Making the case for a sociological approach to better understand research and development for tuberculosis eradication

by

Peta Freestone

petamf@pgrad.unimelb.edu.au
or
petafreestone@hotmail.com

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Abstract:
This paper seeks to foreground tuberculosis as a disease of social stratification that contributes significantly to the global public health burden, causing millions of deaths annually. It provides a historical overview of tuberculosis research and links the increasing privatization of science, under a predominantly Western capitalist paradigm, to a dearth in biomedical innovation to eradicate this disease. Clearly, market forces alone will not solve the tuberculosis problem, despite recently emerging drug-resistant strains presenting an even greater health threat around the world. It is therefore proposed that sociology could make a contribution in this area. Theoretical frameworks from economic and organizational sociology, particularly that of Fligstein, can be used as a starting point for analyzing the institutional frameworks and political-cultural forces acting upon scientific research for new tuberculosis vaccines, diagnostics and drugs. Finally, social network analysis (SNA) is suggested as a potentially fruitful methodology for further research into the pursuit of these innovations for tuberculosis management and eradication.

Keywords:
tuberculosis, science, market, economic sociology, Fligstein, social networks
Science, society, and the market that fails millions: Making the case for a sociological approach to better understand research and development for tuberculosis eradication

Introduction

Scientists discovered the bacterium that causes tuberculosis more than a century ago. A diagnostic test was developed eight years later. Drugs to cure tuberculosis were available to clinics by the 1940s and 1950s. Yet today, the World Health Organisation (2008) estimates that one third of the world’s population is infected with the latent tuberculosis bacterium. Each year, an additional 30 million people are infected, 8 million develop the active disease and 2 million die (WHO 2008). Furthermore, current prevention, diagnostic and treatment tools are now becoming outdated and inadequate to identify, contain and eradicate tuberculosis. In recent decades, scientific research and development in this area has been relatively modest. There are many complex reasons why this is the case, though the majority can be attributed to social and economic inequality.

This paper has three purposes. Firstly, it seeks to provide a background to the tuberculosis situation as it stands today, including the close relationship that has developed between tuberculosis and social stratification. Secondly, the literature and policy on research for new tuberculosis vaccines, drugs and diagnostics will be drawn together. This two-part review will demonstrate that whilst there is considerable publication of tuberculosis research in general, this body of literature leaves us with questions about how to understand and further foster the pursuit of scientific innovation for tuberculosis management. The third section makes a case for a sociological approach to understanding the issues involved with research and development activities for tuberculosis and, more generally, other neglected diseases. Theory from economic and organizational sociology is suggested as a useful framework through which to conceptualise research for tuberculosis. Furthermore, social network analysis (SNA) is identified as a useful methodological tool for improving our understanding of the challenges inherent in this scientific niche and thus contribute to informing policy and resource allocation for innovation.

Background: Tuberculosis as a disease of social stratification

In 1905, Robert Koch won the Nobel Prize for his discovery of *Mycobacterium tuberculosis*, the bacterium that causes tuberculosis in humans. Decades after Koch, several more scientists were honoured with Nobel prizes for discoveries that advanced the treatment of tuberculosis. Koch’s compatriot Gerhard Domagk became a Nobel Laureate in 1939 after demonstrating that the organic compound *sulfanilamide* could be used in the treatment of bacterial infections. The tuberculosis drug *isoniazid*, developed in 1952, was based upon Domagk’s discovery.

More than half a century later, Domagk’s *isoniazid* remains one of the “most powerful” (Farmer 2001:xiv) drugs for the treatment of tuberculosis. Despite the development of several more drugs in the 1960s, no new candidates to advance the eradication of tuberculosis have emerged since. Yet these front line drugs must be
taken for six-nine months to cure a patient from tuberculosis, with significant to severe side effects. The only vaccine for tuberculosis, BCG, was developed in the 1920s and is effective only when administered in childhood, and then only partially so. Diagnostics for tuberculosis have not been significantly updated over the last century (Maartens and Wilkinson 2007). Meanwhile, tuberculosis has evolved from a lethal bacteria feared across the world, to a disease of social stratification, largely invisible in developed economies and closely intertwined with cycles of poverty at local and global levels.

Whilst the prevalence of tuberculosis has been halted or reversed in several populations in the last few years, the overall incidence and burden of the disease continues to rise with global population growth (WHO 2008). Of the estimated 2 million fatal cases of tuberculosis each year, most occur in low or middle-income countries, particularly in Asia, Africa and former soviet Europe, where access to basic health care and tuberculosis treatment is not reliably available. Tuberculosis has been associated with populations living with HIV as it has a particularly high prevalence and mortality rate for these people, the majority of whom live in the above-mentioned regions. Nevertheless, it is estimated that of the 2006 tuberculosis-related deaths, 1.5 million of those were in HIV-negative individuals (WHO 2008).

Tuberculosis also affects populations in advanced economies, in which you are most likely to contract the active form of the disease if you are an immigrant, of a particular ethnicity, living in poverty, or if you are sent to prison. In the U.S., for example where the current prevalence of latent infection is estimated at 4.2 per cent (Bennett, Courval et al. 2008), higher in particular subgroups, including African Americans, Hispanic Americans and people living in poverty. In Australia, the prevalence of tuberculosis is also relatively low compared to other countries in the Asia-Pacific region. Rates of reported cases are generally given as around one thousand active infections per year (Department of Human Services 2008), though there is concern that state and federal government reporting mechanisms are sufficient to identify emerging problems at the local level (Simpson, Clark et al. 2006). As with other areas of the world, there are particular groups that experience higher tuberculosis incidence. One such group is the immigrant population. For example, a study of African refugees arriving in Melbourne in 2005 revealed that 25% were infected with latent tuberculosis (Tiong, Patel et al. 2006), whilst around three quarters of the active tuberculosis cases in the 1990s in Australia developed in immigrants.

The other major group in Australia that experiences higher rates of tuberculosis infection is the indigenous population. In many indigenous communities, reported tuberculosis prevalence is up to a third higher than in non-indigenous Australian-born populations (Grace and Chenhall 2006; Simpson, Clark et al. 2006). This is not an uncommon situation in Australian indigenous communities, as culturally appropriate medical advice is not always available, whilst in some remote areas, clinics are not equipped with the necessary diagnostic tools or drug supplies for tuberculosis treatment (Grace and Chenhall 2006).

**Tuberculosis and science today**

Inaccurate diagnosis, insufficient treatment and the earlier discussed issues associated with social stratification have resulted in the outbreak of multi-drug-resistant (MDR) and extensively drug-resistant (XDR) strains of tuberculosis (Van Rie and Enarson 2006). The emergence of XDR-TB is even more problematic as, with current tuberculosis management tools, XDR-TB is essentially untreatable (Maartens and
Wilkinson 2007; World Health Organization 2007; Zager and McNerney 2008). By November 2007, incidents of XDR-TB had been reported by medical authorities in 41 countries, including several developed economies, such as the U.S., UK, Sweden and Australia (WHO 2007). Meanwhile, even drug-susceptible strains of tuberculosis continue to present problems, as the long term antibiotic courses currently prescribed are now known to produce their own complications such as liver disease and failure (Lewis, Ahmed et al. 2006). Because of these factors, it is now being realized that the existing tools for tuberculosis management are inadequate to eradicate the disease.

Scientific innovations that improve upon the current tuberculosis management tools will provide medical benefits in general and, as new tools will enable better accessibility and lower cost, these will also assist in resolving some of the above issues of social stratification. New drugs that are effective over a short treatment period of weeks rather than months require less patient monitoring and would improve the adherence to full treatment programs in poor and isolated areas. A new, single-dose and affordable vaccine will reduce the overall prevalence of the disease, and requires less logistic and infrastructure investment in developing countries than extended drug treatment programs. Simpler, more accurate diagnostics would reduce tuberculosis transmission in prisons, hospitals and other institutions, and allow health workers to swiftly identify drug-resistant strains.

Unfortunately for tuberculosis sufferers, there are barriers to for scientific innovation in this area. These include low general public awareness and little political conviction that the disease is still a worldwide problem, industry lacking a profit incentive to develop drugs for a disease that predominantly affects the world’s poor, and inappropriate funding schemes that have not inspired or harnessed academic research (Kaufmann and Parida 2007). Nevertheless, the persistence of tuberculosis globally and the increase of resistant strains of TB have recently spurred a number of governments, universities, NGOs and industry into action as demonstrated by the setting of the tuberculosis-related criteria in the Millennium Development Goals (WHO 2008).

These developments have recently led to scientific research into tuberculosis intensifying around the world (Maartens and Wilkinson 2007), if only at a very modest rate. Funding for research into tuberculosis management tools has increased significantly over the last three decades. In the 1980s, the US National Institutes of Health (NIH) invested an annual $1-2 million in tuberculosis research (Kaufmann and Parida 2007). By 2005, this had increased to $158 million, a significant contribution towards the estimated $400 million spent on tuberculosis research worldwide that year (Kaufmann and Parida 2007). Despite this increase, tuberculosis research funding still remains particularly modest when compared to other medical research. For example, the NIH spend $2.9 billion each year on research into AIDS (Kaufmann and Parida 2007).

There are now emerging global consortia and public-private partnerships (PPPs) such as the Stop TB Partnership (WHO 2006) and the TB Alliance for Drug Development (2008), which are attempting to further support the discovery and development of new tuberculosis diagnostics, drugs and vaccines through innovative new business and governance models incorporating the public, private, academic and philanthropic sectors. Despite these “admirable intentions” (Archibugi and Bizzarri 2004:1668), there have been suggestions in the science policy literature that the PPPs involved with tuberculosis research are limited by their financial capabilities and relatively
temporary mandates. These limitations, among others, will be considered in the next section, together with suggestions about the potential contributions towards a solution that could be drawn from economic and organizational sociology and through applying SNA as a methodological tool.

The case for a sociological approach

For researchers working in the social sciences of medicine, the emergence of MDR-TB is regarded as a ‘terrible vindication’ (Farmer 1998:349) of long held views that tuberculosis has become a disease of social stratification. One of the most prominent voices in this area, Paul Farmer (1998; 2001) has called for a revitalizing of the research agenda by social scientists to extrapolate and illuminate the social barriers to eradicating tuberculosis, including racism, poverty and political violence. There are obvious benefits to be gained from continuing social science research into the inequalities that magnify the tuberculosis burden locally and globally, though there is also a case for investigating the processes and structures involved with the pursuit of innovations for tuberculosis management. Such study is needed, as in addition to the scientific challenges of discovering and developing a new tuberculosis drug or vaccine, there are evolving political, social and economic forces acting upon scientific research. Some of these forces are specific to the pursuit of innovations for diseases of social stratification as, in the capitalist economies of Western society where the majority of scientific research is conducted, there is no market incentive for the development of new management tools for diseases that primarily affect populations who cannot afford treatment. Accordingly, this section presents a case for employing sociological theories, particular those from economic sociology, as well as SNA as a methodological approach to further research into this area.

Since the last major innovations in tuberculosis management tools were developed, there have been fundamental changes to science as a discipline and as a profession. There has been a ‘blurring’ (Rhoten and Powell 2007) of the public and private science spheres, demonstrated by the growing connection between government and public university scientific research and the research carried out by industry, largely pharmaceutical corporations. The privatization of science has also more recently increased with the surge in the biotechnology industry, mainly in the U.S. though this industry is also important in Australia, particularly in Melbourne, albeit on a smaller scale (Gilding 2008). Further to changes in organizational and collaborative structures, this blurring has other ramifications. Most profoundly, developments in intellectual property law in recent years have enabled the privatization and protection of innovations previously considered to be in the public domain, such as mathematic formulae and living organisms (Rhoten and Powell 2007). More scientific innovations than ever before can now be commodified, bringing the research and the market closer together. Callon (2002) argues that this hybridization or ‘overflowing’ between science and the market is now taken as a usual occurrence by actors pursing scientific innovation. Whilst Callon offers a theoretical interpretation of how these ‘overflowings’ occur, he calls for further research to address the full effects of this shift in science, urging sociologists to assess the consequences and to investigate the “institutional and material frames promoting or containing it” (Callon 2002:280).

As follows, I suggest that key frameworks for analyzing markets from the perspective of economic sociology, as developed by Fligstein and to an extent by proponents of network approaches, provide a means to engage with the theoretical challenges
proposed by Callon. Fligstein has developed a theoretical approach and a series of research propositions to the study of markets which suggests the importance of interpreting them as the outcome of the ‘unique political-cultural construction of their firms and nations’ (1996:670). I also suggest that SNA, which has emerged from disciplines as varied as history and psychology and has recently offered empirical evidence of the dynamics of life sciences research, is an ideal methodological tool to further investigate tuberculosis research from the perspective of economic and organizational sociology.

Whilst science has been regarded in the past as a global profession, there have long been features distinctive to the evolution of scientific research in particular areas of the world and to the organizations within which such research takes place. These national contexts have become more visible as scientific research has become increasingly integrated with market forces. For example, pioneering organizational sociology studies reveal that collaborative networks across university-industry interfaces in science differ between national and regional contexts. By combining interview and survey data with evidence from official documents, patent databases and publications, Owen-Smith et al (2002) found a higher density and diversity of collaborative ties amongst public-private organizations in the United States, than in Europe. The authors related these differences to historical trajectories, geography and to the cultural context of scientific organizations and nations, such as the reluctance for public research organizations in parts of Europe to move beyond ‘pure’ or basic science (Owen-Smith, Riccaboni et al. 2002). This tendency to favour biomedical science over translational or clinical research has also become a feature of the U.S. government-funded National Institutes of Health (NIH), despite the greater diversity of collaboration in which U.S. universities are engaged. The so-called ‘valley of death’, the space between a basic science discovery and a product or method applicable in a clinical setting is claimed to have widened at the NIH in recent years. This has been attributed to the growing momentum of basic biomedical research as a sub-discipline, in which “promotions and grants are based largely on the papers scientists have published in top journals, not on how much they have advanced medicine” (Butler 2008). Such findings immediately suggest the importance of analyzing institutional and organizational contexts, as well as the individual collaborations and social networks of scientific researchers, to better enable innovation, particularly when we have already identified the NIH as one of the world’s major funding sources for tuberculosis research.

The importance of national and organizational contexts also applies to the tuberculosis PPPs aiming to facilitate scientific research and development from a global, “top-down” approach. Despite their global mission, these PPPs are physically housed within different countries and are shaped and constrained by national contexts. This has been acknowledged in the policy literature to manifest as administrative difference, primary due to varying legal frameworks (Wheeler and Berkley 2001).

However, no studies examining the influence that national contexts may exert on the
organizations and agents conducting tuberculosis research have been identified. Here, further research could be illuminated by Fligstein’s theories on how markets retain features of their national contexts, despite also having interactions with, and influences from, global structures (Fligstein 2001:11). There is an argument for employing this theory, along with other tenets from economic sociology such as Granovettarian concepts of embeddedness (Granovetter 1985), to inform empirical work into how the policy and networks of tuberculosis research vary in different national contexts, and how these then relate to global structures such as the multilateral PPPs.

There are further opportunities for Fligstein’s work to inform empirical study of tuberculosis research, particularly with regards to his arguments that actors seek the survival of the firm and to stabilize their market (Fligstein 2001). Rather than the view of traditional economics that actors are simply seeking to maximize profit, the nuances of Fligstein’s propositions offer ways in which to understand the motivations of firms and other organizations involved with global research PPPs. For example, the PPP policy literature has suggested that large companies benefit from the positive public relations of being involved with a public health exercise (Wheeler and Berkley 2001). These firms may not actually directly profit from their involvement with the PPP, and it is more likely that they will not. These benefits do allow them to promote the viability of their firm and assist with stabilizing the market, that is, if they are involved in partnerships like this, they have a chance to gather information and influence decisions that affect their more general product market. Fligstein also views alliances or joint ventures between competitors as creating interdependence which “links the fortunes of firms together” (Fligstein 2001:69) and stabilizes the competitiveness in their market.

Large companies are likely to be steering the research and policy agenda of these PPPs, however their possible goal of receiving good PR does not necessarily foster the most efficient pursuit of innovation. This potential is evident when we consider the measurements for desired outcomes of the PPPs. This year, the Global Alliance for TB Drug Development is reported to have two drug candidates in the clinical trial pipeline, out of a total of seven near-term drug prospects developed globally (Marshall 2008). However, it has been argued that several of these candidates are “simply refurbished versions of existing medicines” (Marshall 2008), a strategy Angell (2006) accused the major pharmaceutical companies of long employing to minimize investment, maximize profit and protect intellectual property. Considering the amount of public and philanthropic funding being allocated to these PPPs, it is important to further investigate this situation.

The global trends towards commercializing innovation are also claimed to be having impacts on science at the meso and micro levels, or for single organizations, laboratories and for individual scientists. For example, these changes are altering the
motivations, outputs and the identities of public and academic scientists (Owen-Smith and Powell 2001; Colyvas and Powell 2007). In the past, the identified social features of science as a profession or technical community included the concept of global ‘invisible colleges’ or ‘technical communities’ (Chubin 1985), which promoted a common respect and, to some extent, an openness amongst scientists engaged in similar research across the world. However, the increasing enmeshing of scientific research and the market has led scholars to begin questioning “whether the innovative benefits of invisible colleges will persist, or if commercial interests will block informal knowledge sharing among scientists” (2005:73). These changes have been highlighted by proponents of the new economics of science, who argue that “…without the existence of an open science, the social efficiency of research may well be undermined…” (Callon 2002:312).

In this changing environment, the frequency and extent of open collaboration amongst scientists investigating tuberculosis becomes a pertinent point when considering the limited resources being allocated to research into diseases of social stratification. Further research into the processes and structures involved with the pursuit for scientific innovations for tuberculosis could give us greater insight into this area to more accurately assess current outcomes and offer opportunities for fostering improvement. Adopting SNA as a methodological approach can illuminate the process of how actors create, share and transform knowledge to generate innovations (Powell and Grodal 2005). Rather than only observing the formal ties between actors and organizations such as the global PPPs, SNA can also provide insight into the presence (or absence) and strength of informal ties between individual researchers and link these to the relative productivity of organizations (Powell and Grodal 2005). Mapping the social networks of researchers pursuing innovations for tuberculosis will reveal important features of this scientific niche, including whether patterns of collaboration resemble or contrast with research networks from other industries that developed successful innovations (Powell and Grodal 2005). This would appear to be a fruitful area of inquiry for tuberculosis research for two reasons. Firstly, studies of the U.S. biotechnology industry, have asserted that in the life sciences “beneath most formal ties lie a sea of informal ties” (Powell and Grodal 2005). Secondly, SNA lends itself to addressing the issues raised earlier by economic sociology theory, that is, how actors in particular fields establish, maintain and at times, co-opt networks to achieve their goals.

**Conclusion**

A review of the literature has clearly identified tuberculosis as a disease of social stratification and a global health burden that cannot be resolved by market forces alone. The dearth of academic literature that specifically addresses the processes and structures of scientific research into neglected diseases raises questions about our understanding of the current challenges inherent in the pursuit of diagnostic, drug and vaccine innovations. An opportunity therefore exists for sociology to make a valuable contribution into this area, and it is argued that employing SNA as a methodological tool, grounded in economic sociology theory, may further illuminate the current state
of play in biomedical research and development for tuberculosis and, more generally, other neglected diseases. It is hoped that further research will improve our understanding of the inherent issues in this area and may create better outcomes for global public health and improve the lives of the millions of people who contract tuberculosis each year.

References


