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Active Community-Based Case Finding for Tuberculosis With Limited Resources: Estimating Prevalence in a Remote Area of Papua New Guinea

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Abstract

Papua New Guinea is one of the 14 highest-burden countries for tuberculosis (TB) infection, but few community-based studies exist. We evaluated a low-cost method of active community case finding in Kabwum and Wasu in Morobe Province, Papua New Guinea. Over 3 months we visited 26 villages and screened adults and children for symptoms and signs of TB. Sputum samples were examined using smear microscopy. A total of 1700 people had chronic symptoms, of which 267 were suspicious for TB on further examination. Sputum from 230 symptomatic adults yielded 97 samples that were positive for acid-fast bacilli. In addition, 15 cases of extrapulmonary TB in adults and 17 cases of TB in children were identified. One hundred and thirty people were identified with active TB disease among the source population of approximately 17 000, giving an estimated prevalence of 765 per 100 000. One hundred and six (82%) cases were not previously diagnosed. The cost per case identified was US$146. It is feasible to conduct active community-based case finding and treatment initiation for TB with limited resources and in remote areas, and in Papua New Guinea the yield was high. Active case finding and follow-up of treatment in villages is needed to address the hidden burden of TB in Papua New Guinea and other high-burden Asia Pacific countries.

Keywords

active case finding, tuberculosis, remote areas, Papua New Guinea, low-income countries, Pacific Island countries, prevalence survey

Background

Tuberculosis (TB) remains one of the greatest threats to global public health and development. At present about one third of the world's population is considered to be infected with *Mycobacterium tuberculosis*. Globally there are an estimated 9 million new cases every year and

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1.5 million deaths per year. More than half of those cases (56%) are in the South-East Asian and the Western Pacific regions.[1] An estimated 80 000 children die from TB every year.[2,3]

Papua New Guinea, in the Western Pacific region, has been recently added to the list of 14 countries worldwide with a combination of high burden of TB infection and disease, high rates of multidrug-resistant TB, and high rates of coinfection of HIV and TB.[4] Despite effective drug treatment for TB being available for decades, efforts to tackle the disease have been hampered by sociocultural barriers, the economic situation of the people who are most commonly affected, and poor health services in remote areas, including lack of outreach services.

Part of the problem is late diagnosis.[5] As TB is an indolent disease, people with limited access to health services often do not present to health facilities until they have well-established symptoms and have invariably infected many other people in their household or community.[6,7] In these circumstances, passive case detection at health facilities is unlikely to be fully effective in detecting and controlling the disease.[8]

Between 2012 and 2015, a high number of extrapulmonary TB (EPTB) cases were observed at Etep Rural Hospital in Morobe Province. This raised the suspicion of a high number of undetected pulmonary TB (PTB) cases in the community. According to the World Health Organization (WHO), 337 to 534 per 100 000 population are suffering from TB disease in Papua New Guinea.[9-11] A recent study in the Gulf Province of Papua New Guinea estimated a higher prevalence of 1290 per 100 000 population.[12]

The aims of the study were to investigate the feasibility of a low-cost method of active community case finding for TB in Kabwum and Wasu, remote areas in Morobe Province, Papua New Guinea. The model of active case finding included outreach visits to villages, systematic screening of people for symptoms, and sputum smear microscopy in villages. We aimed to evaluate the feasibility and costs of such an approach, the yield of new cases identified, and TB prevalence in the area.

Methods

Site of Study

The catchment area of Etep Hospital includes Wasu local-level government area (around 20 000 inhabitants, part of Tewai/Siassi district) and Kabwum district (around 50 000 inhabitants) in Morobe Province (see Figures 5 and 6 in the online appendix, available at http://aph.sagepub.com/content/by/supplemental-data). Thus, Etep hospital services a population of around 70 000 people according to the Papua New Guinea Census of 2010 with estimates for 2015.[13]

The area is very isolated; the villages have no connection to the main road network. Access to and from the provincial capital Lae is by air, by ship through Wasu station, and by foot across the Sarawaget range. A 4-wheel drive track connects the wharf at Wasu station to the mountainous areas of Kabwum district. This road is the only trade and traffic route within the area. While TB clinical diagnosis and treatment has been provided at Etep hospital, community-based TB programs have been carried out only to a limited extent in the area during the past decade.

The terrain stretches from the coast to densely inhabited areas in the mountains 2000 meters above sea level. People mainly live a subsistence lifestyle; cash income is generated from growing and selling cocoa and coffee. Access to health services is difficult; many community health posts are not functioning, and a journey of a day or more is needed from many villages to reach Etep Hospital.

Design

Twenty-six clusters (villages) with a total population of 17 000 people were selected by single-stage random sampling, including 8 coastal villages and 18 villages from mountainous areas, a ratio consistent with the population distribution in the area. The sampling was based on a prevalence of 750 per 100 000 (95% confidence interval [CI], relative precision of 25%, community participation of 90%, design effect 1.5). The size of each cluster was estimated to be within the range of 400 to 1000 people. We aimed to screen all people in the village.[14]

Community Awareness Raising, Screening, and Selection of Participants

Several days before each visit, the village elders, chiefs, counselors, and health aid-post supervisors were informed about the visit and the aims of the study through meetings and personal consultation. In all villages the visits were welcomed and the communities cooperated to a very large degree.

When we visited a village, a community meeting was held to further inform people about the purpose of the visit. Large turnouts occurred with at least half of the population generally taking part in the explanations about the survey and screening criteria. Those explanations were done in Tok Pisin (the lingua franca of Papua New Guinea) and translated into the local language. The screening symptoms of chronic cough, fever, weight loss, and abdominal distension were explained. In addition, a more detailed explanation of PTB and EPTB was given. Villagers with these symptoms self-identified, and these people were further screened for a possible diagnosis of TB with a detailed history and examination (Figure 3, online appendix, available at http://aph.sagepub.com/content/by/supplemental-data).

Data Recorded and Specimen Collection and Handling

Details of symptoms of TB were recorded, including the presence of productive cough, cough more than 3 weeks, hemoptysis, weight loss, fatigue, fever, and night sweats. Details of gender, age, and family history of TB were recorded. Other variables recorded included smoking habits, overcrowding in the houses, close spacing of houses, weather patterns, altitude, and access to water and sanitation.

People who screened positive to the possible symptoms or signs of TB had sputum collected. As far as manageable, 2 sputum samples were collected, one at the time of screening positive for symptoms and one the following morning. The sputum specimens were smeared on a microscope slide. The slides were examined after Ziehl-Neelsen staining for acid-fast bacilli (AFB) by an experienced laboratory technician from Etep Hospital (Figure 4, online appendix, available at http://aph.sagepub.com/content/by/supplemental-data). The results were classified as negative, scanty, 1+, 2+, or 3+ for AFBs. All positive results, including scanty, were considered as confirmation of TB disease in the context of a person with chronic respiratory symptoms.[15]

Cases with suspicious signs of EPTB were checked clinically by a medical doctor with much experience in dealing with TB.[16] Children were considered as suspicious for TB in case of a TB score above 7 according to the national guidelines, a positive family history, a thorough clinical examination, and exclusion of other possible causes, based on the recommendations of the International Union against TB and Lung Disease.[17] People diagnosed with TB were registered with the national TB program and followed-up as described below.[18]

Statistics and Ethics

For statistical analysis Epi-Info 7 software was used. The study was approved by the Medical Research Advisory Committee of the Papua New Guinea National Department of Health (MRAC Approval No. 16.15), the Papua New Guinea Lutheran Health Service, and the local district health office.

Results

TB Diagnoses and Prevalence Estimates

In community meetings, approximately 17 000 people from the 26 villages were informed about possible symptoms of TB. After volunteering that relevant symptoms were present, 1700 individuals underwent a further detailed history and clinical examination for signs of TB. Table 1 outlines the villages visited and the numbers of cases identified. Based on symptom screening and clinical examination, 267 people were suspected of having TB. Of these, 231 were suspected of having PTB, 15 suspected of having EPTB, and 21 children were suspected of having TB. Two hundred and thirty adults had sputum collected; 161 had 2 sputum samples collected, and 69 had only one sputum sample (Figure 1).

Ninety-seven people tested sputum smear positive for AFB: 38 scanty, 30 +, 17 ++, 5 +++. Ninety were previously undetected TB cases; 7 of the smear positive cases had previously tested as positive at Etep Hospital and were on TB treatment. In 43 patients, both sputum samples collected were positive.

Sixteen people who were on treatment during the time of the study (including 11 still smear positive cases) were included in the prevalence estimate. Eight other people, who had started TB treatment previously but had interrupted or ceased their treatment and had either highly suspicious signs of active TB or were still sputum positive (n = 6), were also considered as active cases.

A total of 113 adults (66 females and 47 males) and 17 children were diagnosed with active TB disease. Table 2 outlines the symptoms they presented with, and Figure 2 in the online appendix (available at http://aph.sagepub.com/content/by/supplemental-data) describes the different types of TB identified. Ninety-eight adults had PTB (97 smear positive and 1 patient who had highly consistent clinical signs of active TB but was unable to produce sputum), and 15 adults had EPTB. The adult EPTB cases were as follows: 8 cases of lymph-node TB, 3 cases of abdominal TB, 3 cases of spinal TB, and 1 case of genitourinary TB. Typical symptoms, including abdominal distention, ascites,[19,20] or kyphotic spinal deformity of Potts disease[21,22] or prolonged hematuria[23] in combination with a positive family history, persistent fever, and weight loss, were considered as highly suspicious for EPTB.

The prevalence of sputum smear positive adults in the district was 97 out of 10 700 adults, thus giving a prevalence of at least 0.9% or 900 per 100 000 (95% CI = 700-1100 per 100 000). When the 15 cases of EPTB in adults plus the 1 smear negative PTB case are added, the prevalence of TB among adults was 113 out of 10 717 adults or 1.05%. In this active case finding survey, EPTB made up 13.4% of all adult TB cases.

Seventeen children had strong clinical evidence of TB (spinal TB 4; abdominal TB 3; lymph node TB 7; systematic features of chronic fever, weight loss, and cough 3; all had a TB score >7).[18] The estimated child population is 6000, giving an estimated prevalence of at least 17/6000 or 300 per 100 000 (95% CI = 150-420 per 100 000).

The age distribution of adult TB cases was 16 to 30 years (19 cases; 17%); 21 to 45 years (36; 32%); 46 to 60 years (28; 25%), and over 60 years (30; 27%). Thirty-eight adults among the 113 adult patients diagnosed with TB reported a positive family history of TB. All children (17 out of 17) had a positive family history.

The total number of TB cases of 130 out of an all-age population of 17 000 (in the villages visited) resulted in a prevalence estimate of at least 765 per 100 000 (95% CI = 650-920 per 100 000).

The remainder of the approximately 1700 people who nominated as having symptoms were considered after thorough clinical examination and sputum microscopy not to have TB. The main complaints were lower back pain, joint pain, fever, and headache. In the coastal areas, a number of patients suffered from malaria and were treated accordingly. The alternative diagnoses for patients initially suspected for PTB on symptom screening, but who were sputum smear negative, are

Table 1. Estimated Populations and Cases of Tuberculosis Identified in the Community-Based Surveys.

Name of Village	Estimated Population	Adults	Children	PTB Adult	EPTB Adult	TB in Children	TB All Cases	Newly Detected Cases	Cases Already on Treatment	Previously Treated Cases Remained Sputum Positive	Total Population in Local-Level Government Area
Wasu LLG											17244
Sio-Nambariwa	492	320	172	1			1			1	
Sio-Lambutina	1182	757	425								
Sio-Leilo	761	481	280								
Ronji	402	252	150			1	1	1			
Singorokai	711	411	300			1	1	1			
Veluvelu	400	250	150	1	1		2		2		
Wawet	660	470	190								
Belombibi	659	419	240	2			2	2			
Komba LLG											18346
Geraun	504	304	200	17	3		20	18	2		
Indagen1	550	350	200	7		3	10	10			
Sikam	480	310	170	8			8	6	1	1	
Konge	543	353	190	13	3	3	19	13	5	1	
Kowaring-Malaman	536	346	190	4			4	3		1	
Ununu	618	368	250	6	4		10	8	1	1	
Wanam	476	300	176			1	1	1			
Timbe LLG											18234
Hem	595	345	250	6			6	6			
Yakub	582	342	240	1			1	1			
Yandu	1120	720	400	6		2	8	5	2	1	
Derimstation	474	310	164	4	1	1	6	5	1		
Selepet LLG											16144
Tipsit	700	450	250		1	2	3	3			
Indum1	1000	700	300	8		2	10	7	1	2	
Upat	507	330	177	5			5	5			
Sorong	667	467	200	3	1		4	3	1		
Wap	655	470	185	1			1	1			
Dengondo	667	450	217	1			1	1			
Dolo	682	442	240	4	1	1	6	6			
Total	16623	10717	5906	98	15	17	130	106	16	8	69968

Abbreviations: TB, tuberculosis; PTB, pulmonary tuberculosis; EPTB, extrapulmonary tuberculosis.

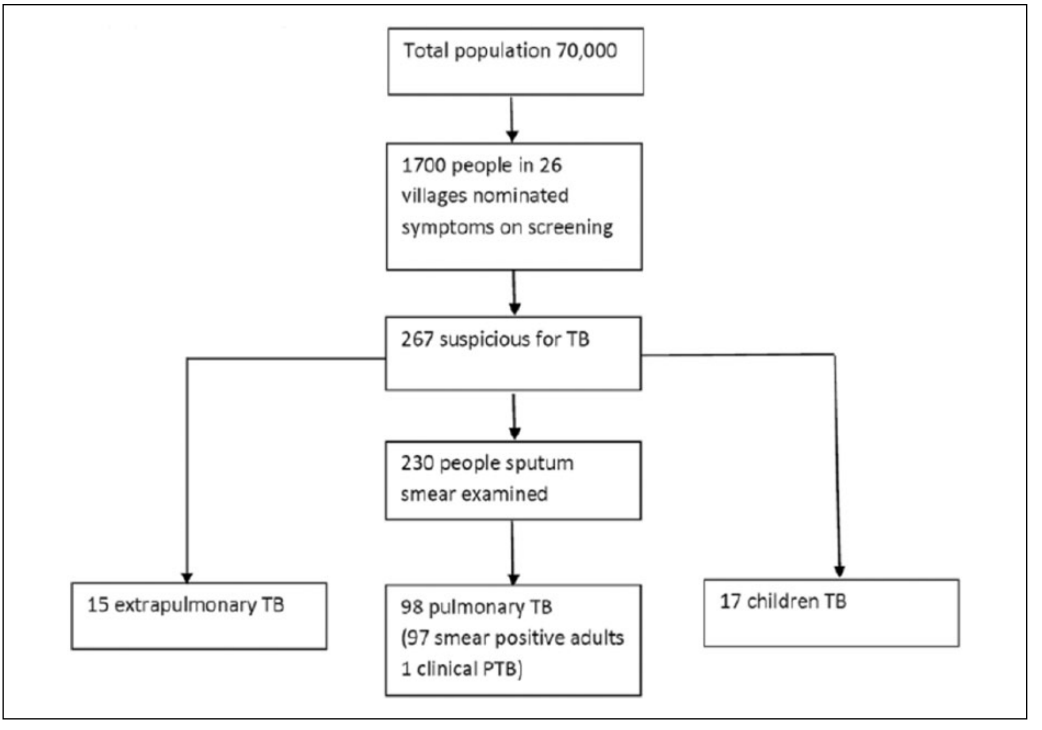

Figure 1. Total population to diagnoses.

listed in Table 3 (online appendix, available at http://aph.sagepub.com/content/by/supplemental-data). Many of these alternative diagnoses required attention, and those who could not be treated in the village were referred to Etep Hospital for further investigation or treatment.

Environmental Conditions and Geographical Differences

The houses in most villages in the mountainous area were built close together on ridges or on infrequent flat parts of the ground. The houses are thatched roofed and have little ventilation. They housed up to 25 people who sleep around the open fire-place used for cooking and warmth, and there is no chimney.

There are marked differences in environmental temperatures for the villages on the coast (mainly Wasu) and those in mountainous areas (mainly Kabwum district). At high altitudes, temperatures often are close to 0°C overnight, and wood fires burn 24 hours a day.

In the coastal areas, 5 out of 3360 screened adults or 0.15% were diagnosed with TB (150 per 100 000; 95% CI = 20-280). In the mountainous areas, 107 patients out of 7357 adults or 1.45% were diagnosed with TB (1450 per 100 000; 95% CI = 1200-1700).

Only a few villages had tap water or easy access to water. Typically, a walk of 10 to 15 minutes is necessary to reach the nearest water source. There are rain water tanks in many places but most are leaking and will not contain water during drier periods. Stream water is usually of good quality.

Follow-up and Treatment

After the survey was completed, several meetings were held with the staff of Etep Hospital, the district heads, and health staff of Kabwum and Tewai/Siassi districts. A list with all people

Table 2. The Symptoms in Adults With Tuberculosis (TB).

Clinical Symptoms	Number (%); N = 113
Cough >2weeks	100 (88%)
Productive cough	99 (88%)
Hemoptysis	14 (12%)
Weight loss	67 (59%)
Prolonged fever	46 (41%)
Night sweat	47 (42%)
Fatigue	61 (54%)

diagnosed with TB was provided to the provincial health office. A local task force planned the allocation of patients to 3 health centers and the provincial health office agreed to supply TB treatment kits. All TB patients are being offered HIV testing. Children under 5 years of age exposed to sputum smear positive family members will receive prophylaxis with 6 months of isoniazid.[24,25]

Cost and Resources Used in the Study

The WHO puts the costs for a prevalence survey at a range of US$1 million to US$4 million,[14] which is unaffordable in a decentralized health system like Papua New Guinea where the flow of funds to a district level is severely limited. We wanted to model a low-cost approach to active community-based case finding where a minimum prevalence estimate could be made. For conducting the surveys, 2 doctors, 2 laboratory technicians, 3 nurses, and a variable number of community health workers and helpers were involved. Three months (November 2015 until January 2016) were spent in the field; during 8 weeks 26 villages were visited. The total cost was Kina 56 900 (approximately US$17 070); see Table 4 online appendix (available at http://aph.sagepub.com/content/by/supplemental-data). The cost per case of TB detected was approximately Kina 438 (US$146). Further costs will be incurred during the treatment phases.

Discussion

This study shows that active community-based case finding is feasible on a limited budget and that the yield can be high. Newly detected cases and patients who had defaulted on treatment made up the majority of people with TB in this active community-based case finding study. We found 6.6 new cases for 1 case previously detected and on treatment (106 cases undetected, 16 detected and on treatment, plus 8 people who had defaulted on treatment). This indicates a maximum passive detection rate of 18% (less if patients who had defaulted on treatment are included). This is far less than the WHO estimate of an average detection rate for Papua New Guinea of 41%[2] and the World Health Assembly case detection aim of 70% of smear positive cases.

Active case finding was a key strategy to eliminate TB in Western countries, with such surveillance including chest radiograph and Mantoux testing.[26] However, the role of active TB case finding has been uncertain since the 1970s, with the WHO not recommending such an intervention to improve case detection, focusing more on improving treatment rates through Direct Observation Short-course Therapy (DOTS), and passive case detection based on symptoms at primary and referral health facilities.[26,27] In recent years, active case finding has been conducted in several high-burden countries, including Nepal, Cambodia, India, and Zimbabwe.[7,28,29] In remote areas of Papua New Guinea, chest radiographs are not even available at all district hospitals, and community-based radiography is not currently possible. With such limitations the role of a more limited approach using community-based symptom screening and sputum smear examination is less certain. However we have shown that it can be successful in substantial new case detection.

The costs required for community-based surveillance were relatively low, being US$146 per case detected. But constraints to the upscaling of such an approach lie with provincial and district health budgets, priorities, and the allocation of resources. Critical questions relate to the availability of staff and the payment of allowances. These are questions of cost-efficiency at district level and are significant constraints to rural service provision in Papua New Guinea.

In other countries there have been several methods of active community-based case detection of TB, including use of a mobile van that visits communities, or door-to-door screening.[29] Our method has similarities to the mobile van, although the lack of roads preclude taking a vehicle. The principle is a community meeting where public education is given rather than individual household door-to-door enquiry. In Zimbabwe, the mobile van/community meeting model was shown to result in superior case detection to door-to-door household screening.[29] It was believed this model provided increased opportunity for encouragement from others, and more time to decide to seek the intervention and find a convenient moment to do so.

The high prevalence estimate we found in these communities is similar to a recent study in the Gulf Province of Papua New Guinea,[12] although this study was based on passive case finding at a rural hospital and using diagnostic tools that included GenXpert MTB/RIF. In our study, the diagnosis of PTB in adults was largely based on smear positive cases to optimize specificity. Thus, a prevalence of 1.05% (sputum smear positive adults) is likely to be a minimum estimate.

The relative yield of active and passive case finding will depend on the burden of undiagnosed TB in any community compared to the number of cases diagnosed based on presentation to health services.[30] This will differ from country to country, and within regions and districts of a given country, and depends on geography, health service access, education, stigma, and other factors. In lower burden Pacific Island countries and countries in Asia where health service access and case detection is better, active community case finding will be less of a priority. For other countries with similar characteristics to Papua New Guinea, for example, Nepal, this approach is likely to be needed.

The proportion of cases of EPTB of all TB patients was relatively low (13.4%), but as the only tools to diagnose EPTB in the field were history and clinical examination, underdiagnosis of EPTB is possible. Underdiagnoses is also possible for children in community-based screening. On the other hand, given the nonspecificity of diagnostic criteria, overdiagnosis of children and adults with EPTB is also a risk of symptom-based screening. The staff involved in our study were experienced in the clinical diagnosis of TB in children. In active community-based case finding, it is important to have people with such skills and experience, especially to ensure that children are not put onto TB treatment unnecessarily.

Although we could not quantify the risk factors easily, overcrowding, smoky houses with poor ventilation in the mountainous areas, high rates of tobacco smoking and betel-nut chewing, poverty, limited water access, and poor hygiene are individual and environmental factors that have multiple adverse health risks, including the transmission of TB. Some or all of these factors were present in these communities.

Due to decay of prices of cash crops, poverty has increased in recent years, and many young men have left the villages and at times during the year are working or looking for jobs in different parts of the country. This may partly explain why there were more women detected with TB than men. Women generally spend more time inside houses, and this may increase their risk. Greater detection of TB in women through active community-based screening has been found in other studies also, and it is another reason why such an approach is needed.[31]

The longer hours spent indoors in poorly ventilated and smoke-filled houses may partially explain the higher prevalence of TB in the mountainous communities. However, prevalence in coastal areas may have been underestimated since some villages were not reached because of rough seas.

Follow-up

Such a survey must be followed-up with treatment if it is to have an effect on disease burden, TB transmission rates, and treatment completion rates. In Papua New Guinea, the DOTS strategy has not worked well, in part because it has not been implemented to the same degree or with the same degree of follow-up as in other countries. The strategies that have been successful in achieving high treatment completion rates in other countries have included patient and family education, roving TB outreach nurses who visit people in their homes and monitor adherence, and the provision of social, financial, and nutritional support to the most destitute patients.[32] In Papua New Guinea, these strategies have not been introduced, but are needed for a successful TB program that also includes active community-based TB case detection.

Limitations of the Approach

Community participation was high in all villages; however, some sick patients may have stayed in their houses during the survey visits. Although cups for sputum collection were given to people who identified that they had sick relatives, the quality of the returned sputum was often not satisfactory.

Neither sputum culture nor modern molecular methods such as GeneXpert MTB/RIF assays[26] could be used to confirm the results, or to explore rates of multidrug-resistant TB, and chest radiography was not feasible in these remote locations. We did not do HIV testing during the survey, but in follow-up activities the district health authorities are offering HIV testing to all who are diagnosed with TB.

Conclusion

A very high prevalence of undetected TB exists in this remote area of Papua New Guinea. Active community-based case finding was conducted on a significant scale with relatively limited means and local resources, identifying many new cases. This demonstrates that such case finding is possible even in very remote locations, and it is arguably the only way to uncover the true burden of TB and halt transmission, especially in areas where health service access is poor. This approach is needed in all provinces in Papua New Guinea, and in other high burden countries, and needs to be supported by a comprehensive approach to treatment and adherence. This has implications for resource allocation, the core activities of district health services, and health worker training.

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References

1. Viney K, Connor JO, Wiegandt A. The epidemiology of tuberculosis in Pacific Island countries and territories: 2000-2007. *Asia Pac J Public Health*. 2011;23:86-99. doi:10.1177/1010539510390671.
2. World Health Organization. *Global Tuberculosis Report 2015*. 20th ed. Geneva, Switzerland: World Health Organization; 2015.
3. World Health Organization. Tuberculosis. *Factsheet*. http://www.who.int/mediacentre/factsheets/fs104/en/. Published 2016. Accessed February 3, 2016.
4. World Health Organization. Use of high burden country lists for TB by WHO in the post-2015 era. http://www.who.int/tb/publications/global_report/high_tb_burdencountrylists2016-2020.pdf. Published 2015. Accessed April 5, 2016.
5. Shu W, Chen W, Zhu S, et al. Factors causing delay of access to tuberculosis diagnosis among new, active tuberculosis patients: a prospective cohort study. *Asia Pac J Public Health*. 2014;26:33-41. doi:10.1177/1010539513502523.
6. World Bank. What is the relationship between TB and poverty. http://www.stoptb.org/assets/documents/events/world_tb_day/2002/1Therelationship.pdf. Published 2002. Accessed April 5, 2016.
7. Sreeramareddy CT, Panduru KV, Menten J, Van den Ende J. Time delays in diagnosis of pulmonary tuberculosis: a systematic review of literature. *BMC Infect Dis*. 2009;9:91. doi:10.1186/1471-2334-9-91.
8. Borgdorff MW, Floyd K, Broekmans JF. Policy and practice interventions to reduce tuberculosis mortality and transmission in low- and middle-income countries. *Bull World Health Organ*. 2002;80:217-227.
9. World Health Organization. Papua New Guinea. http://www.wpro.who.int/countries/png/25PNGpro2011_finaldraft.pdf. Accessed February 18, 2016.
10. World Health Organization. Tuberculosis in the World Health Organization Western Pacific Region: 2012 report. http://www.wpro.who.int/tb/data/rr12/en/index2.html. Published 2012. Accessed February 12, 2016.
11. O'Connor J, Viney K, Wiegandt A. Tuberculosis surveillance in the Pacific Island countries and territories: 2009 report. https://www.spc.int/frp/index2.php?option=com_docman&task=doc_view&gid=169&Itemid=33. Published 2009. Accessed March 24, 2016.
12. Cross GB, Coles K, Nikpour M, et al. TB incidence and characteristics in the remote gulf province of Papua New Guinea: a prospective study. *BMC Infect Dis*. 2014;14:93. doi:10.1186/1471-2334-14-93.
13. National Statistical Office, Papua New Guinea. 2011 National Report (Census 2011). http://sdd.spc.int/en/resources/document-library?view=preview&format=raw&fileId=218. Accessed February 23, 2016.
14. World Health Organization. *Tuberculosis Prevalence Surveys: A Handbook*. Geneva, Switzerland: World Health Organization; 2011.
15. Dawson D, Mohammed A, Bretzel G, et al. *Technical Guide: Sputum Examination for Tuberculosis by Direct Microscopy in Low Income Countries*. 5th ed. Paris, France: International Union Against Tuberculosis and Lung Disease; 2000.
16. World Health Organization. Improving the diagnosis and treatment of smear-negative pulmonary and extrapulmonary tuberculosis among adults and adolescents: recommendations for HIV-prevalent and resource-constrained settings. http://www.who.int/tb/publications/2006/tbhiv_recommendations.pdf. Published 2007. Accessed August 10, 2015.
17. World Health Organization. Diagnosis of childhood TB. http://www.who.int/tb/challenges/ChildhhoodTB_section2.pdf?ua=1&ua=1. Accessed August 17, 2015.

18. Department of Health, Papua New Guinea. Papua New Guinea: national tuberculosis management protocol. http://www.adi.org.au/wp-content/uploads/2013/07/2011_NDOH_National-TB-Treatment-Protocol.pdf. Published 2011. Accessed November 30, 2016.
19. Sood R. Diagnosis of abdominal tuberculosis: role of imaging. *Indian Acad Clin Med*. 2001;2:169-177.
20. Sharma MP, Bhatia V. Abdominal tuberculosis. *Indian J Med Res*. 2004;120:305-315. doi:10.1136/gut.26.12.1275.
21. Kaptigau WM, Mamadi P, Kevau I. The management of spine pathology in Papua New Guinea. *P N G Med J*. 2007;50(12):87-90.
22. Garg RK, Somvanshi DS. Spinal tuberculosis: a review. *J Spinal Cord Med*. 2011;34:440-454. doi:10.1179/2045772311Y.0000000023.
23. Kapoor R, Ansari M, Mandhani A, Gulia A. Clinical presentation and diagnostic approach in cases of genitourinary tuberculosis. *Indian J Urol*. 2008;24:401-405. doi:10.4103/0970-1591.42626.
24. World Health Organization. *Treatment of Tuberculosis: Guidelines*. 4th ed. Geneva, Switzerland: World Health Organization; 2010.
25. World Health Organization. Pursue high-quality DOTS expansion and enhancement. http://www.who.int/tb/dots/en/. Accessed February 21, 2016.
26. Golub JE, Mohan CI, Comstock GW, Chaisson RE. Active case finding of tuberculosis: historical perspective and future prospects. *Int J Tuberc Lung Dis*. 2005; 9:1183-1203.
27. Murray CJ, Salomon JA. Expanding the WHO tuberculosis control strategy: rethinking the role of active case-finding. *Int J Tuberc Lung Dis*. 1998;2(9 suppl 1):S9-S15.
28. Eang MT, Satha P, Yadav RP, et al. Early detection of tuberculosis through community-based active case finding in Cambodia. *BMC Public Health*. 2012;12:469. doi:10.1186/1471-2458-12-469.
29. Corbett EL, Bandason T, Duong T, et al. Comparison of two active case-finding strategies for community-based diagnosis of symptomatic smear-positive tuberculosis and control of infectious tuberculosis in Harare, Zimbabwe (DETECTB): a cluster-randomised trial. *Lancet*. 2010;376:1244-1253. doi:10.1016/S0140-6736(10)61425-0.
30. Pronyk RM, Joshi B, Hargreaves JR, et al. Active case finding: understanding the burden of tuberculosis in rural South Africa. *Int J Tuberc Lung Dis*. 2001;5:611-618.
31. Yamasaki-Nakagawa M, Ozasa K, Yamada N, et al. Gender difference in delays to diagnosis and health care seeking behaviour in a rural area of Nepal. *Int J Tuberc Lung Dis*. 2001;5:24-31.
32. Meressa D, Hurtado RM, Andrews JR, et al. Achieving high treatment success for multidrug-resistant TB in Africa: initiation and scale-up of MDR TB care in Ethiopia—an observational cohort study. *Thorax*. 2015;70:1181-1188.

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