to latent tuberculosis screening recommendations among HCWs.

6. Author contributions

Danielle Taubman: (1) Substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; (2) Drafting the article and revising it critically for important intellectual content; and (3) Final approval of the version to be published. Nava Titler: (1) Substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; (2) Revising the article critically for important intellectual content; and (3) Final approval of the version to be published. Mazen Elias: (1) Substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; (2) Revising the article critically for important intellectual content; and (3) Final approval of the version to be published. Walid Saliba: (1) Substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; (2) Drafting the article and revising it critically for important intellectual content; and (3) Final approval of the version to be published.

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References

- [1] Pai M, Joshi R, Dogra S, Mendiratta DK, et al. Serial testing of health care workers for tuberculosis using interferon-gamma assay. *Am J Respir Crit Care Med* 2006;174:349–55.
- [2] Global Tuberculosis Report 2012. Geneva: World Health Organization; 2012.
- [3] CDC. Trends in tuberculosis—United States, 2011. *MMWR* 2012;61(11):181–5.
- [4] Tuberculosis country profiles-Israel. Geneva: World Health Organization; 2011. <<http://www.who.int/tb/data>> [accessed 20.05.2013].
- [5] Israeli Ministry of Health. Department of TB & AIDS. Tuberculosis, <<http://www.old.health.gov.il/pages/default.asp?maincat=28&catid=63&pageid=365>>; 2011 [accessed 20.05.2013].
- [6] Sherman HA, Karakis I, Heimer D, Arzt M, Goldstein W, Bouhnik L, et al. Housekeeping health care workers have the highest risk for tuberculin skin test conversion. *Int J Tuberc Lung Dis* 2011;15(8):1050–5.
- [7] Joshi R, Reingold A, Menzies D, Pai M. Tuberculosis among health-care workers in low-and middle-income countries: a systematic review. *PLoS Med* 2006;3:e494.
- [8] Harries AD, Dye C. Tuberculosis. *Ann Trop Med Parasitol* 2006;100(56):415–31.
- [9] World Health Organization. TB infection control in health care facilities, congregate settings, and households, <http://www.who.int/tb/health_systems/en/on>; 2012 [accessed 9.05.2012].
- [10] Israeli Ministry of Health. Recommendations for the prevention of tuberculosis among health care workers, <http://www.health.gov.il/hozer/bz02_2007.pdf>; 2007 [accessed 4.05.2013].
- [11] Janz NK, Schottenfeld D, Doerr KM, et al. A two-step intervention of increase mammography among women aged 65 and older. *Am J Public Health* 1997;87:1683–8.
- [12] Chaisson RE, Keruly JC, McAvinue S, et al. Effects of an incentive and education program on return rates for PPD test in patients with HIV infection. *J Acquir Immune Defic Syndr* 1996;11:455–9.
- [13] Malotte CK, Hollingshead JR, Rhodes F. Monetary versus nonmonetary incentives for TB skin test reading among drug users. *Am J Prev Med* 1999;16:182–8.
- [14] Rawl SM, Skinner CS, Perkins SM, Springston J, Wang HL, Russell KM, et al. Computer-delivered tailored intervention improves colon cancer screening knowledge and health beliefs of African-Americans. *Health Educ Res* 2013;27(5):865–8.
- [15] Jensen PA, Lambert LA, Iademarco MF, Ridzon R. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings. *MMWR Recomm Rep* 2005;54(RR-17):1–141.
- [16] Janz NK, Champion VL, Strecher VJ. The Health Belief Model. In: Glanz K, Rimer BK, Lewis FM, editors. Health behavior and health education: theory, research, and practice. San Francisco: Jossey-Bass; 2002. p. 45–66.
- [17] Tanner-Smith E, Brown T. Evaluating the Health Belief Model: A critical review of studies predicting mammographic and pap screening. *Soc Theory Health* 2010;95–125.
- [18] James A, Campbell M, Hudson M. Perceived barriers and benefits to colon cancer screening among African-Americans in North Carolina: how does perception relate to screening behavior? *Cancer Epidemiol Biomarkers Prev* 2002;11:529–34.
- [19] Hyman RB, Baker S, Ephraim R, Moadel A, Philip J. Health Belief Model variables as predictors of screening mammography utilization. *J Behav Med* 1994;17:391–406.
- [20] Janz NK, Becker MH. The Health Belief Model: a decade later. *Health Educ Behav* 1984;11:1–47.
- [21] Joseph HA, Shrestha-Kuwahara R, Lowry D, Lambert LA, Panillo AL, Raucher BG, et al. Factors influencing health care workers' adherence to work site tuberculosis screening and treatment policies. *Am J Infect Control* 2004;32(8):456–61.
- [22] Bratcher D, Stover BH, Lane NE, Paul RJ. Compliance with national recommendations for tuberculosis screening and immunization of healthcare workers in a children's hospital. *Infect Control Hosp Epidemiol* 2000;21:338–40.

- [23] Lutge EE, Wiysonge CS, Knight SE, Volmink J. Material incentives and enablers in the management of tuberculosis. *Cochrane Database Syst Rev* 2012(1).
- [24] Denkinger CM, Grenier J, Stratis AK, Akkihal A, Pant-Pai N, Pai M. Mobile health to improve tuberculosis care and control: a call worth making [Review article]. *Int J Tuberc Lung Dis* 2013;17(6):719–27.
- [25] Joshi R, Reingold AL, Menzies D, Pai M. Tuberculosis among health-care workers in low-and middle-income countries: a systematic review. *PLoS Med* 2006;3(12):e494.

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