Guideline Development Group (GDG) Meeting
to develop consolidated policy guidance on anti-TB drug susceptibility testing

Montreux, Switzerland
February 29th – March 4th

Tuberculosis (TB) causes 9 million cases and 1.5 million deaths annually and it is estimated that 3 million cases go undiagnosed each year (WHO Global TB Control Report 2015). The emergence of multidrug (MDR) and extensively drug-resistant (XDR) TB is a major threat to global TB control. Culture-based phenotypic drug susceptibility testing (DST) methods are the current “gold standard” methods for the detection of resistance to anti-TB drugs. However, culture and conventional drug susceptibility testing can take up to 8-12 weeks to complete, which can lead to prolonged periods of ineffective therapy resulting in ongoing transmission.

Molecular-based drug-susceptibility tests are more rapid and microbiologically safe compared to culture-based phenotypic assays. Line probe assays (LPAs) are rapid molecular diagnostic tests that use DNA strip technology to allow simultaneous molecular identification of TB and the most common genetic mutations causing resistance to rifampicin and isoniazid. WHO recommended the use of a first version of LPA in 2008 but plans to update the initial policy recommendations. In 2012, the LPA for the detection of resistance conferring mutations for fluoroquinolones and second-line injectable agents was evaluated by a WHO Guideline Development Group (GDG) as a replacement test for conventional DST. Recent improvements have been made to the assay and the correlation between phenotypic and genotypic resistance is better understood. Given that new diagnostic accuracy data and new TB drugs are now available, WHO will review the evidence for the clinical use of the MTBDRsl assay (Hain Lifesciences).

A review of the evidence to determine the predictive value of sequencing different resistance genes compared with the current reference standard - phenotypic DST will also be undertaken for the development of this guideline. Furthermore, this guideline will include an update on available recommendations for different DST methods including for the new and re-purposed anti-TB drugs.

Objectives
1. To define how resistance conferring mutations detected by molecular methods (sequencing) can guide the treatment with first- and second line anti-TB agents, comparing to phenotypic testing?
2. To define how Hain MTBDRplus assay results be used to guide clinical decisions to use rifampicin and isoniazid as compared to phenotypic /composite DST?
3. To define how Hain MTBDRsl assay results be used to guide clinical decisions and to serve for surveillance purposes to use second line anti-TB agents in patients diagnosed with rifampicin resistant TB or MDR-TB as compared to phenotypic DST?
4. To determine the appropriate DST method and critical concentrations to use to detect resistance to new, re-purposed and selected anti-TB drugs (delamanid, bedaquiline, clofazamine, linezolid, ethionamid/prothionamid, cycloserine, capreomycin, pyrazinamid, moxifloxacin and levofloxacin);
5. To outline issues to be addressed by WHO in subsequent policy guidance recommendations.
List of Participants

The Steering Group

1. Chris Gilpin, Scientist, GTB/LDR
2. Alexei Korobitsyn, Technical Officer, GTB/LDR
3. Karin Weyer, Coordinator, GTB/LDR
4. Fuad Mirzayev, Medical Officer, GTB/LDR
5. Wayne van Gemert, Technical Officer, GTB/LDR
6. Ernesto Jaramillo, GTB/LDR
7. Dennis Falzon, Medical Officer, GTB/LDR
8. Matteo Zignol, Medical Officer, GTB/TME

The Guidelines Development Group (GDG)

1. Holger Schünemann, Canada, McMaster University Health Sciences Centre (Chair, speciality: methodologist)
2. Gavin Churchyard, Chief Executive Officer, Aurum Institute for Health Research, South Africa (speciality: TB/HIV specialist)
3. Daniela Cirillo, Italy, San Raffaele Scientific Institute (SRL) (speciality: TB laboratory specialist)
4. Moses Joloba, National TB Reference Laboratory, Kampala, Uganda (speciality: TB laboratory specialist)
5. Thomas Shinnick, Associate Director for Global Laboratory Activities, Mycobacteriology Laboratory Branch, Division of Tuberculosis Elimination, Centers for Disease Control and Prevention (speciality: TB laboratory specialist)
6. Chris Coulter, Mycobacterium Reference Laboratory, Brisbane, Australia (speciality: TB laboratory specialist)
7. Jamie Posey, CDC, Atlanta, USA (speciality: TB laboratory specialist)
8. Francis Varaine, Médecins sans Frontières, Paris, France (speciality: TB clinician)
10. Marie Alice Telles, Brasil (speciality: TB laboratory specialist)
11. Leen Rigouts, Institute of Tropical Medicine, Antwerp (SRL)
12. Gregory Fox, Sydney University (speciality: TB clinician)
13. Rebecca Tadokera, South Africa (speciality: civil society advocate)

Technical resource consultants

1. Karen Steingart, Cochrane Infectious Diseases Group, Liverpool School of Tropical Medicine, Liverpool, UK (speciality: systematic reviewer)
2. Grant Theron, Stellenbosch University, South Africa (speciality: systematic reviewer)
3. Claudia Denkinger, Foundation for Innovative and New Diagnostics, Geneva, Switzerland (speciality: systematic reviewer)
4. Ruvandhi Nathavitharana, Beth Israel Deaconess Medical Center, Harvard Medical School, USA (speciality: systematic reviewer)
5. Salman Siddiqi, TB consultant, USA (speciality: technical resource consultant)
6. Claudio Köser, University of Cambridge, UK (speciality: technical resource consultant)

Observers

1. Emmanuelle Cambau, Laboratoire de Bactériologie-Virologie, Paris, France
2. Thomas Schön, European Committee on Antimicrobial Susceptibility Testing (EUCAST)
Bio-data

The Guideline Development Group (GDG)

1. Holger Schünemann

Affiliation: McMaster University, Health Sciences Centre
Address: 1200 Main St West, L8S 4K1

Mail: holger.schunemann@mcmaster.ca

Dr. Schünemann has assumed the role of chair of the department on February 1, 2009. He also is one of two chairs of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group. This international working group developed a common grading system for evaluating the quality of evidence and strength of recommendations for recommendations in health care. Dr. Schünemann is editor-in-chief of Health and Quality of Life Outcomes and co-convenor of the Applicability and Recommendations Methods Group of the Cochrane Collaboration. At McMaster he works with the CLARITY research group. His research interests are guideline development, systematic reviews, health related quality of life, pulmonary function and respiratory disease epidemiology and knowledge translation.

2. Gavin Churchyard

Affiliation: Aurum Institute
Address: Aurum House, The Ridge, 29 Queens Road, Parktown, Johannesburg, 2193

Mail: gchurchyard@auruminstitute.org

Prof Churchyard is a specialist physician and the founder and Chief Executive Officer of The Aurum Institute NPC, an independent, not for profit, proudly South African, public benefit organization that focuses on TB and HIV service delivery, technical assistance and research. Prof Churchyard is the Vice-Chair of the NIH funded AIDS Clinical Trials Group Transformative Science Group for TB, Chair of the ACTG Host Directed Therapy for TB working group, and an Ex-officio member of the TB biomarkers working group, Prof Churchyard is the Chair the WHO Task Force for the Development of New Policies for the Treatment of TB, Chaired the 2013 WHO Post 2015 Research Pillar meeting. Prof Churchyard was also the Chair of the WHO/TDR Disease Reference Group for TB, Leprosy and Buruli Ulcer (2009-2013), and was a member of the WHO Strategic Technical Advisory Group for TB (2010-2014), and was a member of the WHO Working Groups for TB screening and TB/HIV, and a member of the WHO Stop TB Partnership Research Movement that identified global research priorities for TB. Prof Churchyard is a co-author of the WHO guidelines for Xpert MTB/Rif, intensified TB case finding
and isoniazid preventive therapy. Prof Churchyard has published research on TB diagnostics, including MGIT, Capilia, Hain, Xpert MTB/RIF and urine LAM.

3. Daniela Maria Cirillo

Affiliation Fondazione Centro San Raffaele

Address Via Olgettina, 60, Milan, Italy

Tel : +390226437947

Mail: cirillo.daniela@hsr.it

Daniela Maria Cirillo MD, PhD, is a board certified clinical microbiologist, Head of the Emerging Bacterial Pathogens Unit at the San Raffaele Scientific Institute (HSR) in Milan, Italy since 2002. The main activities carried out by the Unit are research on new diagnostic for MDR/XDR-TB, M.tuberculosis pathogenesis, virulence markers and as WHO Tuberculosis Supranational Reference Laboratory, providing technical assistance for implementation of new tools for tuberculosis diagnosis, Quality Assurance Programmes, molecular typing of and first and second line M tuberculosis drug sensitivity testing. Her laboratory is also a WHO collaborating Centre for Laboratory Strengthening and the Italian reference center for molecular typing of Mycobacteria.

Dr. Cirillo’s particular areas of expertise include clinical bacteriology and infection control, new diagnostic tools evaluation, molecular typing of Multidrug resistant Organisms, TB Laboratory strengthening, DRS and operational research protocols development, training packages development, research on new diagnostics for active and latent TB Infections, nosocomial infection. She and her collaborators provide technical support to the following Countries: Mozambique, Burkina Faso, Kosovo, Albania, Bulgaria, Turkey, Nigeria, Ivory Cost, Zanzibar, Turkey, Gibuti and Macedonia. International appointments: Co-Chair of the New Diagnostic Working Group of the StopTB partnership, Core Group elected member of the Global Drug Resistance Initiative (GDI) of the Stop Tb partnership-WHO, member of Global Laboratory Initiative. Member of the Scientific and Technical Advisory Board (STAG) 2011-2014. Member of the Core Group of the ERLN-TB. She was the coordinator of two FP7 projects approved by the EU aimed at development of new diagnostic tools and at the development of an European network for study and clinical management of TB drug resistance. She serves as a peer reviewer for the International Journal of Tuberculosis and Lung Disease, European Respiratory Journal, Journal of Clinical Microbiology, Emerging Infectious Disease, Clinical Infectious Diseases.

4. Prof Moses Joloba

Affiliation National TB Reference Laboratory

Address Kampala, Uganda

Mail: mlj10@case.edu

Prof. Moses Joloba is the current Chair of the Department of Medical Microbiology, Makerere University College of Health Sciences. Dr Joloba completed his MbChB at Makerere University Medical School, Kampala, Uganda, in 1994, did his Master of Science in Microbiology in 1996 and PhD in Molecular Microbiology 2003 at Case Western Reserve University, Cleveland, Ohio, USA. In 2001, he joined Makerere University College of Health Sciences as a faculty member, and in 2003 he established the Molecular Biology laboratory in the Department of Medical Microbiology. He is the current Head of CTRL in Kampala, which is designated as WHO SRL.
5. Thomas M. Shinnick, PhD

Affiliation: Independent Consultant

Mail: tms1@bellsouth.net

I have been formerly working on the laboratory aspects of the diagnosis, treatment, and control of TB at US CDC for more than 25 years. My career has included directing research in academic and public health settings (author/co-author of more than 175 publications) and managing the Mycobacteriology Laboratory Branch of CDC which included the TB Reference Laboratory, research activities, support for clinical and epidemiologic studies, and setting of public health policy for TB laboratories. Most recently, as the Associate Director of DTBE for Global Laboratory Activities, I have been responsible for leading the Division’s efforts in improving TB laboratory capacities and for directing laboratory research in international settings. Also, I serve in leadership roles on international committees that address laboratory needs for TB control in resource-limited settings including the Global Laboratory Initiative (GLI) of the Stop TB Partnership (chair); Bacteriology and Immunology sub-section of the International Union Against TB and Lung Diseases (The Union); Advisory Board for the TB CARE Program; Board of Directors of the African Society for Laboratory Medicine; and Project Steering Committee of the UNITAID-funded EXPAND-TB Program.

With respect to the laboratory detection of TB, I served on numerous WHO Expert Groups that evaluated diagnostics and helped develop recommendations for their use; co-led efforts to provide guidance to USG-supported programs for the programmatic implementation of the Xpert MTB/RIF assay; developed and implemented national strategic plans to implement the Xpert MTB/RIF test MDR TB; and conducted operational research to evaluate the impact of the test on laboratory performance and on MDR TB detection, treatment, and control.

6. Chris Coulter

Affiliation: Queensland Mycobacterium Reference Laboratory, WHO Collaborating Centre, Pathology Queensland

Address: Herston Hospitals Campus, Butterfield St, Herston, 4029, QLD

Tel: +61 7 36460035

Mail: Chris.Coulter@health.qld.gov.au

7. James Posey

Affiliation: US CDC

Address: 1578 Runnymeade Rd, Atlanta, GA

Tel: +1 404-849-1945

Email: hzp9@cdc.gov

8. Dr Francis Varraine
9. Michael Rich

Affiliation  Partners In Health
Address  888 Commonwealth Avenue, 3rd Floor Boston, MA 02215
Tel :  +1 (617) 998-8922
Mail: mrich@pih.org

A global health physician and leading expert in the field of multi-drug resistant tuberculosis (MDR-TB). He is currently a Co-Leader of the endTB project at Partners In Health, which is a $60.4 million UNITAID-funded project that aims to find shorter, less toxic, and more effective treatments for MDR-TB, through increased access to new drugs, a clinical trial, and advocacy at the country and global level. endTB is expected to have significant global impact, by changing WHO policy around the treatment of MDR-TB.

Dr. Rich has worked with MDR-TB programs in Peru, Lesotho, Kazakhstan, Uzbekistan, Estonia, Nepal, Myanmar, Bangladesh, Rwanda, Kenya, Uganda, China, India, and Costa Rica, and is the primary author of multiple WHO guidelines on the management of drug-resistant TB (2006 and 2008), including the most recent 2015 WHO guidance on the subject of drug-resistant TB titled “Companion handbook to the WHO guidelines for the programmatic management of drug-resistant tuberculosis” (WHO/HTM/TB/2014.11).

10. Marie Alles Telles

Affiliation  TB laboratory consultant
Mail: atelles.msh@gmail.com

11. Leen Rigouts

Affiliation  Institute of Tropical Medicine
Address  Nationalestraat, 155, Antwerp, Belgium
Tel :  +32332476551
Mail: lrigouts@itg.be

Dr. Leen Rigouts joined the Mycobacteriology Unit of Institute of Tropical Medicine (Antwerp, Belgium), where she supervised and accomplished studies covering various aspects of human and
bovine TB: (i) molecular epidemiology studies on reinfection versus reactivation, prevalence of multiple M. tuberculosis infections, and transmission rates among MDR and non-MDR TB (ii) drug-resistance studies on its prevalence and incidence various geographic regions, rapid detection of drug resistance by molecular tools, development of drug-resistance, resistance to second-line drugs, and alternative ways for TB treatment (iii) studies on the zoonotic aspect of bovine TB, and (iv) studies investigating social aspects of TB. These projects were conducted in collaboration with Belgian and international universities and research centers, as well as some non-governmental organizations and national TB programs.

Her expertise in ISO accreditation, BSL2-3 laboratory design and biosafety guideline development is frequently consulted by international collaborating centres, including the SRL network. Since 2008 she is professor in Tropical Infectious Diseases at the University of Antwerp (UA), and since 2011, she manages the ISO9001-certified public mycobacterial culture collection (BCCM/ITM).

12. Gregory Fox

Affiliation University of Sydney

Address Sydney Medical School Edward Ford Building A27, Sydney, NSW 2006 AUSTRALIA

Tel: +84 0 1673684681

Email: gregory.fox@sydney.edu.au

In 2009, Dr Fox has stared his work in Hanoi, Vietnam on a PhD project focused on improving tuberculosis control. At the time, the University had no research infrastructure in Vietnam, so Greg set about building it himself from scratch. He established a local research team, implemented a large scale TB screening research project with 36,000 subjects, and launched a collaboration with Hanoi’s National Lung Hospital. He also found the time to conduct medical English classes and research methods courses for local health professionals. As a result of his PhD research, he has secured a major National Health and Medical Research Council (NHMRC) project grant for further work in Vietnam and has also won an NHMRC Early Career Research Fellowship. His leadership skills will have a long lasting impact on public health in Vietnam.

13. Rebecca Tadokera

Affiliation Consultant at the South African Cochrane Centre, South African Medical Research Council (SAMRC) / Member of the Global TB Community Advisory Board

Address: 17 Oaktree, Cornwall Place, Kenilworth, Cape Town 7708

Mobile Phone: +27 71 2531744

Mail: tadokerar@gmail.com

Main Research Interests: Epidemiological research of TB and HIV; HIV prevention studies; TB transmission studies; Knowledge translation and implementation of research evidence to impact policy; Socially-relevant epidemiological research. Academic Awards and Fellowships: Featured in the UCT Research Report, 2015 as one of the most promising and upcoming researchers in the faculty of Health Sciences, University of Cape Town. Claude Leone Postdoctoral Fellowship Award,
Observers

1. Emmanuelle Cambau

Affiliation          Laboratoire de Bactériologie-Virologie, Paris, France
Address             2 rue Ambroise Paré, 75475 Paris cedex 10
Tel:                +33 1 4995 6554
Mail:               emmanuelle.cambau@lrb.aphp.fr

Associate Director of the French National Reference Center for Mycobacteria and their drug resistance since 2006. Member of the European network of national reference laboratories for tuberculosis (ERLnet-TB) for the ECDC since 2010. Post-doctoral position at St George’s University of London, Molecular and metabolic signalling centre, Department of Basis Medical Sciences, care of Pr. L. Mark Fisher. Topics of interest: mycobacteria and mycobacterial infections, antibiotic resistance, quinolones, clinical microbiology, topoisomerases, gonococci, helicobacter. Award Biomérieux (2001) “detection of antibiotic resistance”. Reviewer for AAC, JAC, CMI, EJCMID, CID, JMB, PLoS (>100 research papers). Reviewer for TB projects of the ISTC/STCU program of the European Community.

2. Thomas Schön

Affiliation          European Committee on Antimicrobial Susceptibility Testing (EUCAST). Department of Clinical Microbiology and Infectious Diseases Kalmar County Hospital and Linköping University
Mail:               thomas.schon@ltkalmar.se

Thomas Schön, graduated as a medical doctor from Linköping University, Sweden in 2000. He then continued in Microbiology and received a PhD at the same university in 2002. After 2 years of internship at Kalmar County Hospital, Dr. Schön continued his clinical work to become a specialist in Clinical Microbiology (2010) and Infectious Diseases (2013).

3. David Dolinger, FIND

Affiliation          FIND
Address             Campus Biotech, Building B2, Level 0, 9, Chemin des Mines, 1202 Geneva, Switzerland
Tel:                +41 22 749 29 31
Mail:               David.Dolinger@finddx.org
Dr. David L. Dolinger has over 20 years of industry experience in the development of in vitro diagnostics (IVD) assay from design and development to launch and commercialization. As a Peace Corps volunteer in rural South Korea working in tuberculosis control in 1978, he saw firsthand the pressing need for high quality informative diagnostics as part of a successfully integrated patient management program. From this experience, he pursued a Ph.D. in Microbiology and Immunology from Temple University School of Medicine (1988), followed by post-doctoral training in Molecular Genetics at Princeton University (1988 – 1990).
Dr. Dolinger has held leadership positions in all aspects of the IVD Industry, including the Head of Research and Development, Manufacturing and Regulatory Affairs. Highlights of his career have involved work with the Human Genome Project through a company that he founded in Jackson, Wyoming (Phenogenex, LLC) and Product Development at Visible Genetics, where he spearheaded the development and commercialization of the first US-FDA cleared sequencing-based molecular assay for identification and interpretation of HIV-1 resistant mutations.

4. Samuel Schumacher, FIND

Affiliation FIND
Address Campus Biotech, Building B2, Level 0, 9, Chemin des Mines, 1202 Geneva, Switzerland
Tel: +41 22 749 29 31
Mail: Samuel.Schumacher@finddx.org

Samuel Schumacher is an epidemiologist with a basic science background. He completed his MSc in Molecular Biotechnology at the Technical University of Munich in 2008 and obtained a Postgraduate Diploma in Epidemiology from the London School of Hygiene & Tropical Medicine in 2011. He went on to do a PhD in Epidemiology under the supervision of Dr. Madhukar Pai at McGill University.

Samuel has extensive methodological expertise in study design, conduct and analysis, as well as hands-on field experience. He spent several years doing research on development and evaluation of TB diagnostics while living in Peru and Thailand. In his thesis, he focused on methodological challenges in the estimation of impact of TB diagnostics on patient outcomes, and the estimation of diagnostic test accuracy in the absence of a gold standard with projects in India and South Africa.

Samuel joined FIND in 2015 as a Scientific Officer, where he is responsible for management of projects primarily within the tuberculosis programme. His main focus is on study design of evaluation and demonstration studies that enable WHO review and global/national policy making.

5. Miranda Langendam, University of Amsterdam

Affiliation University of Amsterdam
Address Room J1B-211 | P.O. Box 22660 | 1100 DD Amsterdam
Tel: +31-20-5665935
Mail: m.w.langendam@amc.uva.nl
Guidelines methodology expert

6. Sevim Akhmedov, USAID

Affiliation USAID
Address 1300 Pennsylvania Avenue, NW, Room 2.10
Tel: +12027125699
Mail: sahmedov@usaid.gov

Public Health Expert

The Systematic Review Team

1. Karen Steingart, MD MPH

Affiliation Cochrane Infectious Diseases Group, Liverpool School of Tropical Medicine
Address Pembroke Place, Liverpool, Merseyside L3 5QA, United Kingdom
Tel: +1 646-243-9043
Email: karen.steingart@gmail.com

Dr Karen Steingart is an Editor with the Cochrane infectious Diseases Group. She is a public health physician and methodologist. She is the lead author of two Cochrane diagnostic test accuracy reviews on the Xpert® MTB/RIF assay (original and update) and co-author of a recently published Cochrane diagnostic test accuracy review on MTBDRsl. In addition, she has published several non-Cochrane systematic reviews on the diagnostic accuracy of tuberculosis tests, including fluorescence microscopy and commercial serological tests. Karen is also an Editor with the Cochrane Diagnostic Test Accuracy Working Group. She is trained in the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to grading the quality of evidence and strength of recommendations. She has contributed to several recent World Health Organization policies on tuberculosis. She serves as Coordinator for the Evidence Synthesis and Policy Subgroup of the Stop TB Partnership’s New Diagnostics Working Group. Karen lives in Portland, Oregon, USA

2. Grant Theron

Affiliation Stellenbosch University
Address Administration B building, Victoria Street, Stellenbosch
Tel: +27 21 808 9111
Email: gtheron@sun.ac.za
Dr Theron works on the evaluation of a DNA-based Xpert MTB/RIF technology has influenced national and global health policy; it includes a four-country randomised controlled trial that was the first to demonstrate its clinical impact and feasibility at the point-of-care when done by non-technical staff. His work, conducted through the Lung Infection and Immunity Unit and the Department of Medicine, has also been incorporated into policy documents compiled by the World Health Organisation. Theron was recently honoured at the NSTF Awards in the TW Kambule Emerging Researcher category. In 2014 he was selected as one of the Mail & Guardian’s Top 200 Young South Africans and he holds career development awards from the Wellcome Trust (UK) and the Medical Research Council (South Africa).

3. Claudia Denkinger

Affiliation FIND
Address Campus Biotech, Building B2, Level 0, 9, Chemin des Mines, 1202 Geneva, Switzerland
Tel: +41 22 749 29 31
Mail: Claudia.Denkinger@finddx.org

Dr. Claudia Denkinger completed her medical school training and doctoral thesis in immunology at the Julius-Maximilians University in Wuerzburg, Germany. She trained in internal medicine at the Beth Israel Deaconess Medical Center (BIDMC), Harvard Medical School, Boston and also was the chief medical resident there.

After her internal medicine training she completed a Master in Tropical Medicine and International Public Health as well as a Diploma in Tropical Medicine and Hygiene at the London School of Hygiene and Tropical Medicine. She has worked in non-governmental organizations in HIV and tuberculosis care in South Africa and South America.

After returning to the BIDMC for an infectious disease fellowship, Dr. Denkinger went on to McGill University for a postdoctoral fellowship focused on tuberculosis epidemiology and impact assessment as well as mathematical modeling of tuberculosis diagnostics. She continues to hold a faculty appointment in the Division of Infectious Disease at the BIDMC, Harvard Medical School, Boston and has published over 40 articles in peer-reviewed journals to date.

4. Ruvandhi Nathavitharana

Affiliation Division of Infectious Diseases, BIDMC/Harvard Medical School, Boston
Address 330 Brookline Ave Boston MA 02215
Tel: +16467152601
Email: rnathavi@bidmc.harvard.edu

Clinical Fellow in Medicine, Beth Israel Deaconess Medical Center/ Harvard Medical School, Boston
5. **Salman Siddiqi**

Affiliation: Freelance Consultant Microbiologist  
Address: 15 Glencoe Manor Court Sparks, MD 21152, USA  
Tel: +1410-329 3839  
Email: rnathavi@bidmc.harvard.edu

Dr Siddiqi is a specialist in Infectious diseases. He has participated in the development of the culture-based DST for TB. His research includes microbiology, Immunology and infectious diseases.

6. **Claudio Köser**

Affiliation: Department of Medicine, University of Cambridge  
Address: Clifford Allbutt Building, Hills Road, Cambridge CB2 0AH, UK  
Tel: +44 1223 331664  
Email: cuk21@cam.ac.uk

Claudio Köser’s PhD at the University of Cambridge focused on the impact of whole-genome sequencing on the study and clinical diagnosis of drug-resistance in the Mycobacterium tuberculosis complex. In this context, he studied the genetic basis of antibiotic resistance in Mycobacterium canettii and the M. tuberculosis complex, both to traditional and novel drugs. His post-doctoral work in Professor Sharon Peacock’s group revolved around the translation of rapid whole-genome sequencing from a tool for research to a routine diagnostic test. This has resulted in a number of high-impact proof-of-principle studies that demonstrated the clinical utility of rapid desktop sequencers for a variety of bacterial pathogens – especially for tracking the spread of pathogens in hospitals and the community. More recently, he has turned his attention to applying modern microbiological principles, which have been the standard for other bacterial pathogens as pioneered by the European Committee on Antimicrobial Susceptibility Testing, to define resistance in tuberculosis.