Institution: London School of Hygiene & Tropical Medicine (LSHTM)

Unit of Assessment: UoA1 – Clinical Medicine

a. Context

LSHTM is a world-leading school of public health. Our research activities involve collaborations in over 100 countries. Our established strengths in basic laboratory science, clinical medicine and population health provide numerous pathways for rapid translation of basic scientific discoveries into therapeutic and preventive interventions, and for their subsequent implementation and evaluation.

International users and beneficiaries of our UoA1 research include WHO, UNAIDS, UNICEF, the Global Fund to Fight AIDS, Tuberculosis (TB) and Malaria, the World Bank, major NGOs such as MSF and Sightsavers, and product development partnerships such as the Medicines for Malaria Venture, the Foundation for Innovative New Diagnostics and the Drugs for Neglected Diseases Initiative (DNDi). Our 10 academic staff based overseas, and our numerous international collaborators, have close personal links with their national governments through the Ministries of Health and Education, ensuring that the results of our research influence policy at the national and international levels. Many alumni have held influential positions (e.g. Dan Carucci, Vice President of Global Health, UN Foundation; Luka Monoja, Minister for Cabinet Affairs, and Barnaba Benjamin Bill, Minister of Commerce and Industry, South Sudan; Tedros Ghebreyesus, formerly Ethiopian Minister of Health, now Minister of Foreign Affairs; Francis Kasolo, Director, Disease Prevention and Control, WHO/AFRO), and we maintain close links with them through our alumni network.

Our case studies show that our impact is primarily on improved health outcomes achieved through research leading to new vaccines, drugs and diagnostics, and through influencing health policy at sub-national, national and global levels. In the past five years our research has led to changes in policy for control of HIV, TB and other opportunistic infections in southern Africa, to new malaria control strategies in countries in West Africa, and to improved syphilis control strategies in Brazil, China, Peru, Tanzania, Uganda and Zambia. We have worked with the Gambian National Eye Care programme to eliminate blinding trachoma.

In addition to the health benefits and improved productivity arising directly from new interventions and policies implemented as a result of our research, our UoA1 staff have played a major role in strengthening research capacity in low-income countries. For example, we are partners in six African research capacity-building consortia funded by the Wellcome Trust. Such capacity is vital for achieving sustainable development and long-term health impacts.

Within the UK the users of our research, and those who benefit from it, include: the Department for International Development (new, evidence-based strategies for the control of malaria, trachoma and other neglected tropical diseases); the Department for Business, Innovation and Skills (product development partnerships for new diagnostics for high-burden diseases in low- and middle-income countries); the Food Standards Agency (improved understanding of microbial contamination of the food chain); the Department for Environment, Food and Rural Affairs (development and evaluation of new vaccines against bluetongue virus); the NHS (population genetic studies to track transmission of hospital-acquired infections, such as *Clostridium difficile*, *Acinetobacter baumannii* and *Staphylococcus aureus*); and the Ministry of Defence (development of novel glycoconjugate vaccines to counteract bioterrorist threats). The national Malaria Reference Laboratory is embedded within the School and has benefited from our development of new diagnostic tools such as the LAMP assay.

Industry, including international pharmaceutical and diagnostics companies, is also an important user (e.g. Boehringer Ingelheim for bluetongue virus vaccine, Paladin Labs Inc. for miltefosine, a drug to treat leishmaniasis discovered by School researchers).

b. Approach to impact

This section describes the main elements of our multifaceted approach to impact, and highlights how we have strengthened this approach during the REF assessment period.

Interdisciplinary collaboration

Interdisciplinary collaboration facilitates the translation of our research results into policy and practice and is a key emphasis at the School. Our 13 School Centres cut across disciplines, departments and faculties. For example, the Malaria Centre, established in 1998, fosters a close working relationship across UoA1 and UoA2, and with user communities, enabling us to maximise the impact of our research on malaria control and prevention. The Malaria Centre's annual retreat is attended by more than 100 staff and key external stakeholders and, for example, informal discussion over several retreats led to the award to the School of a US$40m grant from the Bill & Melinda Gates Foundation for the ACT Consortium. Working closely with WHO to ensure policy relevance and impact, the Consortium is tackling key questions on access to artemisinin-based combination therapy (ACT), and targeting, safety and quality, in Africa and Asia.

Since 2012 we have held an annual School symposium to bring all staff together, including those based overseas. In 2013 the theme was 'Achieving impact'; we showcased good practice within the School and discussed how to address specific difficulties concerned with achieving impact. One of the four sessions, 'From innovation to implementation: the example of vaccines', featured speakers engaged in the whole pipeline of vaccine research from antigen discovery and development of a novel approach to the synthesis of glycoconjugate vaccines, through to evaluation of vaccine effectiveness, policy and advocacy. Also in 2012 we launched LSHTM Research Online, an open access repository offering free public access to our research outputs. We are developing an online data repository to facilitate the reuse and reanalysis of data and the validation of research findings both internally and externally.

Engaging with policy-shapers and implementers

We actively encourage academic staff to play a role in organisations that shape health policy. For example, staff submitted to UoA1 sat on nine WHO expert committees from 2008–2013. The School supports staff with periods of paid study leave, and staff in UoA1 have used these to take forward their research findings by collaborating with industry and/or working overseas (e.g. Croft was seconded to the Public Health Foundation of India in 2013). Our large research consortia are guided by international steering committees to ensure inclusion of users' perspectives, including industry stakeholders. For example, the BBSRC programme on diagnostic platforms and vaccines for porcine respiratory pathogens (Wren) has external advisors from Pfizer US and from Canadian and German industry; the cross-council Environmental and Social Ecology of Infectious Disease Programme on *Plasmodium knowlesi* (Drakeley) has external advisors who are research users in Indonesia, Malaysia and the Philippines.

Long-term research collaborations

The clear focus of our mission encourages long-term commitment to work within countries to improve health outcomes. For example, our staff have been working with the MRC Unit in The Gambia for more than 35 years, and in Uganda and Tanzania for more than 20 years. Collaborative studies led by LSHTM staff in the 1990s on the use of insecticide impregnated bed nets in The Gambia (Greenwood) and Tanzania (Curtis) have had a major influence on policy and practice across Africa. Similarly, early work on human immunity to malarial sporozoites (Targett) laid the groundwork for the subsequent development of the RTS,S vaccine, which has been evaluated in LSHTM-supported trials in The Gambia, Ghana, Tanzania and elsewhere and will soon be made commercially available by GSK. School staff (Mabey) showed in The Gambia that a single oral dose of azithromycin was an effective treatment for trachoma, leading to the elimination of blinding trachoma from The Gambia and six other countries.

Supporting technology transfer

A technology transfer office evaluates our laboratory research for commercial opportunities prior to public disclosure. Patents, confidential disclosure agreements and material transfer agreements are assigned to protect researchers' and the School's intellectual property. Eleven patents have been granted across the School during 2012/13. The office helps staff secure external funding to translate research findings into products and interventions. Recent examples include awards from the MRC Technology Development Pathways Funders Scheme to develop drugs for malaria (Baker) and schistosomiasis (Bickle).

Public engagement

Dissemination activities and policy and practice impact are explicitly included as desirable elements of a staff profile in the School's 'career map', which sets the expectations for staff promotion. Following a communications review, the Department of External Relations was set up in 2011 to better support staff members to effectively communicate their research results to policy-makers, the media and the public. The Malaria Centre and the ACT Consortium each employ a specialist communications officer. The impact of these changes is clear: global media coverage of our research increased by 67% in 2012/2013 compared with 2011/2012. One example is an interview given by Riley to Agence France-Presse in November 2012 about the results of the RTS,S malaria vaccine trial that led to over 300 press articles worldwide. Our research is frequently reported in the UK press and in *The Economist* and other global news magazines. UoA1 staff members have been interviewed on all the UK TV news channels and radio stations and on *Horizon*, *Panorama* and *Newsnight*. For example, between 2008 and 2013 Wren had 615 pieces of coverage and Sutherland 426.

To further improve how we communicate with the public, we launched a new website in October 2011, including more comprehensive coverage of our research activities around the world. We regularly appear at science festivals and hold public lectures and high-impact public engagement events with *The Lancet*, the Royal Society of Medicine, University College London (UCL) and the Wellcome Trust, among other partners. Annual open days organised by School staff (Elliot) at the Uganda Virus Research Institute between 2009 and 2013 were attended by more than 1,500 schoolchildren, undergraduates and their teachers, plus media and public leaders, including the Minister of Health on two occasions. Open lectures were given at the Royal Academy of Ireland ('Genes, germs and genomes', Wren), the Science Museum ('Chlamydial infections', Mabey) and the Lichfield Science & Engineering Society ('Drug development for diseases of poverty', Croft).

c. Strategy and plans

Research, teaching and knowledge translation are the three pillars of the School Strategy for 2012–2017. Specific objectives for knowledge translation are to:

- communicate our research to the general public to increase understanding and facilitate greater participation in health policy debate
- engage in responsible partnerships with industry and governments
- develop contract research and consultancy in translational medicine and evaluation
- influence policy and the national and global research agenda
- strengthen and maximise the School's business development, including its intellectual property portfolio.

We recently established the Bloomsbury Research Institute (BRI) as a joint initiative with UCL to develop a global centre for excellence in research on infectious diseases. A new, purpose-built BRI laboratory is expected to open in 2017, providing state-of-the-art facilities for the largest group of academic researchers in Europe working on infectious diseases. Staff have already developed strong collaborative links with two major pharmaceutical companies (GSK, Novartis) and BRI plans to build further collaborations with partners in the biotech sector. These links will represent a

significant inward investment opportunity and will be enabled by an 'open-lab' concept, built around the goal of generating new therapeutic tools. A School-owned company, Chariot Innovations Ltd, was set up in 2012 to focus on commercially-viable knowledge translation activities.

The International Diagnostics Centre will develop further its relationships with the major diagnostics companies (e.g. Alere, Abbott, Becton Dickinson, Standard Diagnostics) and regulatory authorities to reduce barriers to market entry, and hence accelerate access to and reduce the costs of new diagnostic tests for low-income countries. The newly established London Centre for Neglected Tropical Diseases Research (LSHTM, Imperial College, the Natural History Museum) will work with WHO and major NGOs to complete the world map of trachoma, and develop and evaluate a common diagnostics platform to support the elimination of trachoma and other neglected tropical diseases.

d. Relationship to case studies

Our seven case studies show how our unique international reach, our focus on specific diseases and our strategies to promote the uptake of our research have led to significant improvements in clinical medicine, global health and international development. Our approach has enabled UoA1 staff who mapped the global dissemination of drug-resistant malaria parasites over time (Roper) to shape global and national policy on drug choice, combating the development and spread of drug resistance. Our approach has supported staff who made important discoveries on malaria transmission-reducing drugs and vaccines (Drakeley, Bousema, Targett) to influence WHO guidelines on treatment and elimination, and the Medicines for Malaria Venture's criteria for drug development. Our demonstration, using LAMP technology, of vastly improved detection of malaria parasites in suspected cases presenting to UK hospitals (Sutherland) led to the method we pioneered being formulated into a CE-marked kit to be marketed internationally. We have used multi-country clinical trials to provide the science which has underpinned the global trachoma elimination campaign (Mabey).

Our policy of encouraging academic staff to play an active role in international organisations has enabled our researchers to support informed decision-making. For example, Croft identified miltefosine as a promising anti-leishmanial drug, helped to identify industrial partners with WHO-TDR and led work to include the drug in combination studies when he was on secondment as R&D Director at DNDi in Geneva. The drug is now widely used to treat visceral leishmaniasis in Bangladesh, India and Nepal, and cutaneous leishmaniasis in Latin America. Our efforts to promote dialogue with the media have led to extensive press coverage of our research, which has helped to change policy and practice. For example, coverage of our research on the prevention of congenital syphilis (Mabey) raised the profile of this forgotten disease internationally, encouraging WHO to initiate a programme for the elimination of mother-to-child transmission of syphilis. Our support for technology transfer has led to the award of two patents to develop reverse genetics for novel vaccine design and the commercial development of a bluetongue virus vaccine with Boehringer Ingelheim (Roy).

Collectively, the case studies point to the critical success factors in our approach to impact: policy relevant research (addressing health priorities), collaboration (across disciplines, sectors, stakeholders and countries), long-term commitment and effective communication.