

LONDON  
SCHOOL of  
HYGIENE  
& TROPICAL  
MEDICINE



von Delft, A; Dramowski, A; Khosa, C; Kotze, K; Lederer, P; Mosidi, T; Peters, JA; Smith, J; van der Westhuizen, HM; von Delft, D; Willems, B; Bates, M; Craig, G; Mæurer, M; Marais, BJ; Mwaba, P; Nunes, EA; Nyirenda, T; Oliver, M; Zumla, A (2014) Why healthcare workers are sick of TB. *International journal of infectious diseases* , 32. pp. 147-51. ISSN 1201-9712 DOI: 10.1016/j.ijid.2014.12.003

Downloaded from: <http://researchonline.lshtm.ac.uk/2228427/>

DOI: [10.1016/j.ijid.2014.12.003](https://doi.org/10.1016/j.ijid.2014.12.003)

#### Usage Guidelines

Please refer to usage guidelines at <http://researchonline.lshtm.ac.uk/policies.html> or alternatively contact [researchonline@lshtm.ac.uk](mailto:researchonline@lshtm.ac.uk).

Available under license: <http://creativecommons.org/licenses/by-nc-nd/2.5/>



## Why healthcare workers are sick of TB



Arne von Delft<sup>a,b,\*</sup>, Angela Dramowski<sup>a,c</sup>, Celso Khosa<sup>a,d</sup>, Koot Kotze<sup>a,e</sup>, Philip Lederer<sup>a,f</sup>, Thato Mosidi<sup>a,g</sup>, Jurgens A. Peters<sup>a</sup>, Jonathan Smith<sup>a,h,i,j</sup>, Helene-Mari van der Westhuizen<sup>a,e</sup>, Dalene von Delft<sup>a</sup>, Bart Willems<sup>a,e</sup>, Matthew Bates<sup>k</sup>, Gill Craig<sup>l</sup>, Markus Maeurer<sup>m</sup>, Ben J. Marais<sup>n</sup>, Peter Mwaba<sup>k</sup>, Elizabete A. Nunes<sup>o</sup>, Thomas Nyirenda<sup>p</sup>, Matt Oliver<sup>q</sup>, Alimuddin Zumla<sup>a,r</sup>

<sup>a</sup> TB Proof

<sup>b</sup> School of Public Health and Family Medicine, Faculty of Health Sciences, University of Cape Town, Observatory, 7925, South Africa

<sup>c</sup> Paediatric Infectious Diseases, Department of Paediatrics and Child Health, Stellenbosch University, Cape Town, South Africa

<sup>d</sup> Instituto Nacional de Saúde, Ministry of Health, Maputo, Mozambique

<sup>e</sup> Division of Community Health, Stellenbosch University, Cape Town, South Africa

<sup>f</sup> Division of Infectious Diseases, Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts, USA

<sup>g</sup> Wits Health Consortium, Respiratory and Meningeal Pathogens Unit, Johannesburg, South Africa

<sup>h</sup> Department of Epidemiology, Emory Rollins School of Public Health, Atlanta, Georgia, USA

<sup>i</sup> Department of Epidemiology of Microbial Diseases, Yale School of Public Health, New Haven, Connecticut, USA

<sup>j</sup> Visual Epidemiology, New Haven, Connecticut, USA

<sup>k</sup> UNZA-UCLMS Project, University Teaching Hospital, Lusaka, Zambia

<sup>l</sup> Senior Lecturer, City University London, London, UK

<sup>m</sup> Karolinska Institute, Stockholm, Sweden

<sup>n</sup> The Children's Hospital at Westmead and the Marie Bashir Institute for Infectious Diseases and Biosecurity (MBI), The University of Sydney, Sydney, Australia

<sup>o</sup> Maputo Central Hospital, Maputo, Mozambique

<sup>p</sup> European and Developing Countries Clinical Trials Partnership (EDCTP), Cape Town, South Africa

<sup>q</sup> UK All Party Parliamentary Group on Global TB, London, UK

<sup>r</sup> Division of Infection and Immunity, University College London, and NIHR Biomedical Research Centre, at University College London Hospital, London, UK

### ARTICLE INFO

#### Article history:

Received 15 November 2014

Accepted 1 December 2014

**Corresponding Editor:** Eskild Petersen, Aarhus, Denmark

#### Keywords:

Tuberculosis (TB)

Multidrug- & Extensively Drug-Resistant TB

(MDR-TB & XDR-TB)

Healthcare worker (occupational)

Infection control

Prevention

Stigma

### SUMMARY

Dr Thato Mosidi never expected to be diagnosed with tuberculosis (TB), despite widely prevalent exposure and very limited infection control measures. The life-threatening diagnosis of primary extensively drug-resistant TB (XDR-TB) came as an even greater shock. The inconvenient truth is that, rather than being protected, Dr Mosidi and thousands of her healthcare colleagues are at an increased risk of TB and especially drug-resistant TB. In this viewpoint paper we debunk the widely held false belief that healthcare workers are somehow immune to TB disease (TB-proof) and explore some of the key factors contributing to the pervasive stigmatization and subsequent non-disclosure of occupational TB. Our front-line workers are some of the first to suffer the consequences of a progressively more resistant and fatal TB epidemic, and urgent interventions are needed to ensure the safety and continued availability of these precious healthcare resources. These include the rapid development and scale-up of improved diagnostic and treatment options, strengthened infection control measures, and focused interventions to tackle stigma and discrimination in all its forms. We call our colleagues to action to protect themselves and those they care for.

© 2014 The Authors. Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-SA license (<http://creativecommons.org/licenses/by-nc-sa/4.0/>).

### 1. Introduction

Tuberculosis (TB) in all its forms is a major occupational hazard for healthcare workers (HCWs) worldwide.<sup>1,2</sup> The transmission of

drug-sensitive and drug-resistant (DR) strains of *Mycobacterium tuberculosis* occurs through infected droplets aerosolized by patients with active pulmonary TB. The transmission risk to HCWs is highest when patients have unrecognized TB or are receiving inappropriate treatment.<sup>3</sup> However many other factors influence the risk of transmission and progression to active disease, including healthcare setting, occupational category, individual susceptibility/immune status, and the adequacy of TB infection

\* Corresponding author. Tel.: +27 72 6992473.

E-mail address: [vuzumsi@gmail.com](mailto:vuzumsi@gmail.com) (A. von Delft).

control (IC) measures. In recent years there have been alarming increases in drug-resistant TB in some populations, and multi-drug-resistant TB (MDR-TB: resistance to at least rifampin and isoniazid) and extensively drug-resistant TB (XDR-TB: as for MDR-TB plus resistance to a quinolone and one other injectable drug) together pose a colossal yet overlooked public health threat. We relate some personal experiences of HCWs who have been affected by TB, explore factors that increase the risk, and discuss the lack of an effective global response to the growing problem of DR-TB.<sup>4</sup>

## 2. Not TB-proof after all: a healthcare worker's encounter with XDR-TB

“There’s blood in the basin” Dr Thato Mosidi told her husband, while trying to suppress the urge to cough again. Although she had never had TB, she knew the symptoms. Driving to the consultation with her physician in Johannesburg, South Africa, she was calm, secure in the knowledge that TB was curable and that as a healthy young physician, there was little to worry about. A few weeks later her physician called to break the terrible news: she had XDR-TB. It was not until this moment that she realized the gravity of her condition. “I could die” she told her husband, weeping as she hung up the phone.

This is the typical response of a HCW diagnosed with DR-TB. What follows in the long months to years of therapy, is a slow realization of how this diagnosis changes one’s life irrevocably: the debilitating adverse effects associated with treatment, stigma in the community, but also from colleagues and even family, the risk of transmission to your loved ones, financial hardship, and career limitations. And the lingering question: “I’m supposed to be safe, what did I do wrong?”

## 3. Treating our way to incurable TB

Why would a HCW worry about dying from a disease that is considered curable? Despite notable gains in increasing access to treatment, 1.5 million people still lose their lives to TB every year.<sup>4</sup> In addition, the World Health Organization (WHO) has estimated that there are 3 million incident TB cases that go undiagnosed and untreated every year, perpetuating transmission. For those who are diagnosed with TB, presentation to healthcare is often delayed, with an average 2-month interval between symptom onset and the start of effective therapy.<sup>5</sup> Ongoing transmission is also facilitated by the lack of a rapid, point-of-care test to confirm the diagnosis of TB, and a rapid follow-on test for the specific drug-susceptibility of the bacteria.

Increasingly, our ability to cure TB is under threat from highly transmissible DR-TB strains.<sup>6</sup> In 2013, an estimated 480 000 people developed MDR-TB globally; however less than 30% of cases were detected, notified, and appropriately managed by TB programmes.<sup>4</sup> Tugela Ferry (a rural community in South Africa) made international headlines in 2006, when a cluster of XDR-TB patients with unprecedented nosocomial transmission and mortality rates was described,<sup>7</sup> emphasizing the importance of infection control and well-functioning TB control programmes.<sup>8</sup> Since then, the global ‘emergency response’ has been decidedly underwhelming: XDR-TB has been reported in 100 countries, every country where extensive screening has been undertaken.<sup>4</sup> Definitions of DR-TB beyond XDR are controversial, but the reality is that many of these patients suffer from incurable TB. Well-intentioned, yet woefully inadequate attempts at treating them have resulted in strains resistant to every TB drug tested.<sup>9–11</sup>

## 4. What does it mean if we can’t treat TB?

Multiple treatment-related factors are implicated in the creation of increasingly drug-resistant TB strains,<sup>12,13</sup> but the main driver of the global pandemic is underappreciated: the fact that the spread of *M. tuberculosis* (and DR-TB) is airborne and we all need to breathe! Primary person-to-person transmission now accounts for up to three quarters of DR-TB cases.<sup>14,15</sup>

In the absence of a protective TB vaccine, the value of *effective* treatment as prevention cannot be overstated.<sup>3</sup> Unfortunately the vast majority of MDR-TB patients do not have access to appropriate treatment: only 20% of estimated MDR-TB cases started on second-line treatment in 2013 globally.<sup>4</sup> For XDR-TB the scenario is even worse. A recent prospective cohort study in South Africa reported that after 5 years of follow-up, only 11% of patients were cured or had completed treatment. The remainder of the cohort either died (73%) or failed treatment (10%). The median survival of patients with XDR-TB who had failed treatment and were discharged back home was almost 20 months. This is a matter of grave concern: the prolonged transmission of essentially incurable TB amongst families, the community, and at healthcare facilities.<sup>10</sup> These dismal outcomes may result in even greater delays in seeking care, as communities perceive treatment of DR-TB as futile and the diagnosis as a death sentence.

## 5. The burden of TB exposure in HCWs

Why did Dr Mosidi fall victim to DR-TB while believing that she was at low risk of acquiring a serious occupational disease? Was this transmission episode a rare example of failed TB infection control measures? Or was she just unlucky and exposed at random? Neither. The alarming reality is that she was led to believe that she, and all of her ‘healthy’ colleagues, were somehow immune to TB or ‘TB-proof’ – a phenomenon characterized by a heightened awareness of the disease among others, but a low perception of self-risk. An alternative explanation may be that the HCW’s perception of risk is gradually eroded by habituation to the risks of working in a TB-endemic setting.<sup>16</sup>

While many HCWs are rightfully afraid of catching TB from their patients in crowded hospital wards and clinics, they develop psychological defence and coping mechanisms to face work every day. We frequently hear seniors say to younger trainees, “Why are you wearing that (N95) mask? I have worked here for many years and have never gotten TB.” Nervous laughter ensues, and the trainee’s respirator is absent the next day. That attitude of ‘battle-hardened’ invincibility often filters down to younger HCWs, who internalize these reassuring but false beliefs. But as cases of occupational TB grow, and occupational DR-TB is disclosed, this tension between denial and recognition of danger continues to grow.

A systematic review of TB incidence in low- and middle-income countries estimated the annual risk of TB infection in HCWs to range from 3.9% to 14.3% (with between 2.6% and 11.3% attributable to occupational exposure).<sup>17</sup> A subsequent meta-analysis estimated that the average annual risk of developing TB disease was three times higher (95% confidence interval 2.43–3.51) for HCWs (across all settings) compared to the general population.<sup>18</sup> A delay in DR-TB diagnosis, less effective treatment for DR-TB, and longer periods of healthcare contact for DR-TB patients, increase the potential for transmission of DR-TB strains to HCWs. Accordingly, HCWs are up to six times more likely to be hospitalized for DR-TB than the population they care for (incidence rate ratio 5.46 for MDR and 6.28 for XDR).<sup>19</sup> Furthermore, HCWs with DR-TB are diagnosed late and have poor treatment outcomes, even when HIV-uninfected.<sup>20,21</sup>

## 6. The stain of stigma

Stigma, fed by a combination of fear and denial, aggravates delays in diagnosis and treatment, and sustains an unspoken culture of ‘don’t ask, don’t tell’.<sup>22</sup> When HCWs contract TB and are (eventually) diagnosed, they frequently seek treatment secretly. They dread public disclosure of their TB diagnosis, fearing a backlash from colleagues, who themselves are afraid of contracting TB. Among TB patients, it has been shown that disclosure is more likely to occur when the patient is assured that they will not be stigmatized.<sup>23</sup>

HIV is the elephant in the room when discussing stigma and TB in HCWs. In Sub-Saharan Africa, TB and HIV are inexorably linked in the minds of many people.<sup>24,25</sup> If a HCW discloses that they have TB, the reaction of many colleagues is to wonder, or even openly discuss, if that individual could be co-infected with HIV. The psychological effort involved in concealing illness to avoid (valid fears) of further discrimination can be detrimental.<sup>26</sup> Therefore, almost as a rule, they do not disclose their HIV status, even though they are at an even greater risk of TB and could potentially reduce this risk with the use of antiretrovirals, additional IC measures, and/or alternative work placements.

Career implications of a TB diagnosis also play a role in discouraging disclosure and driving stigma. Healthcare work in developing countries is challenging, with generally low salaries and poor working conditions.<sup>27</sup> Many HCWs are at the mercy of the public sector and can be fired or re-assigned if they complain about working conditions. This prevents HCWs from disclosing their TB diagnoses and advocating for safer working conditions, thus fuelling the vicious cycles of misinformation, discrimination, and unchecked TB transmission in health facilities. Migrant HCWs in high income countries may also be reluctant to disclose a TB diagnosis in the face of stigma and their limited entitlement to sickness pay/social welfare due to restrictions on their immigration status.

## 7. Hope for new and improved treatment options

Thankfully Dr Mosidi (in stark contrast to 75% of her fellow South Africans with XDR-TB), did not die. She culture-converted, along with 48 out of 58 other pre-XDR and XDR-TB patients in the same novel clinical access programme (Ndjeka, 45<sup>th</sup> Union Conference, Late Breaker Presentation, 2014). This dramatic difference can be attributed to access to two new drugs: linezolid, a repurposed broad-spectrum Gram-positive antibiotic, and bedaquiline, the first new TB drug developed in 42 years. Unfortunately neither drug is without controversy, with major cost implications for TB programmes and a host of serious proven (and potential) drug-related adverse effects.<sup>28–30</sup> However for patients with a potentially lethal disease, these are costs and risks worth taking.

Delaying access to novel therapies can have dire consequences for patients, but also for the healthcare workforce, as highlighted not only by alarming HCW mortality rates, but also the high prevalence of irreversible and career-ending side-effects, like deafness.<sup>31,32</sup> It is therefore crucially important to fast-track the development of and access to rapid TB diagnostics, novel compounds, and, most importantly, new drug combinations that may slow the transmission of DR-TB by providing more rapidly bactericidal therapy.<sup>3</sup> These innovations could save lives and protect those who care for patients. There is currently no effective and accepted pre- or post-exposure prophylaxis for DR-TB. Isoniazid preventative therapy (IPT) has limited evidence of protection against DR-TB transmission, but data supporting the long-term use of IPT are scarce.<sup>33</sup> This is a major problem, especially for HCWs living with HIV, who at present rely only on

optimized HIV care and where feasible (and status disclosed), alternative work placement.

On a personal level, DR-TB treatment failure decimates family and community structures. DR-TB sufferers live in fear of infecting their loved ones and are often ostracized by their communities. The currently available treatment regimens can be more debilitating than the disease. In addition, for many DR-TB sufferers, the impossible ‘choice’ between adherence and keeping food on their families’ tables is a reality. Additional resources for new preventative and curative therapies, improved patient support, and prevention of household and community transmission of DR-TB are urgently needed.

## 8. Safety first: improving implementation of TB infection control measures

How can Dr Mosidi and her colleagues claim back a safe working environment? The pre- (and post-) antibiotic solution is rigorous implementation of TB IC programmes. This goal is achievable, even in countries with resource limitations.<sup>34</sup> Unfortunately the resources for and implementation of TB IC are often poorest in countries with the greatest TB burden. Two recent South African studies found less than 50% compliance with IC recommendations<sup>35</sup> and that 55% of HCWs did not wear personal respiratory protective equipment when indicated.<sup>36</sup>

Improved access to information on TB infection risk has been shown to influence HCWs IC practices and behaviours.<sup>37</sup> Behavioural change theories are valuable yet underutilized tools to help change attitudes and practices.<sup>38</sup> We need to learn from our HIV colleagues: the personal touch matters. By sharing their stories, occupational TB survivors like Dr Mosidi have not only helped debunk the ‘TB-proof’ fallacy and raise much needed awareness about the importance of TB IC, but have also mobilized resources to address broader priorities such as access to new drugs and improved patient support.<sup>39</sup> In addition to addressing the issue of occupational TB, improved IC measures have potential to avert a broad range of nosocomial infections, with additional patient and financial benefits.

The appalling Ebola virus disease (EVD) outbreak has been a painful reminder of the frailty of our IC systems, and there are no quick fixes: administrative controls should allow for screening and cohorting of symptomatic patients, surgical masks for coughing patients, and access to rapid reliable diagnostics. These controls should also include regular occupational TB screening, appropriate support, employment security, and compensation for HCWs with TB. Managers should be accountable for preventable nosocomial spread of disease, with designated IC officers at all facilities. Pragmatic environmental measures such as ensuring adequate natural and/or mechanical ventilation should be audited regularly. Lastly, staff should be fit-tested for N95 respirators and a reliable supply of quality-assured respirators ensured.

The bulk of TB transmission both in the community and in healthcare settings still occurs before an accurate diagnosis can be made. The onus is on ensuring that TB IC measures are applied in all high-risk settings so that healthcare facilities become known as places of healing and safety, not death and contagion. At the same time, patients and their loved ones should be engaged in efforts to implement TB IC and embraced as part of the solution, rather than the problem.

## 9. When protection is not negotiable

In most resource-poor settings, HCWs are in short supply and should be considered an extremely valuable national asset. In practice, HCWs appear expendable, at least in the minds of policymakers, who consistently fail to allocate sufficient resources



**Photo 1.** Four occupational drug-resistant TB survivors unite behind ZERO TB and ZERO STIGMA on South African National Women's Day. Left to right: Nurse Patricia Bond, Nurse Jolene Samuels, Dr Thato Mosidi and Dr Dalene von Delft. © TB Proof.

to safeguard healthcare facilities. This complacency continues to result in preventable suffering and loss of life. Just as Ebola has caused mass panic and an exodus of HCWs from affected countries, the mounting prospect of incurable forms of DR-TB may further worsen loss through emigration of HCWs from high-burden TB countries.

TB is preventable and, in the majority of cases, is curable. But the reality is that HCWs are not safe, and that means neither are those under their care. We cannot afford, either economically or socially, to wait for the DR-TB situation to deteriorate further. Urgent action is required to improve TB IC implementation and to ensure equal access to better treatment for all. HCWs are on the front lines of care – and on the front lines of risk. We must also be on the front lines of change. [Photo 1](#)

As HCWs we are sick of TB: sick of the ineffectual global response to TB and DR-TB control and sick of the lack of infrastructure and resources to prevent transmission from patients to HCWs. Everything possible should be done to protect and retain the HCW resource through active interventions to reduce the risk of occupational TB. All HCWs should stand together to lobby healthcare policymakers, managers, and colleagues to create safer working conditions in all healthcare facilities, but especially those in high-burden TB settings.

### Acknowledgements

A special thank you to the contributing occupational TB survivors, Drs Dramowski, Mosidi, Von Delft, Willems, and Zumla.

**Funding source:** No funding was made available for the preparation of this article.

**Conflict of interest:** None of the authors have any conflicts of interest to declare.

### References

- Menzies D, Fanning A, Yuan L, Fitzgerald M. Tuberculosis among health care workers. *N Engl J Med* 1995;**332**(2):92–8. <http://dx.doi.org/10.1056/NEJM199501123320206>.
- Fennelly KP, Iseman MD. Health care workers and tuberculosis: the battle of a century. *Int J Tuberc Lung Dis* 1999;**3**(5):363–4.
- Dharmadhikari AS, Mphahlele M, Venter K, Stoltz A, Mathebula R, Masotla T, et al. Rapid impact of effective treatment on transmission of multidrug-resistant tuberculosis. *Int J Tuberc Lung Dis* 2014;**18**(9):1019–25. <http://dx.doi.org/10.5588/ijtld.13.0834>.
- World Health Organisation. Global tuberculosis report 2014. Geneva: WHO; 2014.
- Salaniponi FM, Harries AD, Banda HT, Kang'ombe C, Mphasa N, Mwale A, et al. Care seeking behaviour and diagnostic processes in patients with smear-positive pulmonary tuberculosis in Malawi. *Int J Tuberc Lung Dis* 2000;**4**(4):327–32.
- Marais BJ, Mlambo CK, Rastogi N, Zozio T, Duse AG, Victor TC, et al. Epidemic spread of multidrug-resistant tuberculosis in Johannesburg, South Africa. *J Clin Microbiol* 2013;**51**(6):1818–25. <http://dx.doi.org/10.1128/JCM.00200-13>.
- Gandhi NR, Moll A, Sturm AW, Pawinski R, Govender T, Lalloo U, et al. Extensively drug-resistant tuberculosis as a cause of death in patients co-infected with tuberculosis and HIV in a rural area of South Africa. *Lancet* 2006;**368**(9547):1575–80. [http://dx.doi.org/10.1016/S0140-6736\(06\)69573-1](http://dx.doi.org/10.1016/S0140-6736(06)69573-1).
- Van Rie Annelies, Enarson Donald. XDR tuberculosis: an indicator of public-health negligence. *Lancet* 2006;**368**(9547):1554–6. [http://dx.doi.org/10.1016/S0140-6736\(06\)69575-5](http://dx.doi.org/10.1016/S0140-6736(06)69575-5).
- Klopper M, Warren RM, Hayes C, Gey van Pittius NC, Streicher EM, Müller B, et al. Emergence and spread of extensively and totally drug-resistant tuberculosis, South Africa. *Emerg Infect Dis* 2013;**19**(3):449–55. <http://dx.doi.org/10.3201/eid1903.120246>.
- Pietersen E, Ignatius E, Streicher EM, Mastrapa B, Padanilam X, Pooran A, et al. Long-term outcomes of patients with extensively drug-resistant tuberculosis in South Africa: a cohort study. *Lancet* 2014;**6736**(13):1–10. [http://dx.doi.org/10.1016/S0140-6736\(13\)62675-6](http://dx.doi.org/10.1016/S0140-6736(13)62675-6).
- Udwadia ZF, Amale RA, Ajbani KK, Rodrigues C. Totally Drug-Resistant Tuberculosis in India. *Clin Infect Dis* 2006;**54**(4):579–82.
- Dhedha K, Gumbo T, Gandhi NR, Murray M, Theron G, Udwadia Z, et al. Global control of tuberculosis: from extensively drug-resistant to untreatable tuberculosis. *Lancet Respir Med* 2014;**2**(4):321–38. [http://dx.doi.org/10.1016/S2213-2600\(14\)70031-1](http://dx.doi.org/10.1016/S2213-2600(14)70031-1).
- Migliori GB, Langendam MW, D'Ambrosio L, Centis R, Blasi F, Huitric E, et al. Protecting the tuberculosis drug pipeline: stating the case for the rational use of fluoroquinolones. *Eur Respir J* 2012;**40**(4):814–22. <http://dx.doi.org/10.1183/09031936.00036812>.
- Falzon D, Gandhi N, Migliori GB, Sotgiu G, Cox HS, Holtz TH, et al. Resistance to fluoroquinolones and second-line injectable drugs: impact on multidrug-resistant TB outcomes. *Eur Respir J* 2013;**42**(1):156–68. <http://dx.doi.org/10.1183/09031936.00134712>.
- Cox HS, McDermid C, Azevedo V, Muller O, Coetzee D, Simpson J, et al. Epidemic levels of drug resistant tuberculosis (MDR and XDR-TB) in a high HIV prevalence setting in Khayelitsha. *South Africa PLoS One* 2010;**5**(11):e13901. <http://dx.doi.org/10.1371/journal.pone.0013901>.
- Kasperson RE, Renn O, Slovic P, Brown HS, Emel J, Goble R, et al. The social amplification of risk: a conceptual framework. *Risk Anal* 1988;**8**(2):177–87. <http://dx.doi.org/10.1111/j.1539-6924.1988.tb01168.x>.
- 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. <http://dx.doi.org/10.1371/journal.pmed.0030494>.
- Baassano I, Nunn P, Williams B, Pivetta E, Bugiani M, Scano F. Tuberculosis among health care workers. *Emerg Infect Dis* 2011;**17**(3):488–94. <http://dx.doi.org/10.3201/eid1703.100947>.
- O'Donnell MR, Jarand J, Loveday M, Padayatchi N, Zelnick J, Werner L, et al. High incidence of hospital admissions with multidrug-resistant and extensively drug-resistant tuberculosis among South African health care workers. *Ann Intern Med* 2010;**153**(8):516–22. <http://dx.doi.org/10.7326/0003-4819-153-8-201010190-00008>.
- Tudor C, Van der Walt M, Margot B, Dorman SE, Pan WK, Yenokyan G, et al. Tuberculosis among health care workers in KwaZulu-Natal, South Africa: a retrospective cohort analysis. *BMC Public Health* 2014;**14**(1):891. <http://dx.doi.org/10.1186/1471-2458-14-891>.
- Jarand J, Shean K, O'Donnell M, Loveday M, Kvasnovsky C, Van der Walt M, et al. Extensively drug-resistant tuberculosis (XDR-TB) among health care workers in South Africa. *Trop Med Int Health* 2010;**15**(10):1179–84. <http://dx.doi.org/10.1111/j.1365-3156.2010.02590.x>.
- Courtwright A, Turner AN. Tuberculosis and stigmatization: pathways and interventions. *Public Health Rep* 2010;**125**(Suppl):34–42.
- Zolowere D, Manda K, Panulo B, Muula AS. Experiences of self-disclosure among tuberculosis patients in rural Southern Malawi. *Rural Remote Health* 2008;**8**(4):1037.
- Cramm JM, Finkenflügel HJM, Møller V, Nieboer AP. TB treatment initiation and adherence in a South African community influenced more by perceptions than by knowledge of tuberculosis. *BMC Public Health* 2010;**10**:72. <http://dx.doi.org/10.1186/1471-2458-10-72>.
- Deribew A, Abebe G, Apers L, Colebunders R. Prejudice and misconceptions about tuberculosis and HIV in rural and urban communities in Ethiopia: a challenge for the TB/HIV control program. *BMC Public Health* 2010;**10**:400. <http://dx.doi.org/10.1186/1471-2458-10-400>.
- Scambler G. Stigma and disease: changing paradigms. *Lancet* 1998;**352**(9133):1054–5. [http://dx.doi.org/10.1016/S0140-6736\(98\)08068-4](http://dx.doi.org/10.1016/S0140-6736(98)08068-4).
- World Health Organisation, *The World Health Report 2006 – working together for health*. Geneva; 2006.
- Diacon AH, Pym A, Grobusch MP, de los Rios JM, Gotuzzo E, Vasilyeva I, et al. Multidrug-resistant tuberculosis and culture conversion with bedaquiline. *N Engl J Med* 2014;**371**(8):723–32. <http://dx.doi.org/10.1056/NEJMoa1313865>.
- Sotgiu G, Centis R, D'Ambrosio L, Alfenaar J-WC, Anger H, Caminero J, et al. Efficacy, safety and tolerability of linezolid containing regimens in treating MDR-TB and XDR-TB: systematic review and meta-analysis. *Eur Respir J* 2012;**40**(6):1430–42. <http://dx.doi.org/10.1183/09031936.00022912>.
- Cox H, Ford N. Linezolid for the treatment of complicated drug-resistant tuberculosis: a systematic review and meta-analysis. *Int J Tuberc Lung Dis* 2012;**16**(4):447–54. <http://dx.doi.org/10.5588/ijtld.11.0451>.

31. Seddon JA, Godfrey-Faussett P, Jacobs K, Ebrahim A, Hesselning AC, Schaaf HS. Hearing loss in patients on treatment for drug-resistant tuberculosis. *Eur Respir J* 2012;**40**(5):1277–86. <http://dx.doi.org/10.1183/09031936.00044812>.
32. Sturdy A, Goodman A, José RJ, Loyse A, O'Donoghue M, Kon OM, et al. Multidrug-resistant tuberculosis (MDR-TB) treatment in the UK: a study of injectable use and toxicity in practice. *J Antimicrob Chemother* 2011;**66**(8):1815–20. <http://dx.doi.org/10.1093/jac/dkr221>.
33. World Health Organization. *Guidelines on the management of latent tuberculosis infection*. Geneva: WHO; 2014.
34. World Health Organization. *Guidelines for the prevention of tuberculosis in health care facilities in resource limited settings*. Geneva: WHO; 1999.
35. Health Systems Trust, South African National Department of Health, The National Health Care Facilities Baseline Audit: National Summary Report. Pretoria; 2012.
36. Yassi A. Promoting health equity by addressing the needs of international health workers. *AAAS 2014 Annu. Meet. Innov. Glob. Heal. Res. Bridg. Knowledge-to-Action Divid*; 2014.
37. Kanjee Z, Amico KR, Li F, Mbolekwa K, Moll AP, Friedland GH. Tuberculosis infection control in a high drug-resistance setting in rural South Africa: information, motivation, and behavioral skills. *J Infect Public Health* 2012;**5**(1):67–81. <http://dx.doi.org/10.1016/j.jiph.2011.10.008>.
38. Edwards R, Charani E, Sevdalis N, Alexandrou B, Sibley E, Mullett D, et al. Optimisation of infection prevention and control in acute health care by use of behaviour change: a systematic review. *Lancet Infect Dis* 2012;**12**(4):318–29. [http://dx.doi.org/10.1016/S1473-3099\(11\)70283-3](http://dx.doi.org/10.1016/S1473-3099(11)70283-3).
39. DeLuca A, Lessem E, Wegener D, Mingote LR, Frick M, Von Delft D. The evolving role of advocacy in tuberculosis. *Lancet Respir Med* 2014;**2**(4):258–9. [http://dx.doi.org/10.1016/S2213-2600\(14\)70035-9](http://dx.doi.org/10.1016/S2213-2600(14)70035-9).