



UK Science
& Innovation
Network

UK-India Workshop on New Diagnostics and Therapeutics to Tackle Antimicrobial Resistance

Conference Proceedings

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UK Science & Innovation Network, India

Sheryl Anchan [Lead]

Pradeep Pillai

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Executive Summary

The Indo-UK two-day workshop began with discussing opportunities for drug development research, new diagnostic development, new diagnostic alternatives and ended with various Indo-UK initiatives available to tackle infectious diseases and anti-microbial resistance (AMR).

AMR is a moving target. Conventional mechanisms of drug resistance are being replaced and there are evolving ecological nexuses for horizontal transfer of resistances in the microbial world. While we are trying to understand human behaviour that endangers drug resistance, understanding of drug behaviour is also very crucial.

Having systemic structures and governances in place is very vital to help tackle the issue of AMR. The problem goes beyond technological fixes and eventually commitment and actions on issues like regulation, medical and para-medical education and focus on non-medical determinants as well, would by all means help technology yield its benefits in the long run.

Public engagement plays a very important role in the control of diseases. We need public engagement for the acceptance of technologies at the ground level. These are also dependant on the behaviour change that technologies can engender.

On the public health side, while developing laboratories, there was caution indicated in the need to institute a lot of quality-based testing to make sure that the results obtained in the future will be reliable.

The participation of four UK experts including the University of Edinburgh, UCL, Brighton University and the University of Dundee; senior researchers, key government representation, hospital and industry experts from India; and various funding agencies in India and the UK; was reflective of the commitment, the synergy and the good relationship that exists between the ignited minds of the two countries.

Diagnostics

Panel discussion

- Diagnosis of infectious diseases is underserved in the country. Last-mile health care delivery is very important but microbiology centres in peripheral health centres are lacking. Point-of-care technologies and telemedicine capabilities need to be built up to serve the majority of the population.
- Tests to permit differentiation of viral, bacterial and parasitic infections and enable judicious use of antimicrobials are needed, especially for common diseases such as respiratory and diarrheal infections.
- Two key critical areas that need to be addressed regarding medical diagnostics:
 - 1) Use of existing diagnostics- Validation of methods, standardized operating procedures and quality control are needed for reproducible results. Clear guidelines and implementation of them are needed. The National Institute of Biologicals was set up for this purpose, but sadly people without subject- matter knowledge regulated tests such as Dengue tests leading to dispute.
 - 2) Invention of new tests: Problem definition is first step. Access to sample banks is absolutely essential for iterative product development.
- Bio-banks in the country are few and far in between, and exist only for very few diseases such as TB.
- Data standards and clear definitions of user requirements based on intended use and settings are needed. Regulatory framework in the country need to be modernized for proper product registration.
- India requires capacity building both in terms of infrastructure as well as human resources for developing new medical diagnostics. Capacity building at all steps of the way from basic research to application is needed.
- Institutional mechanisms that facilitate industry-academia interactions do exist in some institutions in the country. There is but a need to have teams in place that know the institutional capabilities on one hand as well as market requirements and challenges on the other.

Recommendations

- When developing tests, testing must be done in local field conditions as well, because temperature, humidity, electric power supply, etc. vary a lot across the country.
- Definition of target product profile (TPP) is important. Proper user requirements specification is a more appropriate starting point compared to a technical view. This is true particularly:
 - In the early stages of test development, when interdisciplinary approach is very important, TPP helps bring together experts from multiple disciplines.
 - For usage in peripheral health care settings: At the periphery level, there should be more screening tests rather than too many specific tests. The problem definition should be carefully done depending on the situation.
- It would be good to define and disseminate target product profiles for various infectious diseases so that developers can access them.
- Diagnostic testing in peripheral settings should also be accompanied by dissemination of latest guidelines.
- Transparent and data-driven decisions must be given by regulatory agencies.
- In order to develop successful diagnostic and technical sciences, it is very important to work with companies and doctors and develop good research in the field. One should not ignore social sciences as behaviour is also an important aspect to consider while developing diagnostics.
- An Inter-disciplinary approach is very vital for successful diagnostic development. PhD programmes around medical diagnostics need to impart skills for the lab to market place transition.
- The surveillance networks set up by the ICMR and its strengthening is a key development which will help inform the current trends in AMR in the country. A down-streaming of real-time information to the clinical community as a whole in the country would be very useful.
- There is a need to develop more precise and concise legislation and better communication strategies between governmental bodies and the citizens; the academic, scientific community and industry. There needs to be a stop to multiplicity of efforts in the public health sector and coherence between guidelines, SOPs and accreditation policies.

Opportunities for UK-India collaborations

Infrastructure

- Setting up of isolate/sample banks for validation of tests- a critical requirement especially for SMEs doing product development.
- Augmenting surveillance networks for antimicrobial resistance patterns can help guide international efforts.

Surveillance

- Collaborations in monitoring of infection patterns, particularly in polymicrobial infections, antimicrobial resistance, and use of tertiary care services would be extremely fruitful.
- The study of environmental AMR should be augmented very rapidly in the Indian situation. Owing to the rate at which environmental degradation is taking place in the country, a research study as presented by Brighton University in the area could be very useful.

Academics

- At the academic level, interdisciplinary research- linking biology, engineering and chemistry, can lead to extremely fruitful outcomes as it is generally seen that this sort of mixture in students or institutions helps engender the best form of innovations. In the Indian scenario, convergence at the interdepartmental level is needed more. UK has had a long experience in multidisciplinary courses and Indian academia could adopt developing such multi-disciplinary courses based on such models.
- Engineering schools in India have now been opening up to working with biologists to develop tools to help biologists. Collaborating with the UK biologists in this regard could be explored.

Applied Research

- Excellent technical research happens in institutions in India and the UK. Strengths should be identified as per areas which can be done through joint-workshops, where researchers could meet and work together to understand problems and problem-solving can be attempted in a multi-disciplinary manner.
- UK and India have complimentary areas in the development of affordable medical diagnostics. It is important to identify specific crucial areas that need to be addressed and then develop networks by recruiting partners for more collaborative work.

Expert networks

- Building and strengthening of mentor networks could be a potential opportunity. Eg. Retired fellows of Royal Council have a life-time of learning that can be leveraged. Similarly, India has a strong clinical expertise in treating tropical diseases and such.
- Mentors in UK and India can help create awareness among early students of the needs of the market.

Regulations

- Regulatory framework in the country needs to be harmonized with international regulations to enable maturation of the industry. NICE UK has technology appraisal guidance which could help inform this area.

Translational research & commercialization

- The concept of health technology assessment could be introduced in India as this will help filter out the vagaries of aggressive marketing of technologies by various agencies. Collaboration with UK regulatory authorities to help frame such policies would be productive. Also, as a follow-up to such collaboration, training of the regulatory personnel in India to help gauge the real value and pitfall of these technologies would be very beneficial.
- In the UK, many disruptive technologies have moved from the lab to public health utilization. In India, this translation and commercialization is at a nascent stage. There could be opportunities to share best practices of technology commercialization. However, it is important to note that any model cannot be readily applied in other settings. Each country has to create its own innovation ecosystem, so there will be learning involved for both UK & India as to what could work. Another factor to be considered is the inclusivity of rural India to participate in technology use if not the development.

SIN Comment

- A joint initiative on a medical diagnostic accelerator to stimulate the growth of medical diagnostics and precision medicine in the country could also be considered.

Therapeutics

Panel discussion

- AMR is seen not just in hospitals all over India, but also across the world. Pan drug resistance is also being seen. TB, MRSA, etc. are well known, but drug resistance in gram negative organisms is underestimated.
- Several factors have led to paucity of new antibiotics:
 - Market has become fragmented and smaller, and costs of drug development higher, decreasing return on investment. .
 - Short-term treatments with antibiotics are less profitable than long-term treatments for life style diseases.
 - If at all drugs for gram negative infections are developed, they are kept as reserve drugs, cutting down profitability.
 - Low risk appetite and inadequate capabilities and capital to conduct R&D plague Indian pharma industry.
- Public health should take high importance. It is more cost-effective than drug discovery and in the face of antimicrobial resistance, infection control is key. In UK, the threat of MRSA was addressed largely by infection control and policy measures.
- PhD level research is not carried forward once PhD is over. This needs intervention.
- It is difficult to do preclinical and clinical trials in India. Common platform for dialogue between various stakeholders should be floated.
- Root cause analysis of past failures can lead to new guidelines. All stakeholders should be involved.
- Nationwide implementation of policy for appropriate antibiotic use is lacking.

Recommendations

Academic research & education

- Academia & industry have to come together. Irreproducibility of academic research is a concern for industry - various reasons for this need to be solved, and both parties have to speak the same language.
- Rigorous portfolio management and project management (e.g. with a stage gate process) is essential even in academic settings.
- Drug discovery education should be pursued rigorously. Foreign collaboration in this area will be beneficial.

- Pooled discoveries form a network of universities is needed.

Business models

- Different business models may be tested, from a disseminated model to a fully- integrated one.
- Start-ups should try to access funding from a variety of sources and partnerships. CSR funds may be tapped into for financing.

Policies regarding new drugs

- Foreign funding seems essential in India as local venture capital access is poor. Patient capital for academia-industry collaborations is necessary considering the long product development life cycle.
- Govt. needs to incentivize pharma with opportunities to gain reputation, govt. funding, other funding (e.g. Wellcome Trust), and harmonize regulations,
- Funding and partnerships to cross multiple valleys of death in the path to market is essential. When funding is given, downstream partners should also be lined up. Can Govt. step in to bridge the gaps in funding?
- A policy level intervention could be shared risk (Govt. funding of R&D) and shared rewards (with buy back policy at agreed upon prices).

Policies regarding existing drugs

- Nationwide policies for appropriate antibiotic use need to be implemented, including those against irrational combination therapies.
- Hospitals need infection control units.
- Use of antibiotics in animal husbandry need to be studied.
- Social and cultural factors related to antibiotic use need to be addressed.

Opportunities for UK-India collaborations

- Education for drug discovery.
- Education for doctors and paramedical staff
- Govt. policy & guidelines
- Regulatory bottlenecks should be cleared
- Necessary systems for surveillance and data sharing on AMR need to be put in place.
- Indian industry has the opportunity to contribute to translational research of academic research done world over.

Annex I

Meeting Agenda

UK-India Workshop on New Diagnostics and Therapeutics to Tackle Antimicrobial Resistance Venue: The Taj Mahal Hotel, 1 Mansingh Road, New Delhi- 110011 Date: 12-13 October 2015

Workshop Objectives	The workshop aims to bring together a select group of UK and Indian experts with complementary interests in tackling anti-microbial resistance. The workshop will help bring experts together to discuss emerging needs, opportunities and challenges to diagnostic development and therapeutics and explore potential collaborative solutions.
Background	Antimicrobial resistance (AMR) is a global and complex issue which cannot be solved by any one country acting in isolation. Drug-resistant infections already kill hundreds of thousands a year globally. Failing to tackle Drug-resistant infections will cause 10 million deaths a year and cost up to USD 100 trillion by 2050.

Monday, 12 th Oct 2015		
Time	Session	Speakers
2.00- 2.20pm	Session 1: Keynote	
	Welcome and Introductory remarks	Sheryl Anchan, UK Science and Innovation Network India
	Collaborative models for the development of Drugs and diagnostics	Professor Simon Croft, London School of Hygiene and Tropical Medicine
2.20- 3.20pm	Session 2: Therapeutics Case Studies – Successes and challenges in drug discovery and development	Chair: Dr. Sinha, DBT
	Drug discovery in academic settings	Professor Alan Fairlamb, University of Dundee
	Open Innovation towards Affordable Healthcare	Dr. Anshu Bhardwaj, OSDD
	Novel treatments for Drug-resistant infections	Dr. Balasubramanium, Bugworks
	Treating resistant TB by novel mechanisms	Dr. Shridhar Narayanan, Foundation for Neglected Diseases Research
	Q&A Session	
3.20- 3.35pm	Break	

3.35-4.35pm	Panel discussion: Main barriers for antibiotic drug development and potential research areas for UK-India collaboration Panel discussion: 30min Q&A: 20min Summarising and wrap-up:10min	Chair: Dr. Abdul Ghafur Panellists: Dr. Anshu Bhardwaj Dr. Shridhar Narayanan Prof. Simon Croft Prof. Alan Fairlamb Dr. S. Sinha Dr. Abdul Ghafur
4.35-5.20pm	Session 3: Therapeutics (contd.)	Chair: Dr. Samathanam
	Challenges on novel vaccine development in India	Dr. Kavita Singh, Malaria Vaccine Development Programme
	Diagnostics in drug development	Dr. Till Bachmann, University of Edinburgh
	AMR and Regulatory Gaps in India: Infection Control, Prescribing Practices and drug development	Ms. Dhvani Mehta, Vidhi Centre for Legal Policy
	Q&A	
5.20-5.25pm	Key take-away lessons	Dr. Samathanam, SRM University Haryana
5.25-5.30pm	Closing remarks	Sheryl Anchan, UK Science and Innovation Network India
Tuesday, 13th Oct 2015		
08.30 am	REGISTRATION; TEA	
09.00-09.25am	Session 1	
	Welcome and Introductory remarks	Sarah Mooney, UK Science and Innovation Network India
	Diagnostics- Opportunities for Innovation Research	Dr. Renu Swarup, DBT-BIRAC
	Priorities for Therapeutics and Diagnostics Research in India	Dr. Soumya Swaminathan, Indian Council of Medical Research
	Session 2:	
09.25-10.25am	Panel discussion: Capacity building for diagnostics R&D, highlighting potential UK-India collaborative areas (centres of excellence; bio-banks; data standards; prototyping facilities, etc.) Panel discussion: 30min Q&A: 20min Summarising and Wrap-up:10min	Chair: Dr. Renu Swarup Panellists: ■ Dr. Till Bachmann, University of Edinburgh ■ Dr. Soumya Swaminathan, Indian Council of Medical Research ■ Dr. Ashok Rattan, Mahatma Gandhi University of Medical Sciences and Technology Jaipur ■ Dr. Anil Wali, IIT Delhi ■ Dr. Arti Kapil, AIIMS Delhi ■ Dr. Renu Swarup
	Break	
10.25-10.40am		
10.40-11.45am	Session 3: New & emerging technologies for lab diagnostics & point-of-care diagnostics	Chair: Prof. Alan Fairlamb

	Rapid AMR testing of M. tuberculosis via direct whole genome sequencing	Dr. Josephine Bryant, University College London
	Transforming Clinical Microbiology by Next Generation Sequencing	Dr. Ashok Rattan, Mahatma Gandhi University of Medical Sciences and Technology
	Electrochemical sensors for rapid point of care diagnostics of AMR	Dr. Till Bachmann University of Edinburgh
	Opto-fluidic Technologies for Pathogen Detection in AMR	Dr. Veerendra Kalyan, IISc Bangalore
	Role of rapid diagnostics in evidence-based prescription of antimicrobials	Dr. Suman Kapur, BITS Pilani Hyderabad
	Q&A	
11.45- 11.50am	Break	
11.50- 12.45pm	Session 4: Perspectives from Academia, Government and Hospital bodies Antimicrobial Resistance Surveillance and Research Initiative of ICMR Antibiotic resistance in the environment Hospital Perspective Case Study: Innovations in new drug development to tackle antimicrobial resistance Q&A	Chair: Dr. Josephine Bryant Dr. Kamini Walia , Indian Council of Medical Research Dr. Marjorie Bardiau, Brighton University Dr. Arti Kapil, AIIMS Delhi Dr. Samuel Raj, SRM University Haryana
12.45- 01.45pm	Lunch Break	
1.45- 1.55pm	Session 5: Regulatory & IP Managing IP for UK-India research collaborations	Dr. Vijay Iyer, UK Intellectual Property Office
1.55- 03.00pm	Session 6: Current and Future Initiatives/ Funding Opportunities for AMR research RCUK: Current and Future Activities in AMR Funding Opportunities from BIRAC for AMR Research Translational Funding for AMR Research by Wellcome Trust Longitude Prize Q&A session	Chair: Sukanya Kumar-Sinha Sukanya Kumar Sinha, UK Research Council India Dr. P K S Sarma , DBT-BIRAC Dr. Shirshendu Mukherjee, UK Wellcome Trust Ms Tamar Gosh , NESTA
03.00- 03.15pm	Wrap-up and summary of key take-away lessons	Dr. Nerges Mistry, The Foundation for Medical Research

Annex II

Bio-sketches of Speakers

(in alphabetical order by first name)

Dr Abdul Ghafur MD(Med) MRCP(UK) FRCPath (UK)

Abdul Ghafur is the primary author and coordinator of the "Chennai Declaration", a document and initiative by medical societies in India, to tackle the challenge of antimicrobial resistance from an Indian perspective. He is a Consultant and Adjunct Associate Professor in infectious diseases and Clinical Microbiology at the Apollo Hospitals, Chennai, India. He is an advisory member of the "Longitude prize" announced by British prime minister. Dr Ghafur had the honour of being interviewed by British Medical journal for the "BMJ confidential", featuring work and opinion of individuals who have made bold steps to make change in their field of work. He is one of the country advisors for India for the Royal college of Pathologists of UK. Dr Ghafur has delivered lectures in numerous prestigious international Infectious diseases and antibiotic policy conferences around the world and has been published in well-reputed journals such as the BMJ, Lancet, etc. He is an editorial board member and reviewer of many international journals. He received Indian Medical Association oration award for his contribution towards tackling antibiotics resistance efforts. He is a core committee member for National antibiotic policy and guideline of Indian Ministry of Health.

Prof. Alan Fairlamb, CBE, FLS, FSRE, FMedSci, FRSB

University of Dundee

Professor Alan Fairlamb is a Wellcome Principal Research Fellow in the Division of Biological Chemistry & Drug Discovery, University of Dundee. He obtained his degrees in Medicine (1971) and PhD in Biochemistry (1975) at the University of Edinburgh. He has published over 250 articles and reviews relating to: modes of drug action; mechanisms of drug resistance; chemical and genetic validation of novel drug targets for parasitic diseases; and drug discovery. He has served as a scientific advisor to WHO/TDR, Wellcome Trust, MRC, MMV and DNDi and is a current Trustee for the Tres Cantos Open Lab Foundation. In 2006, he co-founded the Drug Discovery Unit at Dundee that has delivered pre-clinical candidates for sleeping sickness, visceral leishmaniasis and malaria.

Dr Anshu Bhardwaj

CSIR-Open Source Drug Discovery (OSDD) Unit

Anshu Bhardwaj obtained her Ph.D. in Life Sciences (2008) from Center for Cellular and Molecular Biology, Hyderabad. She conceived, designed and implemented crowdsourcing as a tool to tackle challenging scientific problems (Connect to Decode project) and is instrumental in establishing crowdsourced model for open innovation for OSDD. She has published several articles and reviews relating to: prediction of novel drug targets using systems level approaches; prioritization of natural products for druglikeness; genomics towards genotype-phenotype correlations. She served as an Associate scientific advisor to Science Translational Medicine and is on the Editorial board of Frontiers in Systems Biology. She was selected as one of the young Innovator in India by UNDP and for International Visitor Leadership Program by US State Department.

Dr Arti Kapil MD

All India Institute of Medical Sciences, New Delhi

Arti Kapil is a Professor in the Dept. of Microbiology at All India Institute of Medical Sciences, New Delhi, India. She did her Medical School from IGMC, Shimla and MD in Medical Microbiology from PGI Chandigarh, India. She is presently the chief of the Clinical Bacteriology Laboratory. She is also the In-charge of the hospital infection control committee and chairperson of antibiotic stewardship committee at the AIIMS Hospital. She is a technical committee member of the National Accreditation Board for Laboratories and member of the

National Academy of Medical Sciences, India. She is a member of scientific advisory board and steering committee member for various national bodies on Infection control and antimicrobial resistance monitoring. She was awarded an overseas fellowship at CDC , US and international ambassadorship of SHEA, US. In her more than 25 years of experience in the specialization, her contribution in research is related to the hospital acquired bacterial infections, their molecular epidemiology and antimicrobial resistance. She has published around 200 research publications in Indexed journals, has edited the Textbook of Microbiology, contributed chapters in 4 books and is presently the Editor of the Indian Journal Medical Microbiology.

Dr Ashok Rattan

Mahatma Gandhi University of Medical Sciences and Technology, Jaipur

Dr Ashok Rattan is Professor and Head of Department of Microbiology, Immunogenetics and Molecular Biology at Mahatma Gandhi University of Medical Sciences and Technology, Jaipur. He has many years of academic, research and administrative experience in diagnostic microbiology. His main interest has been antimicrobial susceptibility testing and diagnostic mycobacteriology. He has focused on PK PD of antibiotic action and help develop a program for clinical use. He has been an early mover in evaluating and adapting newer technologies for rapid diagnosis in clinical microbiology such as multiplex Real Time PCR for Respiratory tract infections or MALDI TOF for rapid species identification. Next Generation Sequencing appear to offer a technology which could help integrate rapid pathogen identification and antimicrobial stewardship leading to decrease in hospital costs.

Dr Balasubramanian

Bugworks, Bangalore

Balasubramanian (Bala) is currently President-Discovery, Bugworks Research India, where he leads the antibiotics discovery. Previously, Bala was Director at Cellworks Research, where he led the discovery of novel combinations for the treatment of tuberculosis. Prior to this he spent two decades in anti-bacterial drug discovery at AstraZeneca India, where he led the PK/PD science for anti-TB drugs and the discovery of a clinical candidate for treating tuberculosis. He has served as PI on grants from the Wellcome Trust, BMGF, EU and DBT. Bala received PhD from UW-Madison and was a HHMI fellow at the Albert Einstein College of Medicine, NY. Bala has served as vice- Chair (2007) and Chair (2009) for the Gordon Conference of TB Drug Development.

Ms Dhvani Mehta

Vidhi Centre for Legal Policy

Dhvani Mehta is a lawyer and Senior Resident Fellow at the Vidhi Centre for Legal Policy, New Delhi, an independent think-tank doing legal research and assisting government in making better laws. She is also a doctoral student at the University of Oxford and is writing her thesis on the fragmentation of environmental regulation in India. Dhvani has served on the ethics committee of King Edward Memorial Hospital, one of Mumbai's largest public hospitals. She is keenly interested in the intersection between rights-based approaches to health and drug regulation, and is currently collaborating with Queen Mary University, London and the Oswaldo Cruz Foundation, Rio de Janeiro, on an interdisciplinary project to develop a needs-based system of medicine approvals and surveillance.

Dr Josephine Bryant

University College London

Josephine is a post-doctoral researcher at University College London. Her research centres around the application of whole genome sequencing to pathogens. She is an expert on tuberculosis genomics through her PhD studies at the Wellcome Trust Sanger Institute and is trained in bioinformatics. Her current research on tuberculosis and cytomegalovirus is supported by the EU funded PATHSEEK project. This project aims to use new technology to enable rapid sequencing of pathogens (both bacterial and viral) directly from clinical

samples. This technology has the potential to enable rapid antimicrobial resistance testing, and provide an alternative to current diagnostic pipelines which are often slow and provide a lower resolution of information than genome sequencing.

Dr Kamini Walia

Indian Council of Medical Research

Dr Kamini Walia is a microbiologist by training and has subsequently trained in public health from Johns Hopkins. She is working as Scientist D in the Division of Epidemiology and Communicable Diseases Division of Indian Council of Medical Research. She also spent 2 years in PATH, as Director, Research and Development. Dr Walia has vast experience of working with HIV/AIDS programs, vaccines and diagnostics. She was instrumental in initiating ICMR-NIH collaboration on HIV/AIDS prevention and treatment. This collaboration has now completely 6 years and has been very productive which has benefitted HIV/AIDS related research in country. She is currently leading setting up of Antimicrobial Surveillance Network of ICMR and coordinating activities of Antimicrobial Stewardship Program for entire country. Through this initiative she has been able to build collaborations with Research Council Norway and National Institutes of Health, USA to address different aspects of AMR. She is recipient if ICMR's Shakuntala Amir Chand award and Indian National Science academy, Young Scientist Award. She has received numerous fellowships and trainings from WHO, NIH, USA, IIVI, Seoul, Pasteur Institute, France.

Dr Kavita Singh

Malaria Vaccine Development Program

Dr Singh, is the Program Director of Malaria Vaccine Development Program (MVDP) since July 2009. MVDP is a not-for-profit research society established with an objective to "advance and accelerate cost effective early translational development of novel vaccines against malaria" identified by academic institutes. MVDP has successfully advanced development of three malaria vaccine candidates. Prior to joining MVDP, she worked for about 12 years in the Indian Pharmaceutical and Biotech Industry on clinical development of new drugs and vaccines. Her prior engagements have been with Ranbaxy Laboratories, Shantha Biotechnics (now Sanofi Pasteur group) and Fortis Clinical Research. Dr Singh has a Medical undergraduate degree, MD in Medical Microbiology from PGI, Chandigarh and certificate course in Executive Program in Business Management from IIM, Kolkata.

Dr Marjorie Bardiau

Brighton University

Dr Bardiau graduated in biology and obtained a PhD in microbiology at the University of Liege in Belgium. She worked on enterohemorrhagic Escherichia coli from calves and humans and *Staphylococcus aureus* from bovine mastitis. For both pathogens, she focused a part of her research on antibiotic resistance (antibiotic profile of *E. coli* in wild animals, MRSA isolation from bovine mastitis, etc). Dr Bardiau is currently a Marie Curie post-doctoral fellow in the Environment & Public Health Research Group (EPHReG) at the University of Brighton. Her current research is about antibiotic resistant bacteria in wastewater, how different types of wastewater treatment plants remove these bacteria and how they are spread in the environment via the release of treated (or non-treated) wastewater in rivers. She is also studying antibiotic resistance in wild life in Southern UK.

Dr Nerges Mistry

The Foundation for Medical Research

Nerges Mistry is the Director of the Foundation for Medical Research and Foundation for Research in Community Health. Her interests include molecular epidemiology, evolution and prediction of MDR TB. Her field based research extends to areas of pathways to accessing care and airborne infection control in urban locations. She has worked extensively in rural health with a focus on non-communicable diseases and quality perspectives. She is a guide

at Mumbai University and a member of several Committees at the national level. Her collaborators in the UK include Imperial College, the JR Hospital Oxford, LSHTM, RCOG and NICE. Dr Mistry has 83 publications and has been a principal investigator of 30 major projects.

Dr P.K.S. Sarma

Head Technical (Discovery & Product Development), BIRAC

Dr Sarma has seventeen years of industry research and two years of science management experience. His expertise includes Identifying discovery compounds/technologies that are of commercial and social benefit, due diligence for early stage technologies, anticipating future needs in priority areas and plan for research & translational activities, strategizing translational

activities from research to product development and providing networking support to industry, funding agencies and academia. Prior to joining BIRAC, Dr Sarma worked as Director-Medicinal Chemistry/Synthesis at Jubilant. He obtained his Ph.D from University of Hyderabad & Post-doc from Queen's University, Belfast. His domain Expertise includes Medicinal chemistry, organic synthesis, methodology development, parallel synthesis, total synthesis of natural products & process development and has functional expertise in leading and collaborating on multi- disciplinary discovery teams. His accomplishments include ~80 patent applications, 10 publications, three reviews and three poster presentations in ACS meeting. Dr Sarma's name was mentioned in the inaugural edition of Marquis's Who's Who in Asia.

Dr Renu Swarup

Managing Director, DBT-BIRAC

Renu Swarup is presently Senior Adviser for Department of Biotechnology (DBT). She also holds position of Managing Director, Biotechnology Industry Research Assistance Council (BIRAC), a Public Sector Company incorporated by the Government to nurture and promote innovation research in the Biotech Enterprise with special focus on Start-ups and SMEs. A PhD in Genetics and Plant Breeding, Dr Renu Swarup completed her Post Doctoral at The John Innes Centre, Norwich UK, under Commonwealth Scholarship and returned to India to take up the assignment of a Science Manager in the Department of Biotechnology, Ministry of Science and Technology, Gol, in 1989. At DBT, she heads the National Bioresource Development Board and is involved in developing, funding and monitoring programmes in the area of Energy Biosciences, Bioresource Development and Utilization and Plant Biotechnology - Bioprospecting, Tissue Culture and other Biomass associated programmes. Dr Renu Swarup also holds charge of Managing Director, Biotechnology Industry Research Assistance Council (BIRAC), a Public Sector Company incorporated by the Government of India to nurture and promote innovation research in the Biotech Enterprise with special focus on Start-ups and SMEs. She was responsible for getting the new organisation created and getting it operational. BIRAC successfully runs a large number of funding schemes for Industry Innovation, ranging from the Ignition Grant to Proof of Concept funding, validation and product development. The main focus of the organisation is on enabling and supporting the Biotech Innovation Ecosystem.

Dr Samuel Raj

SRM University Haryana

Samuel Raj is a Professor of Microbiology and Biotechnology and Director of the Centre for Drug Design Discovery & Development (C4D) at SRM University Haryana. He has 10 years Research & Development experience from two major Pharmaceutical Industries Ranbaxy and Daiichi Sankyo and 15 years international experience including the prestigious University of Pennsylvania, USA. He has special interest on antimicrobial resistance (AMR) and neglected diseases (TB, Leishmaniasis, Malaria and Dengue) and initiated the international collaboration to discover new drugs against infectious diseases. He has expounded his ideas at various scientific meetings and workshops in UK, USA, Switzerland, Italy, Japan, China, India and so forth. He has won many international awards including the prestigious Tokyo

Biochemical Research Foundation (TBRF) award, Karmaveer Chakra and STARS Fellow (Switzerland).

Dr Shirshendu Mukherjee

UK Wellcome Trust

Shirshendu Mukherjee, trained as Medical Microbiologist, has Global and national exposure with more than two decades of high level work experience in top organisations , which helps to bring to fore cumulative perspectives on issues related to healthcare (especially public health issues and unmet medical needs), food and nutritional challenges in India as well as across the globe, he has devised and formulated strategies for mitigating challenges and bridging gaps through impact funding. He has worked independently as well as with multitudes of partners (both national & international) for a complete oversight of cutting edge translational research and deep understanding of issues that impinge up on national and global translational research. He has deep knowledge in pharmaceuticals, biopharmaceuticals and med tech industry globally. Presently, Dr Mukherjee, heads the India Initiative of Wellcome Trust and manages the R&D for Affordable Healthcare In India, a £30 million Initiative of the Wellcome Trust in India. The Initiative funds translation research leading to affordable healthcare solution in India and beyond. Dr Mukherjee holds Ph.D. in Microbiology, Law graduate, Advance Course in Strategy Management form IIM Kolkata and management and leadership course form Said Business school university of Oxford.

Dr Shridhar Narayanan

Foundation for Neglected Disease Research

Shridhar has more than 15 years of drug discovery and development experience in Indian pharmaceutical industry in various therapeutic areas. Shridhar holds a PhD in Pharmacology from Ohio State University, and has post-doctoral experience in Neuropharmacology at the University of California, Los Angeles. Shridhar is currently Founder Director and Chief Scientific Officer of Foundation for Neglected Disease Research, a not for profit company with a mission to discover and develop drugs for diseases of the developing world. Previously, Shridhar was the Vice President and Head of Innovative Science for the Infection Innovative Medicines group at AstraZeneca, India and was responsible for the discovery and development of 2 potential clinical candidates in TB and malaria. Shridhar has also been the Executive Vice President-Discovery Biology and Drug Development at Orchid Chemicals and Pharmaceuticals. Shridhar has overseen Discovery and Development of 15 clinical candidates. He has also executed out-licensing deals with major pharma as well as in-licensing of candidates (NCE/NBE) which are in active development. This has generated revenues in excess of 100 million USD. Shridhar has been a member of joint research committees, academic and industry collaborations and has served as a Ph.D. guide.

Prof Simon L Croft PhD FRSB

London School of Hygiene and Tropical Medicine

Simon Croft is Professor of Parasitology in the Faculty of Infectious and Tropical Diseases at the London School of Hygiene & Tropical Medicine (LSHTM). He has worked on the discovery and development of anti-infective drugs in academia, industry and public-private partnerships. Simon's research has focussed on the R & D of novel drugs and formulations for the treatment of leishmaniasis, malaria, human African trypanosomiasis and Chagas disease, including projects on miltefosine, Ambisome and topical paromomycin, all of which reached clinical trials for the treatment of leishmaniasis. Current research interests include PK PD relationships, predictive models for drugs and vaccines, and topical formulations. He works extensively with industry and PDPs on Neglected Infectious Diseases and with a network of collaborators in disease endemic countries. From 2004 to 2007 Simon was the first R & D Director of the Drugs for Neglected Diseases Initiative (DNDi), Geneva and from 2008 to 2014 he was Dean of Faculty at the LSHTM.

Dr Soumya Swaminathan

Indian Council for Medical Research

Dr. Soumya Swaminathan, MD, FIAP, FASc, FNASC, FAMS is a pediatrician by training, having completed her medical education at the Armed Forces Medical College and the All India Institute of Medical Sciences (India) followed by a fellowship in pediatric pulmonology at the Children's Hospital of Los Angeles (USA). She has spent over 24 years at the Tuberculosis Research Centre in Chennai, South India (now renamed National Institute for Research in Tuberculosis) where she was the principal investigator for several clinical trials investigating treatment and prevention of TB among HIV-infected patients and was also involved in operational, epidemiologic and behavioral research. She is currently Director of the centre and heads the NIH International Centre for Excellence in Research. She has over 190 peer-reviewed publications, serves on many national and international committees. Her major research interests are in pediatric and adult TB, their interaction with HIV and nutrition and management of co infections, as well as pharmacokinetics and pharmacogenetics.

Ms Sukanya Kumar-Sinha

RCUK India

Sukanya is Deputy Director at RCUK India. She joined RCUK India in October 2008. In her current role, Sukanya leads on developing and delivering UK-India programmes in joint research across the remit of the UK's seven Research Councils. Over the last 7 years, she has worked closely with Indian partners like DST, DBT, ICMR and DAE to explore and agree mutual priorities for UK-India research partnership. Prior to joining RCUK, she worked with the UK Border Agency office in New Delhi. She has also, previously, worked with The Times of India as Executive in editorial quality audit.

Dr Suman Kapur

BITS Pilani Hyderabad

Suman Kapur is a Senior Professor and HOD at BITS Pilani Hyderabad campus. Her research interests are Genetic markers for vulnerability to chronic human diseases, screening strategies for low-cost settings, medical devices for field deployment in low resource settings and disease prevention through herbal/natural products. Suman holds several patents, has published and/or edited several books, has published >200 peer-reviewed scientific articles, has delivered > 150 invited/keynote lectures and has organized several scientific meetings, workshops and dedicated trainings. Prof. Kapur was awarded the Photon Research Award, 2015 for her work on antimicrobials. She is an expert member on several panels related to stem cells therapeutics, functional foods and nutraceuticals (FSSAI), standards for food and water requirements during disaster management (NDMA) and jury for several award committees for awards in Science e.g. BM Birla, Ranbaxy Research and King Faisal science awards and has received ~1.5 million GBP for research in >20 grants funded by Govt. of India & Indian industries.

Dr Till Bachmann

University of Edinburgh

Till Bachmann is a Reader in Personalised Medicine in Infectious Diseases and Deputy Head of the Division of Infection and Pathway Medicine at The University of Edinburgh as well as the Director of the online MSc in Clinical Microbiology and Infectious Diseases. He is an expert in point of care detection of infectious diseases and antimicrobial resistance, conducting research at the interface of biomarkers and novel detection modalities. Till fulfills a variety of industrial and institutional advisory roles worldwide.

Mr Veerendra Kalyan Jagannadh, M.Sc(Hons), B.E.(Hons).

Indian Institute of Science

Veerendra completed the Dual degree in M.Sc(Hons) Chemistry and B.E (Hons) in Electronics and Instrumentation from Birla Institute of Technology & Science, Pilani (BITS-Pilani) in 2012. As a visiting student, he carried out his thesis work at Bio-Engineering laboratory, D-BSSE, ETH Zurich. Since 2013, he has been a graduate student at the optics & microfluidics

instrumentation lab of the applied physics department at Indian Institute of Science (IISc), Bangalore. The focus of his research is on developing high-throughput optofluidic imaging systems with applications in cellular diagnostics. His other research interests include digital image processing and computational imaging flow cytometry, flow focusing in microfluidics.

Annex III

Testimonial

"The workshop was very well organised and gave us an opportunity to discuss face to face with India delegates the issues and challenges in both of our countries, thereby helping build our knowledge about the ecosystem that exists and the potential areas where collaborations could happen. Thanks to the science and innovation network for such a splendid job!"

Dr. Till Bachmann

University of Edinburgh