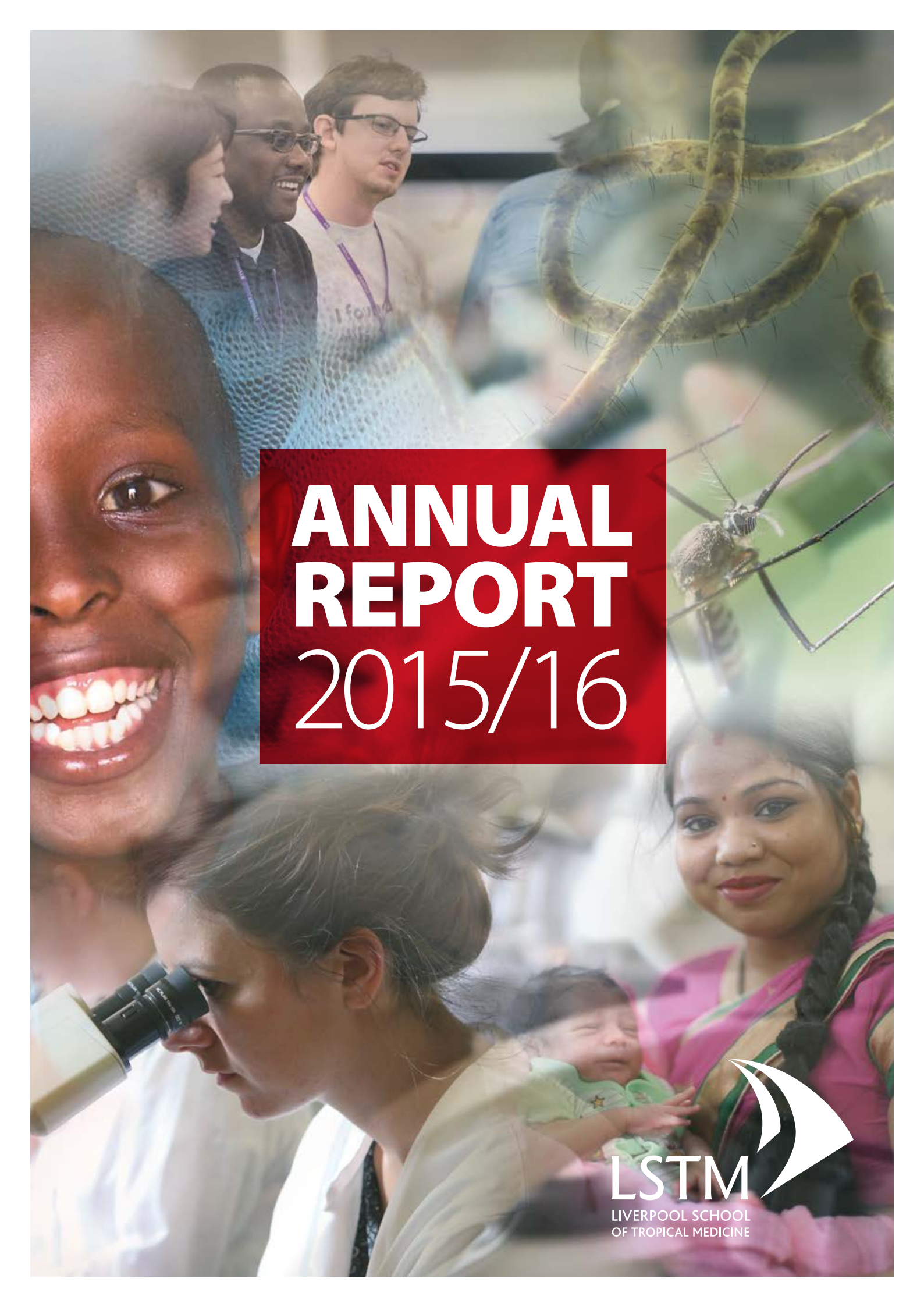




ANNUAL REPORT 2015/16

LSTM
LIVERPOOL SCHOOL
OF TROPICAL MEDICINE



Welcome

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Vision:

To save lives in resource poor countries through research, education and capacity strengthening

Mission:

To reduce the burden of sickness and mortality in disease endemic countries through the delivery of effective interventions which improve human health and are relevant to the poorest communities

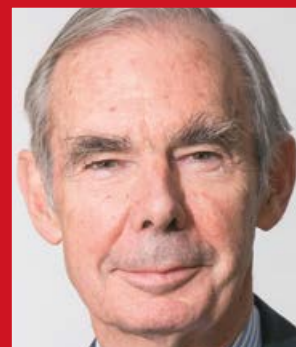
Values:

- Making a difference to health and wellbeing
- Excellence in innovation, leadership and science
- Achieving and delivering through partnership
- An ethical ethos founded on respect, accountability and honesty
- Creating a great place to work and study

COUNTDOWN Cameroon team members are moving their mobile laboratory on foot to various black fly breeding sites in the area of the Meme river basin, Mbonge district, South West Cameroon. The black fly is the vector that transmits Onchocerciasis (river blindness). LSTM is a partner in, and hosts, the **COUNTDOWN** consortium.

Chairman's Foreword

As you will see from the Treasurer's report on page 6, LSTM has had another successful financial year and has produced a surplus. With no borrowings and a good pipeline of research awards, we face the future with continuing confidence.



However there can be no room for complacency, since we are not (yet) consistently achieving the 3% surplus which the Higher Education Funding Council for England has set as a norm for Higher Education Institutions.

Much more importantly, in common with most of academia and the research community, we face degrees of uncertainty which are unprecedented in recent decades. The result of the EU Referendum seems to fly in the face of just about everything which LSTM stands for – international co-operation of the highest degree, the attraction of funding streams from the widest array of sources including the European Union, and the free movement of talent around the world to address the challenges of 'saving lives', regardless of where those lives are lived. LSTM will argue its corner and doubtless the most dire of predictions will prove exaggerated. But this is a most unwelcome challenge.

Against this background, LSTM is now engaged in shaping its strategy for the next five years. More of this over the next few months, but clearly management succession will

figure prominently, as the next generation begins to build on the outstanding success of the current leadership. One of the themes of the fundraising initiative that is being spearheaded by the new Director of Fundraising, Karen Brady, will be investment in the future leadership of LSTM.

During the last decade of growth, LSTM has been extraordinarily fortunate to have a dedicated and effective board of directors. Several of them are now due to retire, having served their statutory terms. I would like to thank and pay tribute to Ian Jones, Jonathan Brown, Trevor Francis, and Andre Winter on behalf of all at LSTM, for their unstinted support of LSTM and their wise counsel.

James Ross OBE
Chairman

“ LSTM has had another successful financial year and has produced a surplus. With no borrowings and a good pipeline of research awards, we face the future with continuing confidence. ”



How donations shaped LSTM

Donations from Liverpool shipping magnates enable the foundation of LSTM. Sir Alfred Lewis Jones, Head of the Elder Dempster Shipping Line, remains a donor over the next decade. The Elder Dempster Ghana and Nigeria Independence Trust continues to support LSTM today.



1898

1899

1900

Director's Foreword

This year has been yet another busy one for LSTM. Long after Ebola ceased to be headline news, we continued to provide training and support, helping the affected African countries restore their health services. Another zoonotic disease, Zika, then made the headlines and our clinicians and vector biologists were in heavy demand, providing help and support to a raft of national and international agencies who were trying to deal with the spread of transmission.

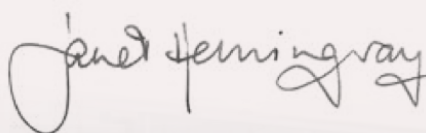
Between both outbreaks, LSTM played host to a joint visit of one of our longstanding and major funders, Mr Bill Gates and the then Chancellor of the Exchequer, The Rt. Hon George Osborne MP. Ahead of a tour of our research facilities, both guests addressed invited guests and media in detail about the Ross Fund, which aims to support the global fight against malaria and is named after the UK's first Nobel Laureate and LSTM's first lecturer, Sir Ronald Ross.

On the teaching front, we are progressing well through the process of obtaining direct Degree Awarding Powers for both teaching and research degrees, with a year of scrutiny completed at our final exam board in September. We hope that the outcome will be the ability to award our own degrees from 2017/18 onwards.

The political and economic uncertainties around Brexit remain a major risk for LSTM, with access to and influence of various European research platforms an issue. The uncertainty around European student status going forward, coupled with changes to overseas student and family visas under discussion, may also affect the balance and size of our student cohort going forward. We are working with various partners and stakeholders to try and mitigate these risks, and ensure that we re-emphasise the global co-operative nature of our activities.

Our research portfolio remains healthy, with major expansions in Maternal and Newborn Health and Insect Vector Behaviour, where we are recognised by many as world leaders. Expansion of our estate, with the new Liverpool Life Sciences Accelerator building due to open in mid-2017, will allow us to cope with our ongoing growth and house our new staff working on antimicrobial resistance. I am also very pleased with our newly recruited Director of Strategic Projects, Professor Peter Winstanley, who will manage and coordinate further growth opportunities.

We are grateful for the continued support we get from so many of our donors and stakeholders, ensuring that we continue to have a positive impact on global health.



Professor Janet Hemingway CBE



Treasurer's Report

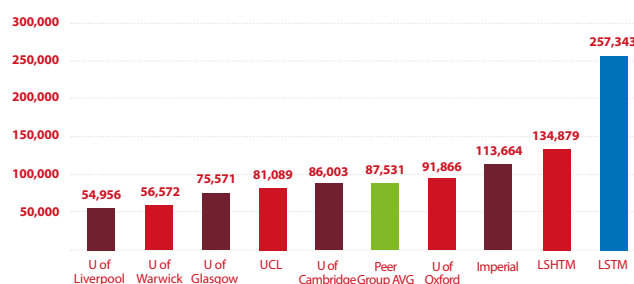
For the eighth successive year the LSTM Group is able to report a record level of income, with an increase of £4m on the previous year, taking the total income to £77m. Of this total, research income accounted for £60m, showing year-on-year growth of almost 10%. Tuition fees and education contracts produced £3.3m, up 13% on the prior year.



After all expenditure, the Group retained a healthy surplus for the year of £3.1m. Under normal circumstances we would have expected this to result in an increase in the total funds shown in the balance sheet to approximately £70m, but new UK accounting standards were introduced which has had a significantly adverse effect on the appearance of the balance sheet. The main difference relates to the treatment of substantial deferred grants, received for past property improvements. Under the previous accounting rules these grants were written-off over a period of many years, but must now be shown in their entirety as a liability. The effect has been to reduce net assets from £70m to £40.4m. As the deferred grants will never need to be repaid, this change, in the case of LSTM, creates a misleading impression, and we are totally confident that the organisation is in a very healthy financial state.

A major factor in sustaining the impressive growth profile has been the continuing significant investment in people, with key vacancies and new posts being filled in a highly challenging skilled labour market. The research grant funding available per staff FTE is significant as the below figure indicates. The number of LSTM Group's full-time employees rose to 490 - an increase of 13% on the prior year - providing a solid platform for the future of the institution.

**Research Grant Funding per Staff FTE
(Research & Teaching/Research) 2014-2015**



The graph shows LSTM's peer HEI group, identified from institutions with a minimum of £40M Annual Research Grants and Contracts. This particular graph demonstrated the Research Grants & Contract Income per Teaching/Research Full-Time Equivalent (FTE), showing that LSTM attracted nearly double per FTE compared to the next institution. Source: HESA published data relating to the 14/15 HESA Finance Return and the 14/15 HESA Staff Return

The excellent facilities which have been created over the past decade have played a key part in attracting top talent to LSTM. In total, an amount well in excess of £50m has been invested in property in the last ten years, with no recourse whatsoever to borrowings. 2015/16 from an estates perspective was, in relative terms, a period of consolidation, although work is ongoing for a further expansion which will, in 2017, see LSTM occupy two floors of the Liverpool Life Sciences Accelerator building currently being built in partnership with Royal Liverpool University Hospital.

When embarking on any new investment programme, the Trustees have full regard of the potential risks, particularly in respect of the possibility of any future significant downturn in activity. With that in mind, the Board looks to a well spread portfolio of research grants with an acceptable profile of future income streams.

As at September 2016, the total of unexpended grants amounted to £169m, spread between many funding bodies, of which the Gates Foundation, DFID, UNITAID, Wellcome Trust, and the Medical Research Council are the top five in value terms.

In summary, the institution is in a good financial position to face the challenges ahead.

On a personal note, this is my final Treasurer's Annual Report, having completed the maximum period of 12 years in office. It has been a fulfilling experience for me to be part of the remarkable journey which LSTM has undertaken and I would like to pay tribute to all of the colleagues who have played their part in making the organisation such a success.

Ian Jones

Introduction to the Feature Articles

LSTM has enjoyed an exceptional period of transformation and growth over the last two decades, concentrating primarily on its research strengths which helped to reduce the incidence of many infectious diseases and supporting the Millennium Development Goals (MDGs).



The MDGs have now been replaced by the Sustainable Development Goals (SDGs), coinciding with dramatic changes in the geo-political, environmental and financial landscape. This volatile situation offers both opportunities and threats to LSTM. Public understanding of for example the threat and importance of infectious diseases has been increased with the outbreaks of chikungunya, Ebola, dengue and Zika. LSTM was able to play an important international and national role in the global response to these outbreaks.

Also, the increased emphasis on impact of research in higher education has benefitted LSTM. With our new Strategic Plan to come into effect in 2017, a number of building blocks are already in place to embed this culture even more solidly in our DNA, ensuring LSTM's research throughout the translational pipeline, from basic research to policy implementation, continues to have impact on the various stages of the four pathways.

The following feature articles and departmental updates highlight how LSTM staff have developed an integrated understanding of translational

pathways to impact and are embracing and honing these principles in order to deliver the next generation of products, policies and practices that can improve the quality of people's lives.

Professor Steve Ward, Deputy Director LSTM



Integrated translational pathways to impact

★ FEATURE ARTICLE

Neglected Tropical Diseases

Neglected Tropical Diseases (NTDs) have gained increased recognition as a 'brand' in global health. Ever since the term 'neglected tropical diseases' was coined at a scientific meeting in Berlin 10 years ago, LSTM has played a key role in bringing these diseases to the attention of health policy makers.

The inclusion of NTDs in the SDGs health targets is testament to how far the recognition of NTDs has come as true markers of poverty. But as LSTM's Professor Molyneux said in a Lancet publication in September 2016, which reviewed the progress made against, what he calls, the 'chronic pandemic of NTDs': "There is still no recognition of the true level of mortality associated with this particular group of diseases. Around 12 thousand people died as a result of the recent Ebola outbreak in Guinea, Sierra Leone, and Liberia, but during the same period of time at least 10 times that many people died as a result of NTDs."

The permanence of major neglected tropical diseases is leading to a revision of the related research agenda towards current and future control interventions and associated targets. The work of LSTM has played an important role elevating this group of diseases on the Global Health Agenda to address, for example, the goal of Universal Health Coverage.

LSTM NTDs has maintained close links with external partners in the NTD field. Dr Dirk Engels, Director of the WHO Department of NTDs, visited LSTM in January 2016, to meet with staff involved in the various departments.



Dr Dirk Engels (left), Director of the WHO Department of Control of Neglected Tropical Diseases (NTD) with LSTM Professor David Molyneux

LSTM NTDs facilitated engagement with the All Party Parliamentary Group on Malaria and NTDs, and close links have been established with the International Society for NTDs (ISNTD) which has enabled platforms for staff at meetings organised by these bodies.

Professor Louis-Albert Tchuem-Tchuente was appointed as LSTM Global NTD Ambassador. He will work with LSTM to raise the profile of NTDs among policymakers, media, and general public, and highlight the plight faced



Professor Tchuem-Tchuente, LSTM's Global NTD Ambassador

by people afflicted by them, and the importance in controlling and preventing NTDs. He will particularly focus on strengthening links with WHO Regional Office for Africa and within African Ministries of Health. This new position complements Tchuem-Tchuente's current role as Cameroon Country Lead for the LSTM-based COUNTDOWN Consortium.

Professor Molyneux recorded a video for ISNTD and a series of keynote talks following the presentation of President Jimmy Carter to both Houses of Parliament in February, discussing the successes and challenges of the Guinea Worm Eradication programme. LSTM NTDs also raised the awareness of the impact of mental health in lymphatic filariasis (LF), highlighting the huge additional burden of mental health caused by NTDs imposes on patients and their caregivers - a neglected topic which is now receiving wider interest within the NTD community.

LSTM NTDs continued the management of the Global Alliance to Eliminate Lymphatic Filariasis (GAELF) Secretariat which has underpinned the advocacy and resource mobilisation support to the Global Programme to Eliminate Filariasis (GPELF).

The Global Filariasis programme has now treated over 6 billion people since it commenced in 2000 and is one of the most successful, beneficial, and cost-effective programmes in global health. The role LSTM plays in the LF partnership brings direct contact with pharmaceutical donors GSK, Merck & Co. and Eisai who donate the drugs for GPELF, technical and strategic advice to NGOs thereby facilitating coordination, sharing research intelligence, and assisting with defining the operational research agenda.

Support has also been provided via the Bill & Melinda Gates Foundation for the launching of the Expanded Special Project on NTDs (ESPEN) and the celebration of the achievements of the African Programme for Onchocerciasis Control.

Many diseases within the NTD portfolio of WHO are represented within current LSTM research activities, supported by a wide variety of donors through both laboratory, field based activities, and policy papers, and from basic drug discovery and molecular diagnostic development to implementation research. This provides an institutional environment which supports the translation from “bench to bush”.

Programmes such as **COUNTDOWN**, CNTD, A-WOL, tsetse control for sleeping sickness, visceral leishmaniasis vector control, the epidemiology and control of cutaneous leishmaniasis in the Eastern Mediterranean region, and the Alister Reid Venom Research Unit are all activities

grounded in the reality of neglected diseases of poor people.

The NTDs team at LSTM, under leadership of Professor David Molyneux, provides a focal point for the many staff engaged in LSTM-wide NTD activities by convening regular meetings to promote greater interaction between groups, centres, and units across departments, and create greater awareness of NTD relevant activities: from basic science to implementation, and advocating these to our external partners.

These activities demonstrate that, while we have an excellent local and national profile, our impact continues to be in the tropics and in populations in need of improved health who continue to benefit directly through the work undertaken with governments and communities. If the SDG targets, defined to 2030, and the WHO Roadmap targets to 2020 and 2025, are to be achieved, LSTM NTDs will continue to have a critical role. This has been demonstrated over the last decade by our success in bringing the diseases of the poor to the global policy agenda yet acknowledging the challenges which remain. LSTM is proud to have been a major player in developing the NTD “brand” which now has a firm place on the development agenda. LSTM NTDs represents the face of the institution in the increasingly complex world of NTD partnerships, research, and our contribution to implementation in the poorest communities throughout the tropics.



Dr Enyong, affiliated to the COUNTDOWN consortium, identifying black fly larvae

Simulium larvae

Tackling the shortage of antivenom

According to the World Health Organization (WHO), around 5 million people worldwide suffer snakebites each year, with more than 100,000 dying as a result and as many as 400,000 suffering permanent disfigurement or amputation.

LSTM's Alister Reid Venom Research Unit, led by Dr Robert Harrison, is doing research into new, more effective, safe, and affordable antivenoms to reduce the deaths and disabilities currently suffered by snakebite victims – treatment that is too often denied to many thousands of people living in very disadvantaged circumstances.



Dr Robert Harrison

Snakebite was given a forum for the first time at the 2016 World Health Assembly (WHA). The WHA discussed the international shortage of antivenom and potential new solutions. One such solution is the use of broad spectrum or poly-specific antivenoms which are effective against bites from a number of species.

However, Sanofi Pasteur halted production of Fav-Afrique due to the fact that, at an average retail price of \$120, it could not sell enough to make production worthwhile, meaning that new methods of production are required to address the problem effectively.

At LSTM Dr Harrison is leading research using a new technique called 'antivenomics' to produce an antivenom effective against all clinically important snake species in sub-Saharan Africa. Funded by a grant from the Medical Research Council (MRC), LSTM is working in partnership with researchers in Spain and Costa Rica to identify all the destructive proteins in venoms of many snake species and combine them to raise antibodies to neutralise each of these toxins.

"Having one effective antivenom for the region will make treatment much easier and cut down on the many side effects associated with the treatment of snakebite," said Dr Harrison: "The movement away from traditional production of antivenoms will also not only address the current high cost of production, making it more affordable for countries with limited health spend and a number of differing priorities, but also increase the shelf life of the products which currently require continuous refrigeration, an obvious problem in remote areas without electricity."

Dr Harrison added "We fully recognise that it will take time for our research plans to become new drugs, and have initiated other, non-lab based projects to help snakebite victims get to health care and to ensure that they are treated with effective antivenoms." Thus, Dr Harrison has very recently established the Kenya Snakebite Research and Intervention Centre whose remit is to:

- gather national data on snakebite-induced death and disability
- pre-clinically test the effectiveness of antivenom before they are used to treat human victims
- test the benefit of a Snakebite Emergency Response System comprising a snakebite APP-coordinated motorcycle ambulance service linked to district hospitals that we will provide with effective antivenom and clinical training in the first aid and hospital management of snakebite.

In 2016, Dr Harrison and his Costa Rican colleague, Professor Jose-Maria Gutierrez, hosted a meeting of representatives from Médecins Sans Frontières (MSF), Drugs for Neglected Diseases initiative (DNDi), Global Snakebite Initiative, Health Action International, AMREF Health Africa, World Health Organization (WHO), and African and Asian governments entitled 'Mechanisms to reverse the public health neglect of snakebite victims.'

The WHO announcement of a new antivenom-prequalification/antivenom-efficacy analysis initiative for sub-Saharan Africa, and the subsequent invitation to hold the 'snakebite-neglect' Side Event at the May 2016 World Health Assembly is testament to the resounding success of this workshop.

How donations shaped LSTM

A fundraising appeal provides LSTM's with a building on its current location, Pembroke Place. It was used as a hospital during the First World War.

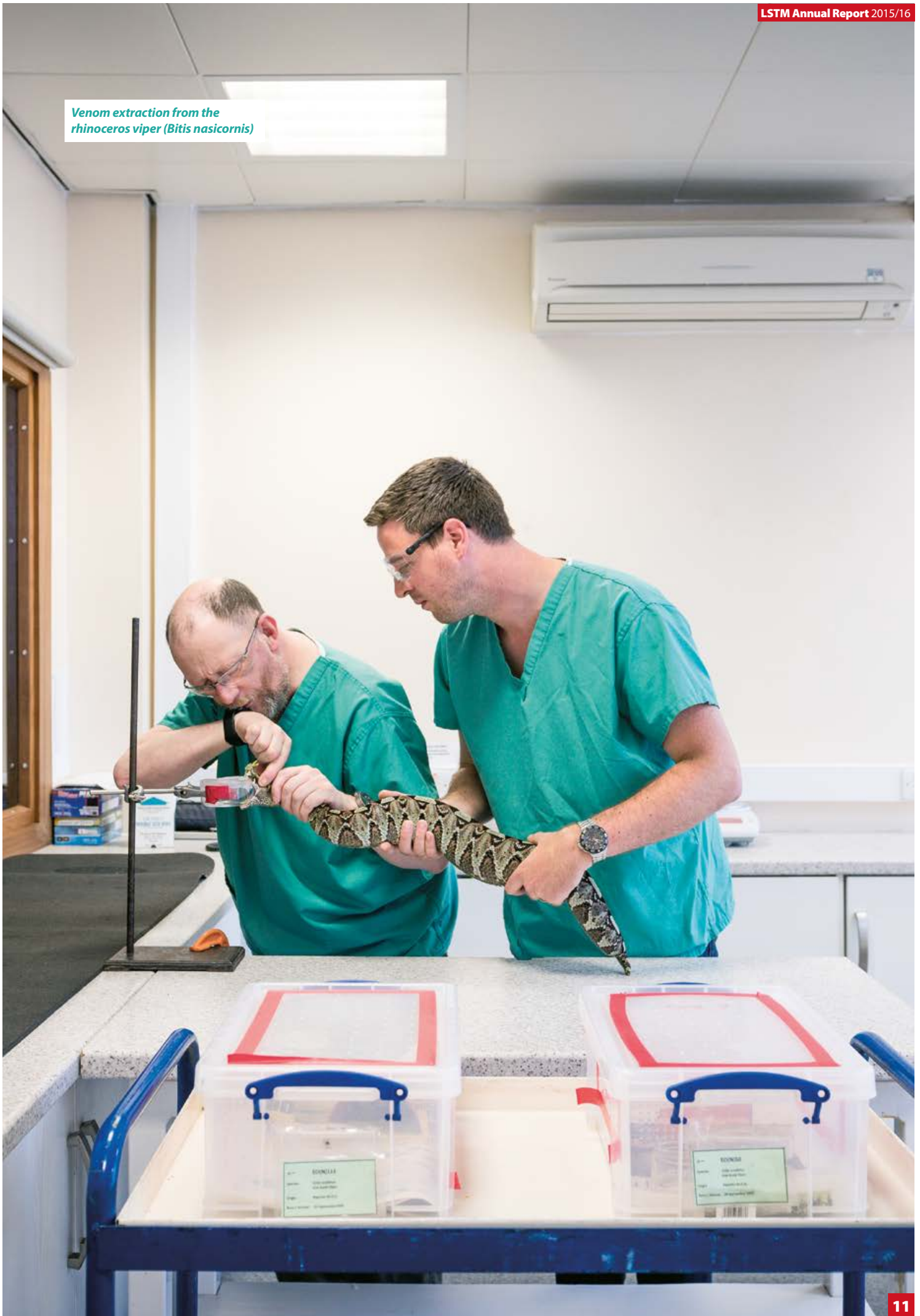


1914

1915

1916

Venom extraction from the
rhinoceros viper (*Bitis nasicornis*)



Department of Parasitology

The Department of Parasitology continues to conduct internationally rated research on the key tropical parasites: malaria, lymphatic filariasis, onchocerciasis, soil transmitted helminths, schistosomiasis, trypanosomiasis, leishmaniasis, and snake venom.



Professor Mark Taylor -
Head of Parasitology

CNTD and COUNTDOWN

The department hosts two large DFID-funded programmes dedicated to neglected tropical diseases (NTDs). The Centre for Neglected Tropical Disease (**CNTD**), now under the leadership of Professor Mark Taylor, is responsible for the implementation and support of NTD programmes.

With an original focus on lymphatic filariasis, **CNTD** has expanded to include onchocerciasis, schistosomiasis, and soil transmitted helminths. Around 32.5 million people were treated with preventive chemotherapy in this last year, with a total of 116 million treated since 2013, and over 200 million treated since the start of the LF programme.



Before and after treatment
against lymphatic filariasis

Mass Drug Administration (MDA) successfully re-started in both Guinea and Liberia following the suspension of their NTD programmes during the Ebola virus outbreak, and the team are monitoring the impact. Managing Morbidity and Preventing Disability (MMDP) is delivered to those suffering from filarial

disease, with 12,739 hydrocele surgeries carried out in 2016, and 5,357 community care workers trained in managing lymphoedema. **CNTD** has played a leading role in setting out the criteria for MMDP within the evidence 'dossier' that all countries will be required to submit to WHO in order to achieve their elimination status.

COUNTDOWN

Calling time on Neglected Tropical Diseases

The **COUNTDOWN** programme is focussing on an integrated multi-disciplinary implementation research approach to overcome barriers to the scale-up of NTD programmes in five African countries (Liberia, Cameroon, Ghana, and Nigeria) at an early, intermediate, and late stage of NTD programme

progress. **COUNTDOWN** has started to trial and evaluate new approaches to drug distribution, which target those who are currently overlooked and excluded. It also examines how NTD programmes can be better integrated into broader health system responses.

Diagnostics

The Diagnostics Unit within our Research Centre for Drugs and Diagnostics (RCDD) was awarded a MRC Zika rapid response grant to work on the development of multiplex diagnostic tests for Dengue, Chikungunya, and Zika viruses. Working with Biogene, the team is developing community-based molecular testing and are currently collecting samples in Guatemala and Brazil to test the prototype. The value of multiplex testing has recently been highlighted in a paper published in *Emerging Infectious Diseases*, showing viral co-infection as a hidden problem in Guatemala. The Unit's work with Warwick University and the Diagnostic Modelling Consortia was reported in *Nature*, on diagnostics tests and health-seeking behaviour for Visceral Leishmaniasis. The work shows that a highly specific diagnostic test may allow some patients to be diagnosed earlier, leading to a reduction in transmission, and the team is now working in Bangladesh to evaluate novel diagnostics tests towards this goal.

Filariasis

A-WOL, the anti-*Wolbachia* consortium, which searches for new anti-*Wolbachia* cures for onchocerciasis and lymphatic filariasis (LF), was awarded further funding from the Bill and Melinda Gates Foundation to continue their programme of drug discovery and development until the end of 2017. At this point the BMGF will select a candidate for further clinical development as a macrofilaricide. A-WOL has already advanced a potent new macrolide, TylaMac™, to candidate selection, in partnership with AbbVie and DNDi, which reduces treatment times from 4 weeks to 7



Loa loa

days or less. A-WOL is working on the lead optimisation of a series of back-up candidates to deliver a robust portfolio of new macrofilaricides.

Loa loa is generally regarded as one of the less pathogenic filariae, but it does create a public health problem in patients with high parasite burden, who are at risk of severe adverse events to ivermectin, creating a barrier to Onchocerciasis and LF control in Central Africa. As part of a Grand Challenges Explorations project, led by Dr Joe Turner with Professors Taylor and Wanji (of University Buea, Cameroon), the team have validated a novel preclinical model of Loa loa. The model system will be implemented as part of the BMGF Macrofilaricide Drug Accelerator (MacDA) to rapidly test the safety of candidate macrofilaricides. Dr Turner and his team have so far tested five late stage preclinical macrofilaricide candidates from MacDA and Janssen against Onchocerca adult parasites.

Malaria

Dr Ian Hasting's modelling group have been applying pharmacological modelling of malaria drug treatment to investigate how surveillance for resistance may be improved, how dosing regimens may be altered to increase effectiveness, and how resistance to drugs may compromise malaria control and elimination programmes. More recently, they have been investigating treatment regimens for severe malaria, and how best to statistically analyse data from drug clinical trials. Another area of research has been to construct genetic models of insecticide resistance and investigate how deployment strategies, such as mixtures and mosaics, may be used to optimise the deployment of the next generation of public health insecticides, that will be used to control mosquito-transmitted infections such as malaria and dengue.

Ongoing malaria projects include an MRC-funded project awarded to Professor Biagini and colleagues investigating the mode of action of 8-aminoquinolines (Primaquine and Tafenoquine) drugs that, despite being used for some 60 years, have hitherto unknown mechanisms of action. A break-through paper by the RCDD team was published in PNAS this year, describing the malaria parasite (*Plasmodium falciparum*) protein targets of the artemisinin class of drugs, currently the first-line of defence against non-complicated and severe malaria.

Schistosomiasis

Professors Stothard and Ward published a study on the pharmacokinetic-pharmacodynamic analysis of praziquantel treatment for intestinal schistosomiasis in young children.

It analysed the relationship between drug exposure and parasitological cure, and showed that treating children with the adult dose of 40 mg was insufficient, and recommended increasing the dose to 60 mg in young children.

Sleeping sickness and leishmaniasis

Dr Alvaro Acosta-Serrano's group published a series of papers highlighting the impact of the current cutaneous leishmaniasis epidemics in the Middle East, which is a direct consequence of the Syrian war and refugee crises. The group also work on the interaction of trypanosomes with their tsetse vector, and has recently demonstrated the essentiality of proline metabolism for the survival of African trypanosomes within the digestive tract of the fly, published in PLOS Pathogens.

Snake venom

The Alistair Reid Venom Research Unit, led by Dr Robert Harrison, has enjoyed a significant expansion of its research portfolio and staff. The award of a prestigious Wellcome Trust/Royal Society Sir Henry Dale Fellowship to Dr Nick Casewell provides 5 year funding to pursue his goal of 'developing a universal antivenom to treat snake venom-induced consumption coagulopathy'. This project integrates into an existing MRC-funded project 'Novel immuno-proteomic strategies to develop a polyspecific, non-cold chain liquid snake antivenom with unparalleled sub-Saharan African efficacy', and a MRC Confidence in Concept project on 'Rational design of a global, pathology-specific antivenom to treat lethal, snake venom-induced haemorrhage'.

Viking lung worm

Genes that protected Vikings from worm infestations have been linked to an inherited trait causing lung disease as published in Nature: Scientific Reports with LSTM Professor Richard Pleass as senior author. Alpha-1-antitrypsin deviants have been common in Scandinavia for the past 2000 years and protects the lungs and liver from an enzyme produced by the immune system, but one that is also present in parasitic worms. Archaeological investigations of latrine pits in Demark revealed that Viking populations suffered large-scale worm infestations. As a way to protect their vital organs from disease caused by worms, their genes created A1AT deviants that now cause lung disease in smokers. These A1AT deviants bind an antibody called immunoglobulin E (IgE) that evolved to protect people from worms. By binding together, IgE cannot be broken down by the enzymes, and persists to cause chronic lung disease.



How donations shaped LSTM

LSTM Chairman, Sir Francis Danson, personally funds a new £500 teaching laboratory, attached to the tropical wards at the Royal Liverpool Infirmary, run by LSTM staff.



1924

1925

1926

 FEATURE ARTICLE

Resistance Research & Management

The global rise of resistance to drugs and insecticides is increasingly dominating the research agenda. Leading science figures such as the UK's Chief Medical Officer, Professor Dame Sally Davies, warn of the implications of the spread of drug resistance, with developing countries and large emerging nations bearing the brunt of this problem.

The progress made against infectious diseases over the last fifty years will be jeopardised and the cost for health systems and affected individuals will increase significantly.

It is estimated that, globally, at least 700,000 die each year of drug resistance in illnesses such as bacterial infections, malaria, HIV/Aids, or tuberculosis. The issue gained further importance with the release in May 2016 by the Government's Review on Antimicrobial Resistance: 'Tackling Drug-Resistant Globally', which was chaired by Lord O'Neill and who visited LSTM in June.

Within that context, and with a proven resistance research track record dating back to the 1920s, LSTM continues to invest in this field by widening its research base through, for example, the MRC Doctoral Training Programme, as well as the MRC Confidence in Concept (CiC) scheme,

which provides funding to support the earliest stages of translational research projects. This is further enhanced with the construction of the Liverpool Life Sciences Accelerator building, a £25m laboratory development that will enable innovative research into antibiotic as well as insecticide resistance.

Malaria

The long half-lives of malaria 'partner' drugs are a potent force selecting for drug resistance. Clinical trials can quantify this effect by estimating a 'window of selection' (WoS), defined as the amount of time post-treatment when drug levels are sufficiently high that resistant parasites can re-establish an infection while preventing drug-sensitive parasites from establishing viable infections.

Dr Ian Hasting and his colleagues investigated the ability of clinical data to accurately estimate the true WoS, using standard pharmacokinetic-pharmacodynamic models for three widely used malaria drugs: artemether-lumefantrine (AR-LF), artesunate-mefloquine (AS-MQ), and dihydroartemisinin-piperaquine (DHA-PPQ). The results suggest current methods of estimating the clinical WoS underestimate the true WoS by as much as 9 days for AR-LF, 33 days for AS-MQ, and 7 days for DHA-PPQ. The new method of estimating clinical WoS (i.e. retaining all individuals in the analysis) was significantly better at estimating the true WoS for AR-LF and AS-MQ.

Previous studies, based on clinically observed WoS, have probably underestimated the 'true' WoS and hence the role of drugs with long half-lives in driving resistance. This has



**LSTM Director Janet Hemingway
with Lord O'Neill**

important policy implications; high levels of drug use are inevitable in mass drug administration programmes and intermittent preventative treatment programmes and the analysis herein suggests these policies will be far more potent drivers of resistance than previously thought.

Insecticide resistance

Throughout the academic year 2015-16, LSTM researchers have been instrumental in highlighting the worsening situation of insecticide resistance. Various editorials and reviews from their hand, in journals such as *The Lancet* and *PNAS*, have outlined the need for a more urgent and proactive approach to insecticide resistance so as the gains made in malaria prevention in the 21st century are not lost.

While the efforts to control the disease have intensified, the selection pressure on mosquitoes to develop resistance to these insecticides have also increased. As a consequence, resistance to pyrethroid insecticides, the only class of insecticide available for use in long lasting insecticidal nets (LLINs), is now widespread in the malaria vectors, and resistance to other insecticide classes used for adult mosquito control is rapidly increasing. The increase in the distribution of resistant mosquitoes and strength of that resistance, threatens the success of malaria control programmes.

Developments to combat insecticide resistance in the African *Anopheles* mosquitoes include working towards the delivery of three new public health pesticides by the product development partnership, the Innovative Vector Control Consortium (IVCC), in cooperation with the Liverpool Insect Testing Establishment (LITE). The reviews highlighted that it is critical not to rely on one single active ingredient, but ideally to deliver three different public health pesticides which can be used in combination and rotation strategies, thereby reducing the likelihood of resistance developing.

Throughout the year, LSTM researchers published numerous studies highlighting various aspects of the



Female anopheles freeborni is taking a blood meal

mechanisms of resistance, such as that to the insect growth regulator pyriproxyfen (PPF) assessing the likelihood of cross-resistance between the chemical and other insecticide classes used in malaria control.

That LSTM is the leading institution in this particular field was further highlighted by being awarded various grants to support its cutting edge research, such as a multimillion grant from the Wellcome Trust to look, together with fellow prominent institutions, how insecticide resistance is affecting the efficacy of bed nets in preventing malaria transmission in Africa. The newly formed three-year study 'Improving the Efficacy of Malaria Prevention in Insecticide Resistant Africa' will function under the name MIRA and follows on the results of the work by the EU (FP7) funded AvecNet Consortium which held its End of Project meeting in June 2016.

New types of multi-drug-resistant African Salmonella associated with lethal infection

The first global-scale genetic study of *Salmonella* Enteritidis bacteria, which is a major cause of blood



Salmonella

poisoning and death in Africa and food poisoning in the Western World, has discovered that there are in fact three separate types, including two novel African ones, which looked the same, but were genetically different from the Western type. Reported in *Nature Genetics*, the study showed the African types had developed resistance to many antibiotics and behaved slightly differently to the one commonly found in the West. This suggests a need to understand where in the African environment the bacteria live, in order to prevent this disease.

How donations shaped LSTM

Donor Imperial Chemical Industries (ICI) collaborates with LSTM on a new antimalarial drug.



1934

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Once *Salmonella* reaches the bloodstream it is known as invasive non-typhoidal *Salmonella* (iNTS) disease, a serious and neglected tropical disease. Last year, it was estimated to cause 680,000 deaths per year worldwide, more than half of which were in Africa. First author Dr Nick Feasey, said: "iNTS disease is a huge problem in Africa, but it is difficult to identify due to lack of laboratory capacity and difficult to treat due antibiotic resistance."



Dr Nick Feasey

The scientists sequenced 675 isolates of *S. Enteritidis* from 45 countries and six continents. Analysis of the *Salmonella* genomes revealed three major types - a common global one and two novel African ones. Routine microbiological testing is not able to distinguish between the *S. Enteritidis* circulating in Africa and the rest of the world.

Identifying these new types is important because the common global type of *S. Enteritidis* is normally associated with poultry and predominantly infects the intestine, causing diarrhoea. However, in Africa the two newly identified types are a major cause of blood poisoning and death, because in people with weak immune systems, *Salmonellae* are able to pass with greater ease from the gut into the bloodstream. The environmental reservoir from which these African bacteria are transmitted to people is unknown.

The study also showed that the two African types carried more of the genes that give them resistance to common antibiotics. These strains do not respond to the antibiotics commonly available, and have to be treated with cephalosporins or ciprofloxacin, antibiotics of last-resort in many African settings.

Clinical TB resistance

A new collaboration has been forged between LSTM and Vietnamese partners. In an MRC Newton-funded multidisciplinary project (2016-2019), Liverpool investigators will be working with colleagues from the Vietnam National Tuberculosis Control Program (NTP), the Vietnam National University, the Vietnam National Institute of Hygiene and Epidemiology (NIHE), and the National Lung Hospital (NLH) to determine the underlying cause of non-MDR TB treatment failure which accounts for 10% of all new TB patients in Vietnam.

Specifically, the project will determine whether drug exposure (pharmacokinetics) or variation in TB drug sensitivity (pharmacodynamics) can explain or predict treatment failure/relapse amongst non-MDR pulmonary TB re-treatment patients in Vietnam. During the project, LSTM will welcome Vietnamese colleagues for bespoke training in pharmacokinetics, pharmacodynamics, and modelling.

Research Centre for Drugs & Diagnostics

Drugs

A-WOL, a partner in RCDD, has already advanced a potent new macrolide, TylaMac™ to candidate selection, in partnership with AbbVie and DNDi. TylaMac™ is a treatment for elephantiasis and filariasis and is predicted to reduce treatment times from four weeks to seven days or less. Importantly this drug has an indirect mechanism killing the bacterial symbiont *Wolbachia* inside the parasite.



Backing up this discovery project another chemically unrelated A-WOL candidate has been candidate selected: AW1066, in partnership with Eisei. Both molecules are totally novel anti-*Wolbachia* based macrofilaricides and have gone through a full formal valuation, from concept to optimisation to candidate selection and are now entering formal pre-clinical valuation.

It is anticipated that both projects will be operationally effective in areas where resistance to ivermectin is problematic.

Carrying on the drug discovery theme the novel fully synthetic antimalarial E209 is about to be candidate selected, in partnership with Eisei. E209 is awaiting full review by the Medicines for Malaria Venture (MMV) before being moving into regulatory pre-clinical studies. E209 is a tetraoxane based long half-life peroxide that is not subject to resistance mechanisms which are currently hampering the use of artemisinins.

The search for highly effective anti-malarial therapies has gathered pace and recent years have seen a number of promising single and combined therapies reach the late stages of development. A key drug development challenge is the need for early assessment of the clinical utility of new drug leads as it is often unclear for developers whether efforts should be focused on efficacy or metabolic stability/exposure, or indeed whether the continuation of iterative QSAR (quantitative structure–activity and relationships) cycles of medicinal chemistry and biological testing will translate to improved clinical efficacy. Pharmacokinetic and pharmacodynamic (PK/PD)-based measurements, available from in-vitro studies, can be used for such clinical predictions. However, these predictions often require bespoke mathematical PK/PD modelling expertise and are normally performed after candidate development and, therefore, not during the pre-clinical development phase when such decisions need to be made.



LSTM researchers have developed an internet-based tool using STELLA® software. The tool, called OptiMal-PK, simulates multiple differential equations that describe anti-malarial PK/PD relationships where the user can easily input PK/PD parameters, in an intuitive way. It utilises a simple stop-light system to indicate the efficacy of each combination of parameters and allows for the investigation of the effect of drug combinations with known or custom compounds. OptiMal-PK is designed to be implemented by medicinal chemists and pharmacologists during the pre-clinical anti-malarial drug development. It can help investigators to identify

which pharmacological features of a compound are most important to the clinical performance of a new chemical entity and how partner drugs could potentially improve the activity of existing therapies.

Multiplex molecular diagnostics

The Diagnostics Unit has renewed its focus on multiplexed molecular tests. These are diagnostic tests to simultaneously detect more than one pathogen or potentially several drug resistance markers for a given pathogen. This ability to detect multiple pathogens is extremely important when symptoms for disease are not specific, for example patients presenting with undifferentiated fever.

In the Americas, many circulating viruses and parasites can cause fever, for example Zika, chikungunya, dengue, malaria, and others. LSTM scientists have worked with Qiagen to produce a reference diagnostic test for chikungunya combined with dengue. We are now working with several SMEs, to produce tests capable of detecting multiple pathogens in “close to patient” settings, for example a health clinic or a district hospital. Currently testing is performed in reference laboratories which results in the patients having to wait a long time to receive the results and subsequent directed treatment. The aim is to reduce this delay by designing tests that can be used near the patients with results given in a timely manner to facilitate the management of the patients. Studies are underway in Brazil and Guatemala within a MRC emergency grant for Zika diagnostics. The work has shown that co-infection with more than one arbovirus is common, for example one third of the patients had chikungunya and dengue at the same time.

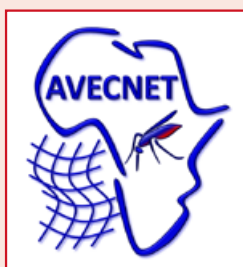
Molecular tools can also be used to detect anti-microbial resistance. There are many genetic targets associated with drug resistance and here multiplex tests become extremely important. We have recently started the design of assays to diagnose drug resistant genotypes from patients with resistance to Carbapenem antibiotics. These diagnostics will be tested against isolates from the UK and Malawi; regionally different assays will be needed to target local resistance patterns.

Department of Vector Biology

The Department of Vector Biology has a wide reaching research portfolio encompassing basic, translational, and implementation research. Fulfilling our mission to improve the control of vector borne disease involves partnership with colleagues across the globe.



**Professor Hilary Ranson -
Head of Vector Biology**



AvecNet: new tools for malaria vector control

The AvecNet consortium held its End of Project meeting in June of this year. This event, attended by over 100 stakeholders, provided an excellent forum to showcase the work from this EU-funded consortium, involving

17 partner organisations from Africa and Europe. Updates were provided on our work in tracking the dynamics and impact of insecticide resistance in malaria mosquitoes, and the exciting new advances in our understanding of how bednets influence mosquito behavior. The event also summarised the results from field trials of a range of new vector control tools, and provided an opportunity to discuss some of the key policy issues that impact on access to proven vector control tools. Results from a large-scale clinical trial of a new bednet combining insecticide and mosquito sterilizing chemistries are anticipated later this year.

Visceral leishmaniasis elimination in India

The department has been working in South Asia to support the Indian visceral elimination programme for a number of years. Previous work using insecticide quantification kits (IQKs) to perform quality assurance assessments of the Kala-Azar Indoor Residual Spraying (IRS) programme in Bihar State, India, provided compelling evidence which instigated a change in national insecticide policy. This year, in collaboration with CARE India, we have expanded this work to establish a three-year monitoring and evaluation (M&E) programme in three Indian States: Bihar, Jharkhand,

and West Bengal. This comprehensive programme covers IRS M&E, quality assurance, entomological assessments, insecticide resistance, sand fly bite exposure, and VL transmission dynamics. This combination of programmatic monitoring, operational research, and basic science will produce an integrated, translational dataset which will deliver wide-ranging support to the VL elimination campaign.

Eliminating Gambian human African trypanosomiasis

Working in partnership with national programmes, the French government's Institute for development research (IRD) and the Belgian Institute for Tropical Medicine (ITM), and with funding from the Bill and Melinda Gates Foundation, the tsetse group are carrying out research to control the vectors of Rhodesian and Gambian human African trypanosomiasis (HAT), the two forms of sleeping sickness found in East and West Africa, respectively. Our research in Chad, DRC, Guinea, Ivory Coast, and Uganda ranges from studies of the impact of vector control on tsetse and incidence of HAT through to economic analyses of these operations and their acceptability to local communities. Highlights in 2016 include the first large-scale deployment of Tiny Targets across 500 km² of Yasa Bonga District in DRC. More than 80% of all cases of HAT reported from across Africa occur in DRC, and Yasa Bonga is a Health Zone with one of the highest case burdens. Working with modelers from the University of Warwick, we have also been assessing whether the WHO goal of eliminating Gambian HAT as a public health problem by 2020 might be achieved in places such as Yasa Bonga. The model suggests that the addition of vector control using Tiny Targets to the current strategy is essential to enable this target to be reached.

Quantifying the impacts of insecticide resistance on malaria control

As African malaria mosquitoes develop ever increasing levels of resistance to the insecticides used in bednets and/or for indoor residual spraying, there is a critical need to understand the impact of this resistance on control programmes. During the past year we have made major contributions to addressing this question, via collaborative studies supported by the World Health Organisation and the National Institute of Health. This work is helping inform WHO policy on insecticide resistance management. A new collaborative project (Malaria in Insecticide Resistant Africa) supported by the Wellcome Trust, will be taking a multi-disciplinary approach to determine why current malaria control strategies are failing in some high burden countries.

Royal Society Summer Exhibition

The department has been very active in public engagement this year, with highlights including exhibits at the Royal Society Summer Science Exhibition in London and the Manchester Science Festival.

Image of Mosquito Diaries at the Royal Society Summer Science exhibition (cut the right side of the image of please to exclude woman with the short dress)

In our exhibit, entitled The Mosquito Diaries, we talked to visitors about malaria, the role of bednets in preventing transmission, and the challenge of insecticide resistance. The London exhibit took place over a week, with 14 members



Mosquito Diaries at the Royal Society Summer Science exhibition

of the department participating. The exhibit used videos, digital games, and live mosquitoes to engage with the public and demonstrate the innovative research being conducted within the department. The Mosquito Diaries also featured the insecticide resistance training game, ResistanceSim, and included videos and games highlighting the innovative mosquito tracking research within the department. The Mosquito Diaries has been hugely successful in showcasing the vector department, and we hope the exhibit will inspire the next generation in the fight against vector borne disease.

Philip McCall awarded Personal Chair

Former PhD student and longstanding faculty member in the department, Philip McCall, has been awarded a Personal Chair for his outstanding contribution to understanding the behavior of disease vectors. Professor McCall is internationally renowned for his work on Aedes and Anopheles mosquitoes, which has led to new insights into how to control these vectors.



Professor Philip McCall

Wellcome Trust Senior Fellowship

Dr Christophe Antonio-Nkondjio (OCEAC, Cameroon) has been awarded a five-year Wellcome Trust Senior Fellowship in Public Health and Tropical Medicine under the sponsorship of Dr Charles Wondji. This extremely prestigious award will enable Antonio to continue his productive collaboration with LSTM in a new project to assess the performance of long-lasting larvicides in reducing malaria burden in African cities. Antonio is the first person to be awarded a Senior Fellowship under this scheme, and joins a cohort of 15 Wellcome Trust Fellows at earlier career stages that are sponsored by the department.



Dr Christophe Antonio-Nkondjio



How donations shaped LSTM

John Holt and Company pledges £20,000 to launch a new malaria research fund.



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1946

★ FEATURE ARTICLE

Malaria & Other Vector Borne Diseases

Insects transmit approximately 17% of global infectious disease in humans. Malaria alone kills over half a million children each year, and the incidence of other mosquito borne diseases such as Zika, dengue, and chikungunya is increasing rapidly.

Six of the 17 neglected tropical diseases listed by WHO are transmitted by insect vectors, and one involves a snail intermediate host.

Zika

The highly publicised outbreak of the mosquito-borne Zika virus in Brazil, and its rapid spread into mainly Latin American countries, coincided with the build-up to the Rio de Janeiro Olympics. It resulted in a rapid response from LSTM staff, both to identify key knowledge gaps, but also to inform the public over the risks.

One of the key findings that emerged from research, conducted by Professor Philip McCall and colleagues, was the absence of evidence to support many of the vector control techniques routinely used to prevent virus infections transmitted by *Aedes aegypti* mosquitoes, such as dengue fever, chikungunya, and Zika. They called for a global independent advisory body to guide decisions regarding the selection of approaches and tools for control or prevention of infections transmitted by urban *Aedes*

sp. vector populations, and the design of appropriate multi-centre trials to evaluate their effectiveness. Dr Gerry Killeen is responding to this call and investigating whether effective anti-malaria mosquito repellents can be repurposed for Zika control. Also in response to the outbreak, Professor Luis Cuevas and team are developing novel point-of-care diagnostic tools for the simultaneous diagnosis of Zika and other arboviruses.



Alongside these efforts, LSTM organised in February 2016 a special symposium on the Zika virus outbreak in South America with over 130 in attendance comprising of LSTM staff, postgraduate students, and students undertaking the Diploma and Tropical Medicine and Hygiene (DTM&H) course. Professor David Laloo, Dean of the Faculty of Clinical Sciences and International Public Health, chaired the symposium, which consisted of an informative lecture delivered by Dr Lee Haines, a postdoctoral researcher in the Department of Vector Biology. The symposium was split into three sections consisting of an introduction to the virus and routes of transmission, followed by its potential links to other conditions, particularly microcephaly and the impact that this has had in terms of gender equity and rights. The presentation concluded with current and future vector control solutions and vaccine development.

Throughout the outbreak, LSTM experts conducted numerous national media interviews as well as public talks, speaking to groups mainly in the Northwest to increase general understanding of the transmission and the impact of Zika, and to debunk many of the myths surrounding the disease.



Testing the efficacy of the next generation of insecticide treated nets in the DRC & LSTM

The past decade has seen a huge increase in the use of pyrethroid-treated bednets across the African continent, and with it, a growing problem of pyrethroid-resistance.

Two groups within LSTM have been working on solutions to this problem. Dr David Weetman's group is working in the north of the Democratic Republic of the Congo (DRC) to evaluate the effectiveness of the next generation of LLINs, which contain an insecticide synergist to block the action of key metabolic enzymes.



Data from IRMapper showing populations of malaria

Linking with a major, province-wide distribution of approximately 650,000 bednets, provided by the Against Malaria Foundation, LSTM staff have established baseline resistance data for the local

Anopheles malaria vector populations and tested LLINs in situ and in the laboratory. Longer-term monitoring work will now assess their continuing effectiveness against mosquitoes in the field.

Whilst larger programmes are underway, an important aspect of the next generation LLIN testing, advocated by the WHO, is the need for evaluations in different settings and against different mosquito populations. Driven by the logistical difficulties of working in the centre of Africa, the hitherto uncharacterised malaria vector populations in this economically-deprived region of high malaria endemicity will certainly fulfil this remit.

One of the major mechanisms of pyrethroid-resistance is conferred by a group of enzymes called P450s that can detoxify pyrethroids are increasingly prevalent. Dr Mark Paine's Enzyme Characterisation Group has been developing rapid tests to investigate the effects of these enzymes on the performance of new insecticides being introduced for malaria control. Working with Professor Hilary Ranson's team, recent studies have found that

the same enzymes that metabolise pyrethroids can also metabolise other insecticides including pyriproxyfen, an insect sterilising agent being incorporated into 'new generation' bednets. This is a warning of potential underlying cross-resistance issues in field populations of *Anopheles* mosquitoes.

Local government mosquito abatement in urban Tanzania

Cities represent the best opportunities to eliminate local malaria transmission because high population density dilutes out vector biting burden and urban planning can dramatically reduce it, while infrastructure, institutional capacity, and governance systems are often better developed than in rural areas. Over the last 14 years, Dr Gerry Killeen has supported the development of a locally driven programme for community-based management of malaria vectors in the Tanzanian city of Dar es Salaam, where aquatic, larval-stage mosquitoes are targeted with environmentally friendly biological insecticides or drainage before they can emerge as biting adults. The programme is now sustainably governed, managed, and funded by the Tanzanian government and has reduced malaria transmission intensity levels where it is unstable and could be eliminated.



Sandflies

How donations shaped LSTM

Unilever and The United Africa Company fund the expansion of filariasis research.



1953

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1955

Control and prevention of cutaneous leishmaniasis in the Middle East

Cutaneous leishmaniasis (CL) is highly prevalent in the Middle East, and whilst it is generally not fatal, it can lead to disfiguring wounds and scars that result in social stigmatisation. The collapse of the Syrian health system and large number of externally and internally displaced people has resulted in CL affecting hundreds of thousands of people living in refugee camps or who are trapped in conflict zones. Dr Alvaro Acosta Serrano's team, in collaboration with the Saudi Arabian Ministry of Health, has developed a programme aiming to prevent and control CL. The programme focuses on developing a rapid diagnostic test and identifying markers for disease exposure. In due course it is hoped that these tools can soon be applied in other CL-endemic countries, including refugee settings.

A blood based assay quantifies individual's exposure to bites from the female sand fly (the vector of CL). The test is based upon antibody response to components of the sandfly's saliva and can be used to assess vector control efficacy (spraying/bednets) and identify people with high anti-saliva antibody titres who are at risk of contracting CL.

Tsetse research

The tsetse group is carrying out research to control the vectors of Rhodesian and Gambian human African trypanosomiasis (HAT), the two forms of sleeping sickness found in East and West Africa, respectively. Working in partnership with national programmes, the French government's Institute for Development Research (IRD) and the Belgian Institute for Tropical Medicine (ITM), and with funding from the Bill and Melinda Gates Foundation, we are conducting operational research in Chad, DRC, Guinea, Ivory Coast, and Uganda to support the large-scale deployment of 'Tiny Targets' to control riverine tsetse. Our work ranges from studies of the impact of vector control on tsetse and incidence of HAT through to economic analyses of these operations and their acceptability to local communities. Highlights in 2016 include the first large-scale deployment of Tiny

Targets across 500 km² of Yasa Bonga District, in DRC. More than 80% of all cases of HAT reported from across Africa occur in DRC, and Yasa Bonga is a Health zone with one of the highest case burdens. Working with modellers from the University of Warwick, we have also been assessing whether the WHO goal of eliminating Gambian HAT as a public health problem by 2020 might be achieved in places such as Yasa Bonga. The model suggests that the current strategy of active screening and treatment has halved the numbers of HAT cases over the last 15 years, but will not eliminate HAT from Yasa Bonga. However, the addition of vector control using Tiny Targets is predicted to achieve the target.

In East Africa we are examining the transmission dynamics of Rhodesian HAT in the wilderness areas of Tanzania, in collaboration with scientists from Scotland's Rural College, Roslin Institute, SACEMA, and TTRI. In particular, we are analysing the risk posed by tsetse within the Serengeti National Park to people living in surrounding areas. Our preliminary results suggest that there is an unexpectedly sharp decline in the numbers of tsetse at the interface of the park and farming areas. Modelling shows that this decline is due in part to changes in vegetation, but the model suggest that other factors are also involved. Preliminary studies of local cattle suggest extensive use of insecticides which may be controlling the spread of tsetse.



Tsetse fly

Department of Clinical Sciences

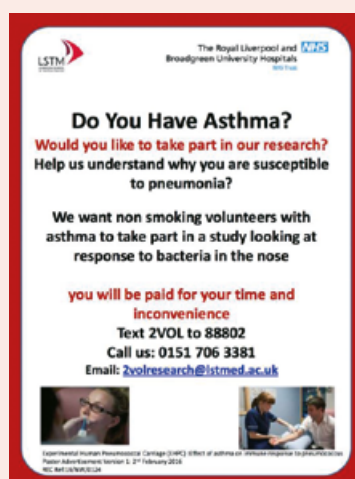
The Department of Clinical Sciences continues to be vibrant, cohesive, and collaborative, and provides an excellent platform for research, from concept and clinical trials to evidence synthesis. With a team of over 100 staff, we aim to facilitate policy changes and solutions that benefit populations of low-resource settings.



**Professor Luis Cuevas -
Head of Clinical Sciences**

We welcomed back Tim O'Dempsey, who contributed to the fight against the Ebola epidemic in West Africa. Seconded to WHO, Tim initially worked as a clinician in the Ebola Treatment Centre in Kenema, and throughout 2015 was WHO's Clinical Lead in Sierra Leone, developing clinical guidelines, providing training and mentorship for international and national health workers, and supporting the Ministry of Health and Sanitation in developing strategies for the epidemic response, early recovery, and longer term outbreak preparedness and response. We also welcomed Tao Chen, Magdalena Muc, and Victoria Watson as new staff for our Tropical Clinical Trials Unit, and Drs Wei Shao (Shanghai), Leilei Pei, Chao Li, Kaina Zhou, and Lingxia Zeng from Xi'an Jiaotong University as academic visitors from China.

Respiratory research



The Respiratory Infection group completed a large vaccine trial for the experimental human pneumococcal carriage and continues recruiting volunteers. The team is increasingly recognised internationally and works closely with NHS Trusts in the UK, the Malawi-Liverpool Wellcome Trust Clinical Research Programme (Malawi), and Butantan

Institute (Brazil) to improve the quality of life of patients in the UK and underserved populations in Africa and South America. The Cooking and Pneumonia (CAPS) trial, led by Kevin Mortimer, is making steady progress towards completion in late 2017. This large trial randomised 150 villages in Malawi, and households with a child up to the age of 4.5 years received fan-assisted stoves to replace traditional cooking methods (mainly open fires) to test whether reducing exposure to biomass in the household reduces the

incidence of pneumonia in children.

Evidence synthesis

The evidence synthesis for Global Health Group Cochrane editorial base expanded its scope to include HIV/AIDS. HIV/AIDS synthesis asks different questions to standard trial



**Mother and child in Malawi
in smoke infested hut during
cooking using traditional
methods**

effectiveness research, requires a greater range of methods including systems, observational, and qualitative data, and needs to be nimble. The group teamed up with colleagues in Stellenbosch University and University College London and is making rapid progress to bring a range of reviews to completion. The group's impact on guidelines and policies continues. Paul Garner was the methodologist on the WHO HIV/AIDS Operational Guidelines Group, David Taylor Robinson (Liverpool University) contributed to the WHO soil transmitted helminths Guideline Panel, while Hannah Ryan and Paul contributed substantively to the production of the India National Guidelines for extra-pulmonary TB, released in August.

Malaria

The Malaria in Pregnancy (MiP) Consortium secretariat at LSTM initiated a new collaboration with the Oxford-led Worldwide Antimalarial Resistance Network (WWARN), to develop a module on malaria in pregnancy. The collaboration supports the curation of clinical data from across all known trials and studies, to enable pooled analyses to create an

evidence base for policy. Professor Ter Kuile's group works closely with WHO and its Evidence Review Group (ERG) on malaria in pregnancy, to ensure relevant research findings are considered by policy makers. A notable achievement this year was an ERG recommendation for WHO to review its malaria policy for treatment of pregnant women as a result of a meta-analysis by Stephanie Dellicour on the safety of artemisinins in the first trimester of pregnancy. Jenny Hill's new EDCTP grant for translational activities allowed the dissemination of research outputs from MiP Consortium's studies, conducted between 2008-2016, to Ministries of Health in Africa and to provide in-country support for national policy change. Our clinical trials work expanded with EDCTP and MRC/DFID/WT Joint Global Health Trials grants to evaluate the safety and efficacy of intermittent preventive treatment with dihydroartemisinin-piperaquine in Kenya, Tanzania, and Malawi, as an alternative to the current policy which is under increasing threat due to drug resistance. We are also nearing the completion of a large three-year trial of preventive treatment in pregnant women in Indonesia, with nested studies on acceptability, feasibility, and cost effectiveness.

Tuberculosis

Our TB activities continue to expand. Funding from EDCTP and Stop TB Partnership supported Luis Cuevas' team to evaluate new diagnostics for TB in Nigeria, Ethiopia, and Moldova, and to develop health system approaches that facilitate population access to diagnostics and treatment.



These studies led to the up-scale of approaches to reach communities in rural Ethiopia and urban slums of Nigeria. Next year will see the launch of IMPACT TB, a study funded by the European Union and led by Maxine Caws, to increase case-finding in Vietnam and Nepal. Many TB cases are undiagnosed in these countries due to barriers to access services, illiteracy, unsuitable clinic hours, or financial barriers. IMPACT TB will document these barriers and the health system costs using different service provision models. We will assess the potential long-term effects of sustained active case-finding on the TB epidemic and will work with local policy makers to develop scale-up plans for national implementation.

Health Economics

Over the past years, LSTM Health Economics has grown in numbers and is increasingly contributing to LSTM's mission to combat the impact of major diseases through the development of appropriate and affordable, efficient and equitable innovations. Numerous publications on chronic diseases led to our participation in a forthcoming Lancet series on Chronic Diseases and Health Economics, with the leading paper on poverty impact.

Typhoid fever

Typhoid fever is a re-emerging problem in sub-Saharan Africa, and a persistent problem in Asia. Whilst there is considerable optimism about the role that conjugate vaccines will play in the future of typhoid control, it is likely that we will need a combination of vaccination and Water, Sanitation, and Hygiene (WASH). With funding from the Bill and Melinda Gates Foundation, Nick Feasey and collaborators will support the control of typhoid fever by vaccination through identifying the environmental reservoirs of *Salmonella Typhi* associated with human infection to target interventions to interrupt transmission. The identification of *S. Typhi* from food, water, and the environment has previously been challenging, but a number of novel or repurposed methods should change this and we will develop methods to identify environmental reservoirs of *S. Typhi* and use these findings to inform targeted interventions through spatial modeling.

How donations shaped LSTM

The Nuffield Foundation provides a gift of £70,000 for a new extension to LSTM's campus.



1965

1966

1967

★ FEATURE ARTICLE

Lung Health & TB

LSTM's lung health and tuberculosis (TB) research takes a holistic, person-centred perspective recognising that men and women, boys and girls experience a heavy burden of lung disease which manifests with a range of symptoms including disabling coughing, breathlessness, and wheezing. Of the 10 million people who die each year from lung diseases, some 80% live in resource-limited countries.

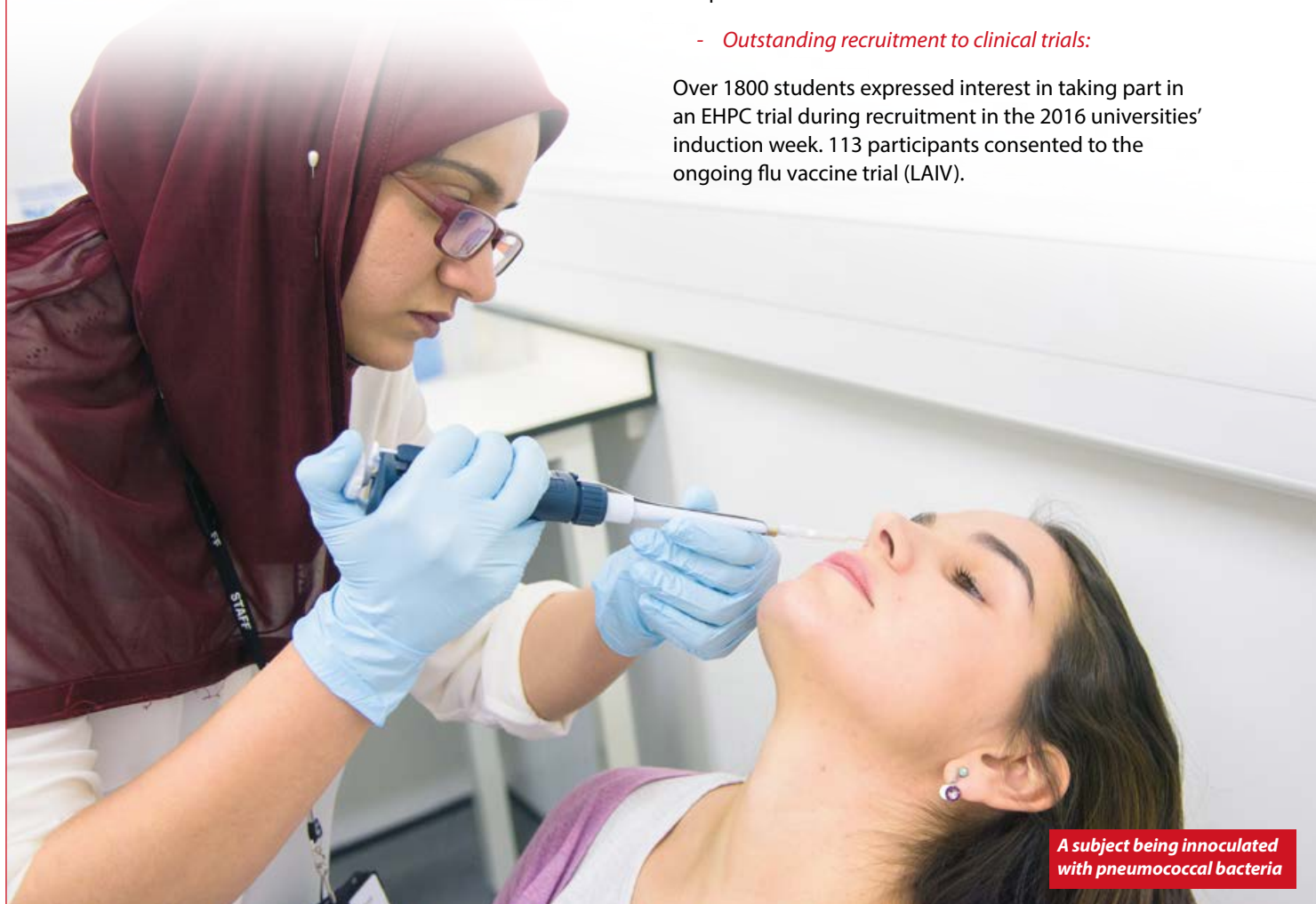
Pneumonia vaccine research

The Respiratory Infection team had another successful year in delivering translational research which will impact on the health of the world's most vulnerable populations. The team is using the unique Experimental Human Pneumococcal Carriage (EHPC) model to develop improved pneumonia vaccines. This Programme explores a simple and bold idea: controlled introduction of pneumococcal bacteria into the nose can induce strong protection at a population level and at an individual level, by reducing transmission and susceptibility to disease.

We use this controlled infection to better understand mucosal immunity, host susceptibility and the interactions of bacteria with common viruses such as flu. To date, over 600 volunteers have been inoculated with pneumococcus, 200 of those within the last year. The work is funded by the Bill and Melinda Gates Foundation and the Medical Research Council, and supported by the NIHR Clinical Research Network and the Royal Liverpool University Hospital.

- Outstanding recruitment to clinical trials:

Over 1800 students expressed interest in taking part in an EHPC trial during recruitment in the 2016 universities' induction week. 113 participants consented to the ongoing flu vaccine trial (LAIV).



A subject being inoculated with pneumococcal bacteria

- *Co-infection of live attenuated influenza vaccine and pneumococcal carriage (LAIV):*

"Does nasal flu vaccination alter the potential to transmit pneumococcus in a population?" More than half of young children are colonised with pneumococcus, and in the UK, all are offered the vaccination. Increased transmission of the bacteria in the community has potential to increase pneumonia disease, especially in vulnerable people such as the elderly.

The first trial of this study is now complete. 130 participants were randomised to receive either standard or nasal flu vaccine, then to have controlled pneumococcal inoculation. The second trial started in late 2016, and will randomise 150 participants to receive inoculation first, then followed by randomised vaccination. Final results will be available in April 2017.

- *Understanding host susceptibility to pneumococcus – 2 new studies now online:*

Some populations are more vulnerable to pneumococcal infection. We are specifically investigating the effects of asthma, and of ageing. 62 volunteers with asthma and 74 volunteers aged 50-85 are taking part. Their immune responses to the bacteria will be compared to those of healthy young adults. We are now expanding this work to Malawi and will study the impact of HIV infection on potential for pneumococcal transmission, and of individual susceptibility to disease.

- *Developing a live attenuated pneumococcal vaccine:*

This new project, recently funded by the MRC, will test pneumococcus strains lacking virulence factors as nasal vaccine using the EHPC model. These may protect against subsequent acquisition of virulent pneumococcus. This will be done in collaboration with researchers at the University College London.

- *A novel assay to stratify treatment of sepsis patients:*

This project is exploring the use of a whole blood assay of phagocytosis to identify patients who need adjuvant therapy for sepsis. This flow cytometry-based assay was optimised using samples from 30 healthy volunteers, and is now being tested in adult patients in the medical wards and Intensive Care Unit at Aintree Hospital in Liverpool. We are extending the validation into paediatric groups, with collaborators from Alder Hey hospital in Liverpool. Recruitment has been highly successful thanks to a close working relationship with NIHR. We expect to conclude the study within six months.

Quantification of Streptococcus pneumoniae inoculum using the colony counter

Clean cook stoves

Initial results from the LSTM-led Cooking and Pneumonia Study (CAPS) in Malawi indicate that cooking with cleaner burning biomass-fuelled cook stoves reduced the risk of burns in children under the age of five by over 40% compared to traditional open fire cooking.

The two-year study was the largest of its kind anywhere in the world, with more than 10,000 children enrolled across randomised villages in Chikhwawa and Chilumba, in Malawi. Half of the families involved were given two cleaner burning cook stoves to see if the new stoves, which can reduce emissions by up to 90%, would stop the children getting pneumonia, a major cause of death in this group. The study found that while the cookstoves were well liked, required less fuel, and were quicker to cook over, there was no effect on the risk of pneumonia.



Co-Principal Investigator, Dr Kevin Mortimer, Reader at LSTM and Respiratory Consultant at Liverpool's Aintree University Hospital, announced the key findings on the opening day of the 47th Union World Conference on Lung Health in October 2016. Dr Mortimer said: "Household air pollution kills more than 4 million people worldwide including half a million children who die from pneumonia. The results of our study suggest that by themselves, cleaner burning biomass-fuelled cookstoves are not sufficient to reduce the risk of pneumonia in the under-

5s. They do, however, appear to be substantially safer by reducing the risk of burns in young children. Effective solutions to the problem of household - and outdoor - air pollution are urgently needed. It is likely that cleaner burning cookstoves will be part of the solution, but as part of a package of interventions that deliver clean air rather than as standalone solutions. Such a package will need to address issues including the burning of rubbish - a common source of smoke exposure in our study - and tobacco smoking which is an increasing problem even in the world's poorest and most vulnerable populations"

"What was particularly striking about our results was the large reduction in burns within the households using the cook stoves." Dr Mortimer continued: "out of 10,000 children we saw over 1,500 burns during the study, 19 of which were very serious and one which proved fatal, so while further work certainly needs to be carried out to deliver solutions for household air pollution, the safety aspects of the cleaner-burning cook stoves are compelling."

Tuberculosis

Tuberculosis (TB) disproportionately affects the poor and vulnerable, especially in developing countries. It can affect any part of the body, but in most cases it causes disabling lung damage, robbing people of their livelihoods and pushing them further into poverty because of the costs of

health care-seeking and treatment. TB has caused more deaths in the last 200 years than any other infectious disease and yet receives only 1/6th of the funding that HIV research does.

Drug-resistant strains of tuberculosis are becoming more common worldwide and unless more effective ways to fight TB are found, there will be a return to the pre-antibiotic era, when there were no effective drugs for TB.

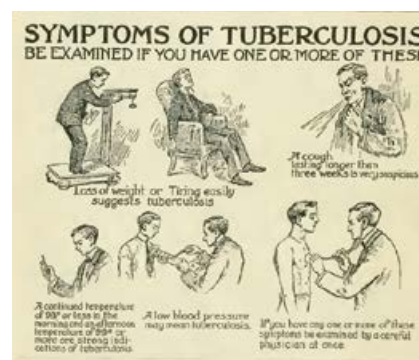
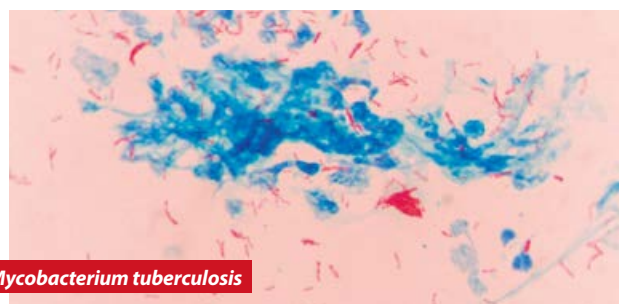


Illustration from the July 1918 issue of North Carolina's Health Bulletin



Mycobacterium tuberculosis

LSTM and WHO's STOP TB targets

The STOP TB department of WHO has set an ambitious target to eliminate TB as a public health problem by 2050. To achieve that we need:

- Improved diagnostic tests to detect the disease early and break chains of transmission
- Shorter and more effective drug treatment combinations and new drugs especially for drug-resistant tuberculosis
- Improved understanding of how to treat TB and HIV together, as people with HIV are more likely to suffer from TB
- A more effective vaccine than BCG which does not provide complete protection from TB disease
- Systematic and rigorous evaluation of the evidence to determine which new drugs and diagnostic approaches are effective

Further research is also needed into the optimal way to integrate new approaches to TB control in health systems which have limited funding and human resources, and are struggling with many pressing health problems.

LSTM's TB research spans the whole spectrum of this complex problem, taking a practical approach to find the best solutions which can be effectively applied in resource-constrained countries, including those with the highest number of TB cases. LSTM researchers are actively involved in various partnerships, such as PreDICT-TB and Treat TB, to develop new diagnostic and treatment tools, but also in networks such as the Effective Health Care Research Consortium and the Collaboration for Applied Health Research and Delivery to deliver outcomes on evaluation via systematic reviews and the impact on health systems and economies.

An example of that is the study in November 2015 by LSTM's Drs Sloan and O'Dempsey examining the impact of the recent Ebola outbreak on TB incidence rates in Sierra Leone. They stated that the high death rate among healthcare workers, closure of routine facilities, stigma around health-seeking behaviour, and fragmented drug supply represent considerable challenges for National TB Programmes. Evidence from elsewhere shows that TB case detection is compromised in fragile states. If a similar pattern is repeated with Ebola, each non-identified new TB case carries a 50% risk of mortality and may generate ten to fifteen onward transmissions. They stated that recent events in West Africa were a reminder that super-imposed epidemics are a constant threat and that the antidote is sustained commitment to fundamental strengthening of core services.

- Lung Health Conference 2016 in Liverpool

LSTM played an instrumental role in getting the 47th World Conference on Lung Health coming to Liverpool in October 2016. This year's theme was on 'Confronting Resistance: Fundamentals to Innovations' and addressed a number of critical areas for discussion, including the growing problem of resistance to existing TB drugs. Numerous LSTM researchers chaired sessions, spoke, or presented abstracts and gave live demonstrations.

WHO's Director of the Global TB Programme, Dr Mario Raviglione, came to LSTM to give a Seminar on 'TB in 2016, burden, challenges, and innovations'. Dr Raviglione stressed especially that the poorest and most vulnerable populations are the ones who carry the burden of TB, explaining the poverty – disease cycle. He paid tribute to LSTM's pivotal role in publishing data about this problem and stressed the importance of the new End TB Strategy Goal of eliminating catastrophic care-seeking costs for TB patients. He also called for more investment in research, saying that funding around new diagnostics, drugs, and vaccine development is essential.

- IMPACT TB

An example of the above can be found in the TB incidence rate in Vietnam and Nepal. Next year will see the launch of IMPACT TB, a study funded by the European Union and led by LSTM's Maxine Caws, to increase case finding in Vietnam and Nepal. Many TB cases are undiagnosed in these countries due to barriers to access services, illiteracy, unsuitable clinic hours, or financial barriers. IMPACT TB will document these barriers and the health system costs using different service provision models. We will assess the potential long-term effects of sustained active case-finding on the TB epidemic, and will work with local policy makers to develop scale-up plans for national implementation.

- Vietnam & Philippines – MRC Newton Fund projects

Two new MRC Newton Fund projects started this year. A new collaboration has been forged between LSTM and Vietnamese partners (2016-2019). Liverpool investigators will be working with Vietnamese colleagues to determine the underlying cause of non-MDR TB treatment failure which accounts for 10% of all new TB patients in Vietnam. Specifically, the project will determine whether drug exposure (pharmacokinetics) or variation in TB drug sensitivity (pharmacodynamics) can explain or predict treatment failure/relapse amongst non-MDR pulmonary TB re-treatment patients in Vietnam. In the Philippines Ivor Langley and colleagues at LSTM are introducing discrete event modelling to help policy decision making on where to deploy GeneXpert diagnostic machines for the diagnosis and treatment of multi-drug resistant TB.

Department of International Public Health

The Department of International Public Health brings together people from diverse professional backgrounds. Our portfolio includes large-scale research studies evaluating the scale-up of interventions of proven efficacy, clinical trials of new interventions, and health systems research to inform policy and programming.



*Professor Shabbar Jaffar
- Head of Department of
International Public Health*

HIV-infection in Africa

The department has seen a major expansion in HIV-related research. Following-on from the appointment of Professor Shabbar Jaffar in mid-2015, in August 2016, we recruited Frances Cowan as Professor of Global Health. Professor Frances Cowan is based in Zimbabwe, leading extensive large-scale studies around prevention of HIV-infection in key populations including sex-workers and adolescents, evaluation of the scale-up of male circumcision, and mental health. In addition, she is conducting an evaluation of the Zimbabwe government's national elimination of mother-to-child transmission programme. Alongside Dr Miriam Taegtmeier, Professor Cowan is a partner in the large consortium evaluating the expansion of HIV self-testing in Africa – a potential game changer in the field. Professor Cowan is Director of the Centre for Sexual Health and HIV AIDS Research Zimbabwe.



Dr Taegtmeier, who was promoted to Reader during the year, won a large grant to evaluate dolutegravir in pregnant women, in partnership with colleagues at the LSTM Clinical Trials Unit and Liverpool University.

Professor Jaffar is collaborating on three new studies: evaluation of the scale-up of cryptococcal antigen screening (led by NIMR Tanzania), implementation of meningitis screening (led by St Georges University of London), and management of confirmed cryptococcal meningitis (led by LSHTM). The group has teamed with partners across Europe and Africa to plan a mega trial on the causes of high HIV-associated mortality.



**Professor
Matthews Mathai**

Capacity Research Unit

The Capacity Research Unit (CRU) is at the forefront of operational research into capacity strengthening. The group was joined by a new Senior Lecturer, Dr Justin Pulford, to take forward CRU's pioneering work in assessment, learning, and evaluation methodologies appropriate to capacity strengthening initiatives in low- and middle-income countries. During the last year, it acquired major new funding to support capacity development in the Wellcome Trust-DFID funded DELTAS Africa initiative.

Centre for Maternal & Newborn Health (CMNH)

CMNH is an internationally recognised Centre of Excellence with strong international partners to promote the health of women and newborns in low-income countries through high-quality research, teaching, and technical assistance. Its team is multidisciplinary, comprising more than 100 staff, with programmes across Asia and Africa. In July 2016, the group were joined by Matthews Mathai, Professor of Maternal and Newborn Health.

Monitoring, Evaluation, Training and Research Group

The METRe Group (Monitoring, Evaluation, Training and Research Group) is a global leader in the development

and use of monitoring and evaluation techniques. In 2016, METRe collaborated with the Government of Bihar and CARE International in informatics, and with UNICEF New York to develop methods to rapidly assess Child Health Days in sub-Saharan Africa. In South Sudan, METRe has continued its support to the Ministry of Health to complete two major national studies on quality of care. The five-year Community and District Empowerment for Scale up (CODES) project in Uganda to support strategic resource allocation and annual planning for malaria, pneumonia, and diarrhoea comes to an end in 2016.

Health Systems

The Health Systems Development group has been through a strategic planning exercise over the past year and is rebranding itself as the Health Systems & Workforce Strengthening (HSWS) Unit. It has recently successfully completed its four-year EU-funded PERFORM project, which developed a viable district management strengthening model using action research. The unit is now negotiating a five-year project that uses implementation research for scaling up the model at district level.



HSG2018 to Liverpool

LSTM, together with a number of UK partners, won the bid to bring the Health Systems Global Conference to Liverpool in October 2018. Many staff had their work showcased at the preceding Vancouver Health Systems Global Conference in October 2016.

How donations shaped LSTM

The Diploma in Child Health and Tropical Paediatrics is established following a grant of £45,000 from the Leverhulme Trust.



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Maternal, Newborn & Child Health

Maternal and neonatal conditions still represent major global health risks, especially in low and middle income countries. Complications around pregnancy and childbirth; infections with malaria HIV and tuberculosis during pregnancy and severe acute malnutrition and undernutrition amongst children under the age of 5 pose significant global health challenges.

The challenges are stark, and within this context LSTM positions itself as a global centre of excellence in implementation research.

Maternal & Newborn health

Over the past academic year LSTM's Centre for Maternal & Newborn Health (CMNH) has seen further growth. As a recognised Centre of Excellence it has expanded its research portfolio to now include the broader continuum of maternal and newborn care; skilled birth attendance, emergency obstetric care and ante-natal and post-natal care and invested in new expertise in Health Systems Strengthening, Quality of Care and Newborn Care.

CMNH, under the leadership of Professor Nynke van den Broek, conducted research in 18 countries over the past academic year, seven of which are new.

• Implementation Research

- Making it Happen (MiH)

The DFID funded MiH Phase 2 Programme was successfully completed in August 2016. MiH aimed to reduce maternal and newborn mortality and morbidity by increasing the availability and improving the quality of Skilled Birth Attendance (SBA) and Emergency Obstetric and Newborn Care (EmOC&NC).



EmOC&NC training participants in Zimbabwe

CMNH developed three new approaches:

- Designing and delivering a '**skills and drills**' **EmOC&NC training package** training critical numbers (80% or more) of health care providers working in the maternity areas in health care facilities and using expert volunteers to build in-country capacity
- Designing and delivering a **MiH with Data** workshop package that helps health care providers to better collect, understand and use routine data on maternal and newborn healthcare provision and health outcomes
- Designing and delivering a comprehensive workshop package to **strengthen Quality Improvement methodology** (maternal and perinatal death audit and standards-based audit) at health care facility level.

The four year programme, which started in 2012 spanning 11 countries, consistently scored A+ in DFID reviews and achieved:

- 18,600 healthcare providers trained
- 83.7% demonstrated improved knowledge and 99.2% improved skills
- 1,700 Master Trainers, 20 skills labs and 275 training rooms equipped and functional
- 69% of healthcare facilities increased the availability of EmOC&NC by 12 months after training
- Improved quality of care, team work, triage and referral when needed
- Increased number of women and newborns recognised to need and received EmOC&NC
- Reduced case fatality rates with an estimated 13,161 lives saved.

Sierra Leone was one of the target countries for the MiH programme and CMNH was active in the country during the Ebola epidemic. Two studies gained significant attention, one on the '*Situational analysis of the stress levels among Sierra Leonean health care workers during the Ebola epidemic*' and one on '*The effect of the Ebola Virus epidemic on the availability, uptake and outcomes of maternal and newborn health services in Sierra Leone.*'

CMNH hosted an international conference in 2016 to present the results of the MiH programme and present its wider implementation research. The conference was attended by over 60 partners, including colleagues from governments, professional associations and UN organisations from 15 countries.

- Maternal Death Surveillance and Review (MDSR)

MDSR is a new approach, advocated by WHO, international donors, and UN partners, for reviewing and acting on the results of maternal death reviews. CMNH, a WHO Collaborating Centre for Research and Training on Maternal and Newborn Health, was commissioned by WHO to review country experiences of implementing MDSR. The review highlighted the need for:

- Strengthened social and team processes at facility level; ensuring a more positive attitude towards the benefits of MDSR, promoting a 'no shame, no blame' culture, and the ability to reflect on practice and manage change as a team for recommendations to be acted upon
- Increased knowledge among healthcare workers and management regarding classification methods for establishing cause of, and factors associated with maternal death such as the International Classification for Maternal Mortality (ICD-MM)
- Improved health system inputs including adequate funding and reliable health information systems to enable identification and analysis of cases;
- Central coordination of dissemination of lessons learnt, monitoring of implementation, and development of recommendations for facility or national level.

Working in close partnership with the Government of Kenya, Professional Associations and UN partners, CMNH has established a national MDSR secretariat in Kenya. In the first three years this secretariat will support a review of all maternal deaths that occur in major county and national referral hospitals. The first Kenya MDSR national report will be launched by the Minister of Health in November 2016

- Perinatal Death Surveillance and Review

CMNH is working in collaboration with WHO to develop an Android smartphone app to help healthcare providers in low and middle income countries review cases of stillbirth and neonatal death with a view to finding solutions and reducing preventable deaths. The app will provide a quick reference guide on how to conduct perinatal death reviews; assign cause of death for stillbirth and early neonatal death; automatically apply the new WHO International Classification of Diseases for Perinatal Mortality (ICD-PM) and identify areas of care for which quality is sub-standard. This will provide useful information to inform strategies and action for improvement in quality of care for newborn babies.

- Stillbirth Review

With 98% of the annual 2.6 million stillbirths occurring in low and middle income countries, it is important to understand the cause of, and factors contributing to, stillbirth in low resource settings. Funded by DFID, CMNH has completed a multi-country study to assess cause of death and contributing conditions for

stillbirths occurring at health facility level in Kenya, Malawi, Sierra Leone and Zimbabwe, with a view to identifying priority areas where improvement in quality of care is needed and likely to reduce preventable stillbirths. Data generated will also be used to test the newly released WHO classification for perinatal mortality.

B!rth: a Global Festival of Theatre and Debate

CMNH was the scientific advisor to this international theatre festival developed by Manchester's Royal Exchange Theatre and the Oglesby Charitable Trust.



The aim of the festival was to provoke debate on global health inequality through the performance of seven plays, written by seven female writers from seven different countries, exploring the issue of childbirth and women's health across the world.

CMNH participated in panel discussions and debate following the performances, alongside other leading experts in the field of women's health. The B!rth festival presented a unique opportunity for CMNH to engage with the wider community and brought together science and art to highlight the importance of improving maternal & newborn health globally.

- Improving maternal health and well-being during and after pregnancy

CMNH firmly advocates that all women have the right to the highest attainable standard of health and well-being, including physical, psychological and social aspects. The team undertook a large multi-country descriptive observational cross-sectional study to measure maternal morbidity in a holistic and comprehensive manner using self-reported symptoms, clinical signs and investigations in addition to assessment of psychological and social health using both objective and subjective measures.

CMNH assessed 11,454 women in India, Malawi, Kenya and Pakistan to determine their health needs during and after pregnancy. The study showed that women have a significant burden of ill-health during and after pregnancy that is at present largely unrecognised and untreated.



How donations shaped LSTM

Funding from the Wellcome Trust helps to establish the Venom Research Unit.



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CMNH is working to adapt current antenatal and postnatal care packages in low and middle income countries such that these will meet the identified health needs of women in a comprehensive holistic way, to improve maternal health and well-being during and after pregnancy.

- *Quality Improvement of integrated HIV, TB and malaria services in antenatal and postnatal care facilities*

Funded by Global Fund, CMNH will, from late 2016 onwards, implement, document and disseminate innovative approaches that demonstrably improve the availability and quality of antenatal and postnatal care inclusive of the identification (screening, testing) and management (prevention and care) of HIV, TB and malaria integrated into comprehensive, holistic health service delivery, which addresses the identified health needs of mothers and babies during and after pregnancy.

- *Improving Neonatal Health*

With 2.9 million deaths occurring each year, neonatal mortality (death in the first month of life) accounts for 45% of all under-5 child mortality. The majority of these deaths happen in low-and middle-income countries. Better respiratory support may help in reducing neonatal mortality. Continuous Positive Airway Pressure (CPAP) is a type of respiratory intervention which has the potential for large scale implementation in low and middle income countries as it is relatively simple and cheap. However, using CPAP is not free of adverse events such as pneumothorax, or severe nasal lesions.

CMNH is conducting a national study to assess the use of CPAP across India. The results of the assessment will inform policy makers and health care implementers from India and other low and middle income countries about the feasibility and standard of practice of CPAP and its effectiveness with regard to health outcomes. The assessment will inform the development of new standards of care for CPAP and what is needed to support this.

• **Programme Evaluation**

Over the past academic year CMNH has successfully completed the following external evaluations:

- *A four year evaluation of the Health Transition Fund in Zimbabwe*

CMNH's evaluation showed that the design of the Health Transition Fund had a good degree of relevance, effectiveness and flexibility to respond to emerging needs with a catalytic approach to health system strengthening. The evaluation highlighted areas for improvement particularly related to opportunities to maximise efficiency in implementation and a need to focus on equity in the future, as well as to engage more comprehensively at community level. CMNH was delighted to receive a score of 3.2 out of 4 from the internal UNICEF evaluations Quality Assurance system for its final evaluation report.

- *A one-year evaluation of the Nigeria Maternal, Newborn & Child Health Weeks (MNCHW) Initiative*

The evaluation made a series of policy recommendations including the development of an accountability framework in collaboration with partners and state governments at central and state levels to monitor, input, activities and outputs and the establishment of a national steering committee with clear Terms of Reference developed in collaboration with UNICEF and other partners to provide strategic oversight, drive the implementation of the accountability framework and develop an exit strategy.

- *A 10 month evaluation of the Rwanda Community Health programme*

The evaluation commissioned by UNICEF looked at the impact, relevance, effectiveness, efficiency and sustainability of the Community Health Programme. Preliminary findings showed that the programme contributed to increase access to antenatal care and facility-based deliveries, increased the use of modern contraceptive methods and the access to treatment of childhood diseases for children under 5. However, irregularity of trainings, lack of means for supervision and regular shortage of supplies hampered the programme. With the decrease in external funding in the last years, the sustainability of the programme is jeopardised. Community-Health Workers' cooperatives that were created to substitute for Performance-Based Financing did not provide the expected benefits.



Malaria in Pregnancy

Malaria infection during pregnancy is a significant health problem to both the mother and the unborn child. Each year up to 125 million pregnancies occur in malaria endemic countries. Malaria infection during pregnancy can result in pregnancy loss, maternal death, severe maternal anaemia and low infant birth weight which increases the risk of death in the neonate. It is associated with as many as 100,000 children dying needlessly every year.



The Malaria in Pregnancy Consortium, led by LSTM, was established with an initial grant of \$30 million from the Bill and Melinda Gates Foundation (BMGF) and is also supported by the European Union and EDCTP. It aims to find new and innovative solutions to tackle the problem of malaria infection during pregnancy.

A new partnership this year has seen MiP join forces with the Worldwide Antimalarial Resistance Network (WWARN) to establish a malaria in pregnancy research programme. It aims to develop a better understanding of the impact of resistance on the effectiveness of current prevention strategies and help ensure that all pregnant women with malaria receive safe and effective malaria treatment.

2016 saw also LSTM's MiP group working with colleagues in Africa to complete studies looking at alternative drugs and strategies to prevent malaria in pregnancy. Both studies, carried out in Kenya and Malawi, looked at the safety, efficacy and acceptability of intermittent screening and treatment using dihydroartemisinin-piperaquine (DP) as an alternative strategy to intermittent preventative treatment with sulfadoxine-pyrimethamine (SP), currently recommended by WHO for malaria prevention in pregnancy. While both studies found that screening and treating confirmed cases of malaria with DP was not a suitable alternative to the current policy, the trial in Kenya found that DP offered a potentially effective alternative to SP for intermittent preventative treatment, the effectiveness of which is under threat from the growing problem of drug resistance.

Child Health

While great strides have been taken to reduce the deaths in children under the age of five in the last 40 years, with numbers reduced by more than half, progress in relation to malnutrition is not as impressive. Severe Acute Malnutrition (SAM) is most prominent in low-income countries, and undernutrition is thought to be an underlying contributor in up to 45% of all deaths in that age group.

Cases of SAM have inflammation of the gut that breaks the healthy structures down which in turn leads to impaired food digestion and nutrient absorption as well as probable increases in secondary infections, including sepsis due to bacteria crossing the damaged mucosa.

LSTM's Professor Stephen Allen has begun a pilot study in Malawi to measure the impact of specialist foods on the treatment of SAM in young children. The team evaluates therapeutic feeds designed to treat food intolerance and intestinal inflammation. The aim is to recruit 120 children between 6 months and 2 years old who are all being admitted for 2 weeks each to the Moyo House Ward in Blantyre. Results are due in early 2017.

The study is funded by an award via the Joint Global Health Trial scheme from the MRC, Wellcome Trust and DFID and the research is being done in partnership with the Malawi-Liverpool-Wellcome Trust Clinical Research Centre and collaborators in the Netherlands and Canada.

In a linked qualitative research project on the Moyo ward, MTP student Emilie Macher, developed a model for a better therapeutic alliance between parents/carers and staff in the management of malnutrition.

Working with collaborators in Canada and using an untargeted metabolomics approach, we have described metabolic abnormalities in children with malnutrition in Northern Nigeria. This should lead on to further research to determine if the derangement of specific metabolites may guide improved management and/or act as novel biomarkers for assessing response to treatment.

Alongside the research in malnutrition, we are also advancing proposals to undertake a programme of research in acute diarrhoea and dehydration in Nigeria, thalassaemia in Sri Lanka and standards for neonatal care in low-resource settings.

In the UK, our article "Time to go global: a consultation on global health competencies for postgraduate doctors" was chosen as the Editor's Choice for the September issue of International Health. At Alder Hey Hospital in Liverpool, we have established a programme for hosting RCPCH Visiting Fellows and also provided teaching in clinical audit. We have increased our collaboration in international research studies of inflammatory bowel disease in children and are developing investigator-led projects that complement the overseas research.

We have led a collaboration between the BSPGHAN/NIHR-Children Gastroenterology, Hepatology and Nutrition Research Working Group and the charities Crohns and Colitis UK and The Children's Liver Disease Foundation to secure a total of £70,000 for start-up research grants.

Strategic & Clinical Partnerships

Malawi-Liverpool-Wellcome Trust (MLW) Clinical Research Programme

The Malawi-Liverpool-Wellcome Trust Clinical Research Programme celebrated its 21st anniversary in 2016. This health research partnership is a collaboration between LSTM, the University of Liverpool, and the University of Malawi's College of Medicine, with major support from the Wellcome Trust. MLW's two major Programmes reflect the health needs of Malawi and the wider region. They focus on "How can deaths from infectious disease be prevented?" and "How can disease transmission be reduced?" In addition, a Strategic Initiative led by the Director asks "How can we reduce the burden of chronic disease and disability?"



- Preventing death from infection

Sepsis, pneumonia, diarrhoea, meningitis, malaria, and neonatal infection remain major killers in Malawi. This Programme has vaccine prevention, treatment improvement, and behavioural strategies to reduce death. Vaccine research includes both pathogenesis studies and clinical trials for vaccines against respiratory viruses, enteric viruses, rotavirus, pneumococcus, and malaria. Treatment strategies in pneumonia, meningitis, malaria, and sepsis, in both adults and children, include supportive care with ventilation and oxygen as well as strategies to optimise fluids and evade and prevent antimicrobial resistance. The Programme is underpinned by excellent surveillance platforms in the community, in health centres, and in the hospital, together with our state-of-the-art laboratories that are not only flagship reference facilities for both Malawi and the region, but also playing a critical part in our understanding of the global spread of infection.

- Preventing disease transmission

HIV, TB, and malaria remain the most prevalent and feared diseases in Malawi. MLW has developed world-leading expertise in geospatial mapping and geospatial statistics that underpin the study of disease incidence, community interaction, migration, and the effectiveness of control strategies to interrupt transmission of infectious diseases, particularly HIV, TB, and malaria. New diagnostics, particularly HIV self-testing, community attitudes, and underpinning immunology and experimental treatment strategies, are all part of this Programme which has been greatly strengthened by the Wellcome Trust Senior Fellowship re-awarded to Professor Corbett. The community sampling, surveillance, and testing platforms are also ideal to extend the reach to include typhoid, non-typhoidal salmonella infections, as well as enteric and respiratory viruses. The role of vaccines in transmission reduction are under active study for rotavirus, pneumococcus, malaria, and salmonella.

- Chronic diseases and disability

The demographic trajectory of Malawi indicates that in 15 years, the population will have doubled to over 30 million. Currently, chronic lung impairment is found in 40% and hypertension in 30% of adults, with HIV prevalence at 11%. Chronic stunting with accompanying neurocognitive functional loss is found in 40% of children. There is a rising prevalence of adolescent obesity and diabetes. The MLW Programme has recently established focused excellence in four key areas in which there are very limited African data - lung health, chronic effects of HIV including stroke, HIV/diabetic retinopathy, and long-term effects of acute malnutrition. Immediate aims in Lung Health will be accurate phenotyping and determination of aetiology for small lungs, including association with infection, Household Air Pollution, and nutrition. In chronic HIV, they will establish the basis of vascular inflammation that leads to stroke. In HIV diabetic retinopathy they will determine why this group have a five-fold worse prognosis than patients with either disease alone. They will plan long-term cohorts to determine interventions that will prevent early-life insults with long-term sequelae.

- Training

MLW has an established institutional reputation for providing excellent early career development in a number of strategic disciplines including immunology, molecular microbiology, epidemiology, public health, clinical infectious diseases, behavioural science, lung health, and paediatrics. This allows them to attract the brightest graduates, and retain them in training through to postdoctoral level. In order to maintain this competitive pipeline and provide a foundation of scientific excellence to support Research Group development and productivity, they propose a central training strategy managed jointly with the College of Medicine (COM). The aims are to maximise the productivity of Research Group members with "tenure-track" potential through Core investment to complement existing opportunities, and facilitate successful Fellowship applications at all levels of seniority. Support will include early research internships, degree training, and postgraduate courses that provide key skills required by Research Groups, bridging support to enable "tenure-track" potential researchers to apply for independent training and research funding.

- Policy Unit

In Malawi's extremely resource-constrained health sector, it is important that decisions about allocation and prioritisation of public funds are taken on the basis of robust research and economic evidence that has been objectively synthesised and transparently considered. MLW leads in EVIDENT, a DFID-funded Evidence Based Decision Making Network for Health Policy and Practice in Malawi. The EVIDENT vision is to improve the health and economic status of the country by providing

advice and technical support in the use of scientific data in decision making about health policy and practice.

MLW will play both leadership and active participant roles in the EVIDENT network. EVIDENT will address key hurdles in effective formulation of evidence informed health decisions, and strengthen cross-linking and coordination between agencies. MLW will do this by linking work in Blantyre and nationally with a new Lilongwe Policy Unit, positioned near to government and key stakeholders.

BREATHE

BREATH

The BREATHE
Africa partnership
(Biomass
Reduction

and Environmental Air Towards Health Effects), led by LSTM, brings together experts involved in air pollution research. It is estimated that 3 billion people worldwide and 700 million in Africa are exposed to toxic air pollution through the burning of biomass fuels (particularly for cooking) in their homes, resulting in premature deaths and ill-health. The partnership shares expertise through linking with and building on ongoing air pollution research, facilitates collaborative research, and expands knowledge through the PATS MECOR research training programme. BREATHE Africa brought international researchers together with junior African researchers at the most recent PATS MECOR training at the Malawi College of Medicine in July 2016, and also supports four PhD students in the thematic areas of exposure and biomarkers, mechanisms, health effects, and interventions & policy.

Wellcome Trust Liverpool Glasgow Centre for Global Health Research (WTCGHR)



MLW is supported by WTCGHR, one of five Wellcome Trust Centres for Global Health Research. LSTM Dean of Clinical Sciences and International Public Health, Professor David Laloo, is Director of the Centre that also delivers the Wellcome Trust Clinical PhD Programme, a flagship scheme supporting the most promising medically qualified clinicians wanting to undertake rigorous research training.

KEMRI/CDC in Kenya



The collaboration between the Kenya Medical Research Institute (KEMRI) and the US Centers for Disease Control and Prevention (CDC) in Kisumu, western Kenya, and LSTM (KCL) was strengthened this year with the receipt of several new grants by staff from LSTM's Department of Clinical Sciences. These include a grant for a large

menstrual hygiene intervention trial in adolescent school girls, led by Dr Phillips-Howard and due to start early-2017, and malaria related studies, led by Professor Feiko ter Kuile, which includes a new multicentre trial of malaria chemoprevention in the post-discharge management of children with severe anaemia ongoing in four hospitals in western Kenya. There is also

a large trial to determine the safety and efficacy of new malaria chemoprevention regimens for the control of malaria, sexually transmitted and reproductive tract infections in pregnancy. In addition, a new five-year cooperative agreement was awarded by CDC to Professor ter Kuile's group for further research related to malaria elimination and malaria vaccine studies, as part of the collaboration with CDC in western Kenya. A trial looking at ivermectin for malaria control was also successfully completed this year. Professors Donnelly and Torr have increased their collaboration with the entomology group in western Kenya looking at novel methods for entomological surveillance of malaria vectors and insecticide resistance. Five PhD students from Kenya and the USA are currently enrolled as part of these studies.

The Global Alliance to Eliminate Lymphatic Filariasis (GAELF)



A FUTURE FREE OF LF
Global Alliance

GAELF brings together a diverse group of public-private health partners to support the Global Programme to Eliminate Lymphatic Filariasis (GPELF) by mobilising political, financial, and technical resources. GAELF's secretariat has been hosted by LSTM since 2004, and was incorporated into LSTM Neglected Tropical Diseases in early-2015.

According to the latest WHO Weekly Epidemiological Record, since the launch of the GPELF, a cumulative total of 6.2 billion treatments have been delivered to >820 million people at least once. In 2015, national programmes targeted 698.3 million people for treatment during MDA, and according to data reported to WHO, by September 2015, had treated 556.2 million with a programme coverage of 79.4%. Of the 73 countries currently considered endemic, MDA is no longer required in 18 countries where post-MDA surveillance is now ongoing. The GPELF is considered to be one of the most successful elimination programmes.

University of Warwick (UoW)

THE UNIVERSITY OF
WARWICK

The partnership between LSTM and UoW's Schools' of Medicine and Life Sciences began in 2012 and draws upon complementary areas of expertise, providing an excellent opportunity for talented researchers to make significant contributions to the international health agenda.

Central to the partnership is the study of the science, policy, and economics of applied health research and delivery. Coordinated by LSTM, the Collaboration for Applied Health Research and Delivery (CAHRD) brings together individuals and disciplines across the full range of applied health research encompassing operational, implementation, and health systems research.

The NTD Modelling Consortium is coordinated by UoW and acts as a point of contact to commission modelling to address questions concerning the elimination and control of NTDs. Mathematical modelling plays an increasing role in public health planning and decision-making (such as determining cost-effectiveness of drugs and vaccines), but for NTDs such as approached previously have been rarely used.

Lancaster University (LU)



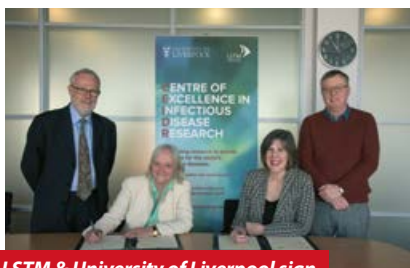
Strong cross-cutting links with LU have already generated collaborative projects with all of LSTM's departments and along the entire translational research pipeline continuum. A Translational and Quantitative Skills Doctoral Training Programme in Global Health was established in 2016. Supported by a grant from the Medical Research Council's Doctoral Training Programme (MRC DTP), LSTM and LU have started with the first cohort of six students and, over three years, will train some twenty students as the next generation of scientists in translational and quantitative research.

University of Liverpool (UoL)



UNIVERSITY OF
LIVERPOOL

The Centre of Excellence in Infectious Disease Research (CEIDR) has been developed in partnership with the University of Liverpool to exploit the largest concentration of translationally-focused public sector research and development expertise in infectious diseases in the UK. With support from Liverpool City Region and Liverpool Health Partners, CEIDR will build on existing relationships with commercial companies. CEIDR will utilise both our academic expertise and state-of-the-art facilities to accelerate solutions for existing and emerging infections. The project is being led within LSTM by Professor Peter Winstanley who has been appointed as Director of Strategic Projects.



LSTM & University of Liverpool sign the MoU on CEIDR

In response to the 2015/16 Zika virus outbreak, Scientists from UoL's Institute of Infection and Global Health were awarded over £500,000 as part of a rapid-response funding initiative from the MRC. The money is funding four research

projects carried out as part of the National Institute for Health Research (NIHR) Health Protection Research Unit (HPRU) in Emerging and Zoonotic Infections, and the partnership between LSTM, UoL, and Public Health England.

Although the formal affiliation with the University of Liverpool (UoL) ended in July 2013, when LSTM obtained higher education institutions status, the academic collaboration to deliver world class education and research continues to thrive as illustrated in numerous research initiatives such as MLW, WTCGHR, CIDG, and LIV-TB, to name a few.

LSTM's postgraduate degrees, and most of the diplomas, continue to be awarded by UoL until LSTM has obtained degree awarding powers, foreseen in 2017.

ACT Consortium



Artemisinin-based combination therapies (ACTs) are the first-line treatment for malaria in Africa and Asia. The ACT Consortium brings together 24 global academic and public health partners, including LSTM who work in 10 countries, to examine the effectiveness of ACTs over time, the cost-effectiveness of delivery strategies, acceptability, safety, and how to improve ACT use by prescribers and patients. Professor David Lalloo's eight-year collaboration with the ACT Consortium came to an end this year. He was a member of the ACT Consortium Steering Committee and the Safety Working Group Lead. Resources developed over the project continue to be used by LSTM and other research projects, and whilst the Group found no clinically important safety issues, the importance of continuing to monitor for ongoing safety of ACTs is recognised.

Stop TB Partnership



Although TB is treatable with a six-month course of antibiotics, it still kills 1.5 million people each year. Founded in 2001, the Partnership's mission is to serve every person who is vulnerable to TB and ensure that high-quality treatment is available to all who need it. Together, Stop TB's 1300 partners are a collective force that is transforming the fight against TB in more than 100 countries.

At LSTM, TB research spans the whole spectrum of this complex problem, taking a practical approach with partners in developing countries to find the best solutions that can be effectively applied in these settings. LSTM's Professor of Clinical Tropical Medicine, Bertie Squire, is Secretary to the Partnership's TB & Poverty Sub-group, a sub-group of the DOTS Expansion Working Group and a network of individuals and organisations who focus on ensuring that the specific needs of poor and vulnerable populations are addressed in the delivery of TB services.

The Partnership is working towards the target of eliminating TB as a global public health problem by 2050.

Mersey Maritime



MERSEY
MARITIME
— MEMBER —

The Mersey Maritime network represents the interests of the Ports and Maritime Sector on Merseyside. LSTM became a member in 2015, enabling further development of maritime business opportunities, initially occupational health, pre- and post-travel screening services, and training and education. Both LSTM's Director, Professor Janet Hemingway, and the Well-Travelled Clinics' Managing Director, Philippa Tubb, have attended a number of meetings and presented the work of LSTM at a number of networking events.

Knowledge Quarter Liverpool

The unique mix of science, medicine, and culture has already attracted the Royal College of Physicians (RCP) who have chosen Liverpool Knowledge Quarter as the home for their new Northern Centre of Excellence. KQ Liverpool presented its vision during a launch event in London in October 2016, and earlier in the year appointed Colin Sinclair, former director of one of the UK's largest family-owned property companies, Bruntwood, as its Chief Executive.

KQ Liverpool is supported by its founding partners: LSTM, University of Liverpool, Liverpool John Moores University, Liverpool City Council, the Royal Liverpool and Broadgreen University Teaching Hospital Trust, Visit Hope Street CIC and Liverpool Vision.



Liverpool Health Partners (LHP)

LSTM is part of LHP, a strategic partnership of ten primary care NHS organisations, LSTM and the University of Liverpool. LHP aims to improve health and deliver exemplary research, education, and healthcare, specifically in Personalised Health, across the Liverpool City Region.



NHS

LSTM's expertise is increasingly called upon in the UK and regionally by the NHS. LSTM's clinicians work across a number of NHS trusts in the North West including the Royal Liverpool and Broadgreen University Hospital, Aintree University Hospital, and Alder Hey Children's Hospital. Central to this is the Tropical and Infectious Diseases Unit (TIDU) at the Royal Liverpool University Hospital, which is staffed by a number of LSTM clinicians, all experts in different aspects of tropical medicine.

As well as the management of clinics, LSTM also works with the NIHR Clinical Research Network: North West Coast, with special lead on respiratory medicine being LSTM's Senior Clinical Lecturer, Dr John Blakey. The work allows the NHS to benefit from the research expertise of LSTM and other institutions locally, encouraging regional clinicians to take on more studies.

The Experimental Human Pneumococcal Carriage (EHPC) collaboration utilises the strong clinical links between LSTM and the Royal University Hospital with the various studies examining the role of pneumococcal carriage in the nasal cavity in relation to susceptibility to disease. Thanks to the partnership with the NIHR, the studies now have enough volunteers to participate in current and future studies.



LIV-TB

LIV-TB is a cross-campus collaboration between LSTM and the University of Liverpool. It holds a monthly seminar with a presentation on a TB-related theme by members of the group or visiting researchers in the field, followed by wide-ranging discussion and update. Meetings this year have included talks about addressing poverty to control TB, the effects of household pollution (HAP), and patient's experiences of TB treatment in the North West and the challenges that clinicians face.



Asthma UK

Dr John Blakey continues to work with Asthma UK developing research and implementation strategies relating to connected technologies such as smart inhalers. These devices can improve self-management and concordance with medication, and it is intended that they will soon inform asthma attack risk prediction, building on current on-line tools that Dr Blakey has developed with Asthma UK and the Respiratory Effectiveness Group, an international network of respiratory experts.



Public Health England

LSTM clinicians continue to provide specialist advice to Public Health England (PHE), the government body responsible for protecting the nation's health and wellbeing, and reducing health inequalities.



Professor David Laloo continues to chair PHE's Advisory Committee on Malaria Prevention in Travellers, and Dr Nick Beeching, LSTM Senior Lecturer and Honorary Consultant at the Royal Liverpool University Hospital, is part of the PHE Imported Fever Service.

NaTHNaC

The National Travel Health Network and Centre (NaTHNaC), commissioned by PHE, protects the health of British travellers, by providing the latest information and advice to the public and the travel industry. As co-founder, LSTM has been working with other network partners including the Hospital for Tropical Diseases and LSHTM, both in London.



IDAMS

In the IDAMS project a consortium of international experts, including from LSTM, work together to develop new and innovative tools to be applied to the control of dengue in a global context and aims at improving diagnosis and clinical management of dengue.



★ FEATURE ARTICLE

Applied Health

Applied health research is central to LSTM's mission to ensure that advances in science make their way from the laboratory bench to people in endemic countries. The new products and interventions needed to improve the prevention and treatment of diseases require an understanding of their impact which can only be derived through effective and constant monitoring and evaluation.

Expertise in product development, as well as translational and policy research focussing on health systems improvement and capacity strengthening, puts LSTM in an ideal position to work with partners across the globe, taking interventions from regulatory approval through to field implementation, moving it into policy and practice.

CAHRD

2016 saw the shift in global health priorities from the Millennium Development Goals, which expired in 2015, to the new framework of Sustainable Development Goals (SDGs) with their 2030 timeline. CAHRD, led by Professor Bertie Squire, with Dr Kevin Mortimer as Deputy Director, continued its alignment to the SDGs (which started with its inaugural Consultation in 2014) throughout 2016 by successfully partnering with the Institute for Development Studies and others for DFID-funded work on Knowledge for Development, supporting DFID's decision-making



around strategic investments in development work to support progress towards the SDGs.

A number of additional grants in the CAHRD theme of Lung Health & TB were successful, including a Newton Fund grant from the Medical Research Council (MRC) to focus on impact assessment of diagnostic algorithms and tools for multi-drug resistant (MDR-TB) and drug sensitive tuberculosis (TB) in the Philippines. This work continues a strand of work on operational modelling of the impacts (e.g. on patients, health systems, and costs) of new technologies and drug regimens for TB. Along with other funding streams, this grant has facilitated CAHRD's establishment of cross-LSTM Health Economics and Modelling (HE&M) Group which will be instrumental in further growth of our applied health research and delivery portfolio.

Along with expertise in other disciplines, the HE&M Group is key to CAHRD's support to the College of Medicine, Malawi, the Department of Planning in the Malawi

Ministry of Health, and the Malawi-Liverpool-Wellcome Trust Clinical Research Programme in developing a context-specific national model for policy formulation. This work is important because, in resource-constrained health systems, it is vital that public funds are used wisely. Decisions about allocation and prioritisation of such funds should, therefore, be taken on the basis of good research and economic evidence that has been objectively synthesised and transparently considered. Models for enabling this process are lacking in many developing countries.

CAHRD continues support to the MRC Doctoral Training Partnership PhD programme, which enables LSTM to recruit up to seven PhD students, annually. The scheme pairs novel multidisciplinary PhD research with the next generation of leaders in health and biomedical provision.

Evidence synthesis

The Effective Health Care Research Programme Consortium, which encompasses the Cochrane Infectious Diseases Group and partners worldwide, saw the publication of the WHO Guideline for iron supplementation in malarial areas. WHO

had originally acknowledged the results of a large trial that suggested harm. However, the Cochrane review of 35 trials, including almost 32,000 children, put these results in context of all the evidence and concluded that iron supplementation was safe in areas with reasonable malaria control measures.



There was also more debate around the deworming of schoolchildren. The Cochrane review stimulated a re-analysis of the most controversial study and this was published, identifying errors and an absence of several effects that the study was purported to demonstrate. The debate reached The Guardian, and the lead author was interviewed on Tim Harford's "more or less" on BBC Radio 4.

India has the highest burden of TB in the world, and LSTM was honoured to work with the Government of India and the All India Institute of Medical Sciences in developing national guidelines for extra-pulmonary diseases. The Liverpool-Vellore team worked with thirteen different speciality groups to form guidelines for detection and treatment using evidence-informed guideline approaches. These have been agreed and are now being rolled out across the country.

Lots of other guideline work at WHO and at national level in Kenya and South Africa has been happening; there have been a number of Cochrane reviews, with 60% of all publications led by someone from a low- or middle-income country, and more than half of these LMIC authors are women. There have been a number of courses run in evidence-based development for the International Union in tuberculosis in India, and in Ghana, in neglected tropical diseases. The team are now developing a portfolio of Cochrane reviews in HIV/AIDS, led by a team in Cape Town, with technical support from Liverpool.

Health systems development

As part of the ReBUILD Research Programme Consortium, LSTM has been working with a range of partners in post-conflict settings to improve access to effective and equitable health care, especially for the poorest households. ReBUILD's research is helping to understand how best to support a skilled and motivated health workforce, and how to ensure that poor households in a post-conflict and post-crisis environment can access essential health care without risk of impoverishment.



Community health workers in Cambodia

At international level, the findings have been feeding into policy and practice, through engagement with organisations including the Global Fund on AIDS, TB & Malaria, the World Bank, and with stakeholders working on health systems strengthening in fragile and conflict-affected settings including Syria, Yemen, and Burma. ReBUILD has also been more generally raising the profile of health systems research in FCAS, especially through the development of a Health Systems Global's Thematic Working Group on Health Systems in Fragile and Conflict-Affected States.

One of ReBUILD's partners is the College of Medicine and Allied Health Sciences (COMAHS) in Sierra Leone. Although the initial research in Sierra Leone was to understand the issues of health systems reconstruction following the civil war, the work continued through the recent Ebola outbreak, providing important insight into the health system during the crisis, and evidence to support the post-Ebola reconstruction. As well as providing evidence and supporting its use in developing equitable health systems, a key component of LSTM's work has been supporting country partners' own long-term capacity for evidence-based strengthening of its health system. In Sierra Leone, this is being continued through a new EDCTP-funded programme – RECAP-SL – in which LSTM (led by Dr Joanna Raven) is helping to establish a research centre within COMAHS that will lead on health system research and capacity strengthening within Sierra Leone. The centre will deliver credible, relevant research for effective policy making and practice, especially during the post-Ebola period, when the need is greatest and the demand strongest.

Gender and health

LSTM's Research in Gender and Ethics: Building stronger

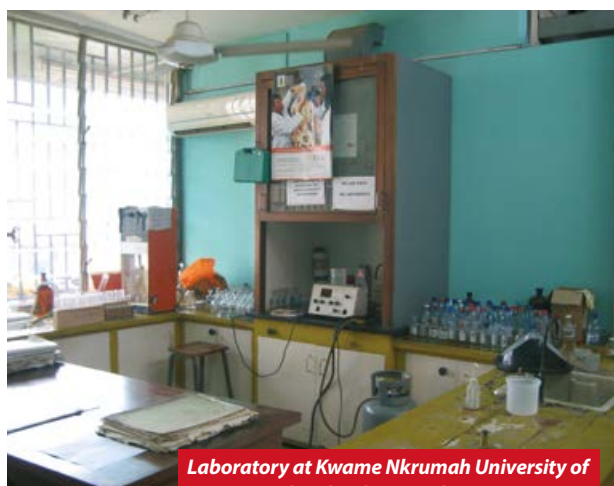


health systems (RinGs) group has been very active over the previous year, holding a consortium meeting for joint analysis of data, writing papers and other outputs, and ensuring ongoing active dialogue with policy makers and practitioners. Professor Sally Theobald presented on a panel during the World Health Assembly in Geneva on Health Systems Strengthening: Women's Leadership, Peace, and Security which included the Honorable Minister Dr Bernice Dhan, the Minister of Health in the Republic of Liberia. Professor Theobald presented work from Building Back Better on gender and health systems in post-conflict contexts, which links to ReBUILD and RinGs.

The team has also undertaken a consultancy with European Commission, training EC delegates in gender and health systems, and presented findings of an MRC-funded exploration of the drivers of child marriage at a national dissemination meeting in Sudan. Current research includes a theme on understanding what enables gender equitable scientific research careers as part of the DELTAS Learning Research Project (led by the Capacity Research Unit) exploring the Wellcome Trust-funded DELTAS: Developing Excellence in Leadership, Training and Science Initiative.

Capacity strengthening

The Capacity Research Unit (CRU) at LSTM specialises in the development and application of innovative tools and transferable approaches for catalysing more effective research capacity strengthening (RCS). CRU is at the global forefront of research in RCS assessment, learning, and evaluation. CRU's mission is to improve the effectiveness, impact, and value for money of current and future RCS implementation activities in low- and middle-income countries (LMICs), through the advancement of a dedicated, implementation-focused RCS science.



Laboratory at Kwame Nkrumah University of Science and Technology in Ghana

With the Royal Society and DFID, CRU is continuing to support UK-African research consortia to identify and implement strategies to develop the universities' research environment and improve doctoral programmes.

As a part of the Wellcome Trust and DFID's DELTAS Africa initiative, CRU is implementing a 'Learning Research Programme' designed to produce research-based learning about how to train and develop world-class researchers, foster their careers and collaborations, and promote research uptake.

CRU continue to provide laboratory strengthening expertise in LMIC, including a recent overview of antimicrobial resistance (AMR) surveillance systems in Ghana, Malawi, Nepal, and Nigeria in support of the Fleming Fund's ongoing efforts to strengthen global AMR surveillance capacity.

Health programme monitoring and evaluation

In 2016, the Monitoring Evaluation Training and Research (METRe) Group supported the Government of Bihar (GoB) and CARE International in informatics and learning within a Bill and Melinda Gates Foundation financed project. METRe aided the GoB and CARE's consortia to strengthen and quality assure its current monitoring and evaluation work, ensuring its efforts have a strong theoretical basis. This project will have additional innovations such as the Annealing Techniques (AT) which is intended to improve coverage estimates provided by HMIS data by bringing it together with a small probability community survey. This will render the HMIS more useful for decision makers, allowing the calculation of prevalence estimates, and demonstrating that surveys complement rather than replace HMIS.

METRe also supported UNICEF/New York to develop methods to rapidly assess Child Health Days in sub-Saharan Africa. Working in Benin, Niger, and Madagascar, METRe has both built the capacity of UNICEF and district Ministry of Health teams to carry out these assessments using the Lot Quality Assurance Sampling (LQAS) method, and to use the data to identify gaps in coverage.

In South Sudan, METRe has continued its support to the Ministry of Health by working in partnership to complete two major national studies. The first applies LQAS in nine of ten states to assess the key maternal, newborn, child, and reproductive indicators. The second is a health facility in all ten states to assess the quality of clinical care for mothers, newborns, and children.

The five year Community and District Empowerment for Scale up (CODES) project in Uganda comes to an end in 2016. The project helped district managers to improve their strategic resource allocation and annual planning for malaria, pneumonia, and diarrhoea for children under the age of five years. Both community and health facility LQAS were used to obtain district specific baseline, mid, and endline data. The project equipped the district staff to identify the gaps (bottlenecks) in the district health service provision, the root causes for the gaps, and the possible solutions to the identified problems. Annual peer to peer review meetings were scheduled close to the district survey data dissemination and work-plan development

process meetings. Additionally, the project supported the districts to implement the Health Facility Quality Assurance Program (HFQAP) process as an entry into a district wide Continuous Quality Improvement effort.

Health economics

LSTM Health Economics consists of a stabilised core group of health economist and related disciplines. It holds collaborations across the departments of the School and with partner institutions in selected country teams, especially in Bangladesh, Kenya, Malawi, Ghana, and Cameroun, and with project support from a larger number of settings in Asia, the Middle East, and in sub-Saharan Africa. These existing collaborations lead to additional funded opportunities, involvement in ongoing LSTM projects, and joint and stand-alone courses. The increasing stream of related high-impact scientific publications focusses on the poverty and equity impact of major diseases on households and health care systems and value-for-money options to combat those diseases in an efficient and equitable way. Projects related to major neglected tropical diseases, such as malaria, tuberculosis, HIV-infections, and chronic diseases such as diabetes, cardiovascular disease, lung health, and cancers. Cross-cutting themes are catastrophic expenditures, poverty-impact of diseases, economic and societal benefits of control programmes, the cost-effectiveness of complex intervention programmes as well as their effects on access and impact inequalities.

Now there have been new findings in the field of malaria control, as well as neglected tropical diseases across the world. The stream of publications related to chronic diseases has resulted in participation in the next Lancet Series on Chronic Diseases and Health Economics, with the leading paper on poverty impact. It is foreseen that the group's work on the interaction of poverty and disease will contribute to LSTM REF profile, and to a number of other LSTM projects.



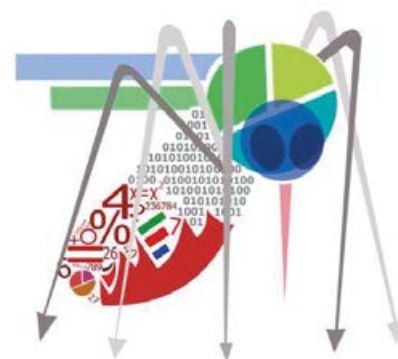
Patients waiting at a clinic entrance

Over the past year, LSTM Health Economics has shown to contribute to LSTM's mission to combat the impact of major diseases globally and locally through the development of appropriate and affordable innovations in a demonstrated efficient and equitable way.

Data management and monitoring

LSTM researchers are coordinating efforts to improve the effectiveness of vector control programmes in order to gain the largest impact in controlling diseases with limited resources. The Disease Data Management system, with its unique suit

of tools, has been deployed in Africa and India resulting in significant changes in policy on insecticide choice and method of vector control delivery. This has resulted in a wealth of data that is shared with the modelling consortiums to further enhance vector control.



How donations shaped LSTM

A £1.5m grant from the Wolfson Foundation creates the UK's first laboratory for molecular biology of insect vectors.



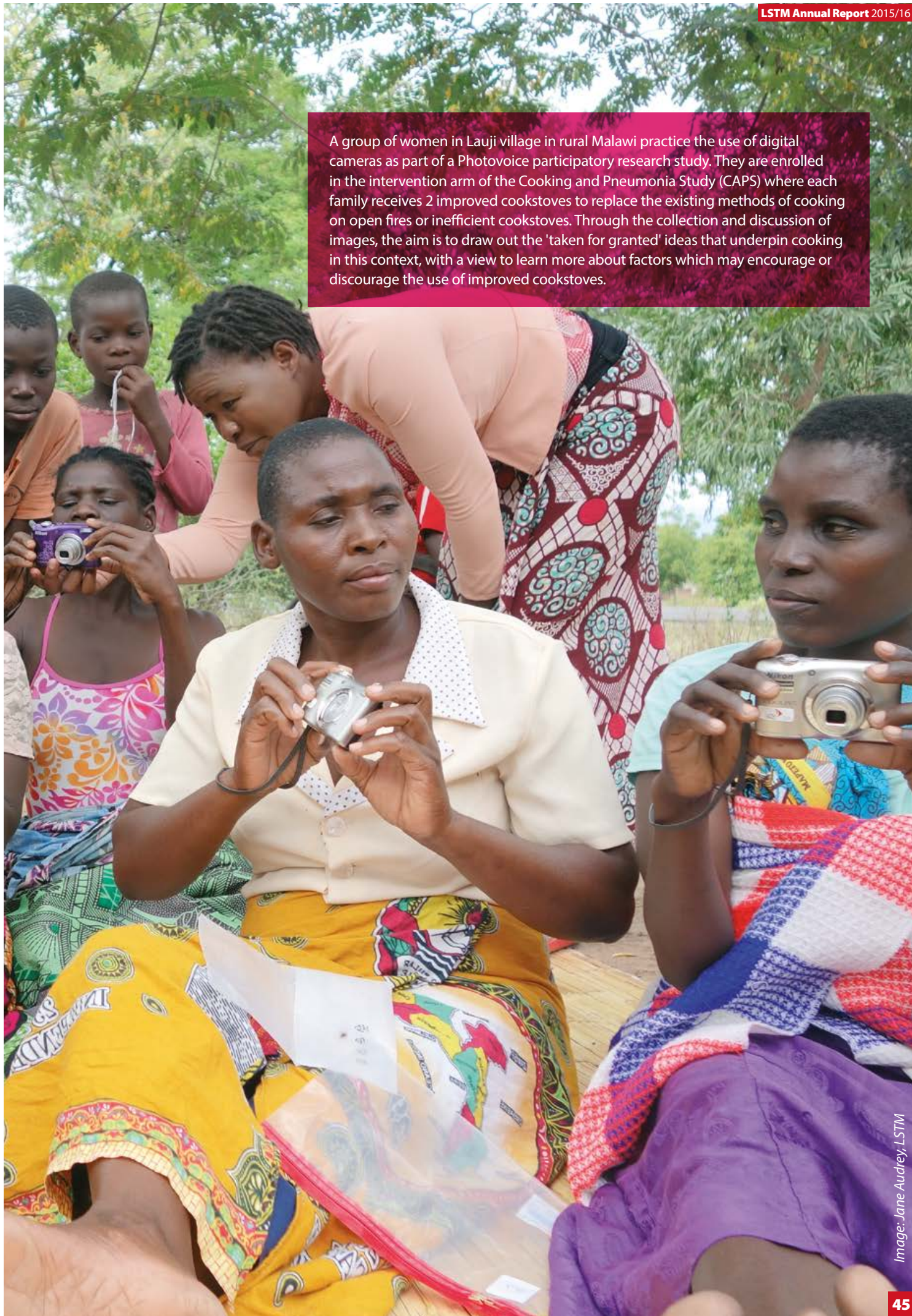
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A group of women in Lauji village in rural Malawi practice the use of digital cameras as part of a Photovoice participatory research study. They are enrolled in the intervention arm of the Cooking and Pneumonia Study (CAPS) where each family receives 2 improved cookstoves to replace the existing methods of cooking on open fires or inefficient cookstoves. Through the collection and discussion of images, the aim is to draw out the 'taken for granted' ideas that underpin cooking in this context, with a view to learn more about factors which may encourage or discourage the use of improved cookstoves.



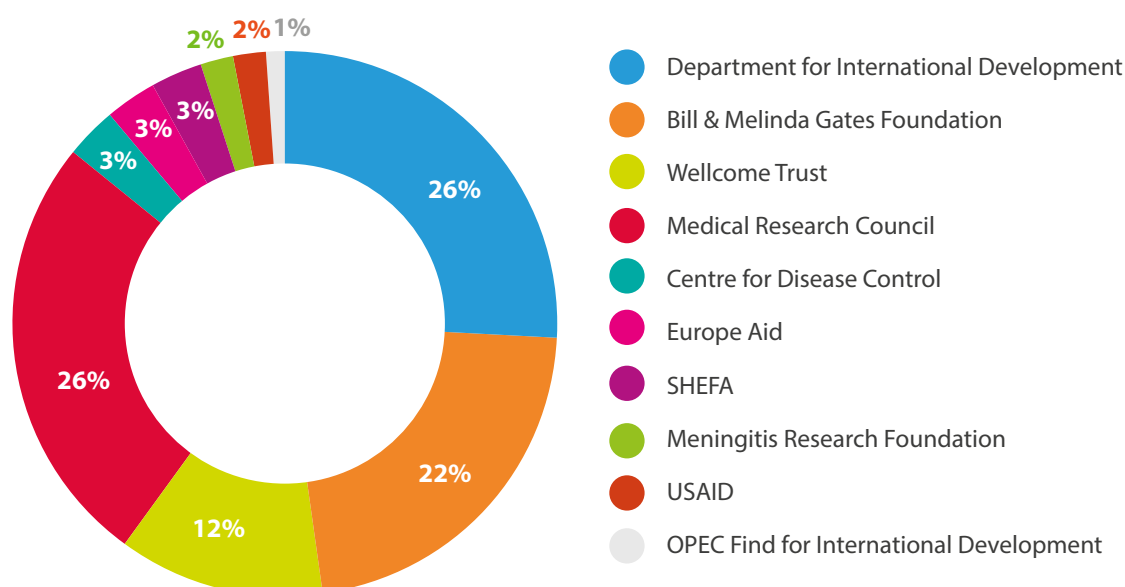
LSTM's top research funders

The tables below show LSTM's top funders¹, in terms of total contract value (ultimate source of funding), during the financial years 2014/15 and 2015/16.

The comparison of the two last financial years shows that the awards during the year from our funders largely remained the same, namely the Bill & Melinda Gates Foundation, the Wellcome Trust, and the Medical Research Council.

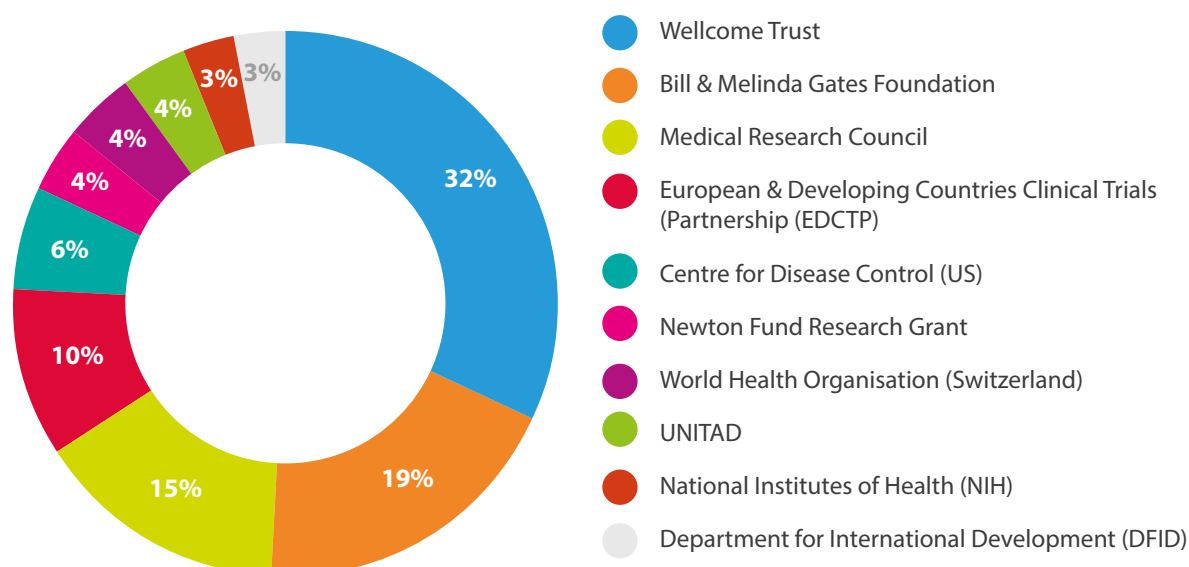
Top 10 research funders (by total contract value) - FY 2014-15

Source: Advanced Analytics [23.10.2015]



Top 10 LSTM research funders (by total contract value) - FY 2015-16

*Data does NOT include IVCC £46.9m. grant from BMGF and IVCC £44.1m. grant from UNITAID Source: Advanced Analytics [15.09.2016]



¹Top funders by total contract value, not number of applications awarded.

Research Committee 2015-2016

LSTM's Research Committee is responsible for defining and shaping detailed strategic research plans linked to LSTM's overall research strategy and mission. It does so by advising the Management Committee on the strategic direction of research and identifying priority areas for research, as well as by developing and promoting policies and practices that stimulate research programmes in agreed areas. The committee also has responsibility for overseeing the implementation of the Strategy at an operational level, as well as monitoring achievement of its priorities.



*Professor Giancarlo Biagini -
Chair of the Research Committee*

In 2014/15, the research committee set three strategic priorities: (1) to improve LSTM's research outputs, (2) to maximise LSTM's research funding in identified strategic areas, and (3) to continuously develop the research strategy. The key achievements towards these priorities for the period 2015-16 include:

- Support to the Research Excellence Framework (REF) process in collaboration with the REF Coordinator. A first REF mock run was conducted in February 2016.
- Agreement on strategies to allocate open access funds, in collaboration with the Library.
- New publication policy post-REF 2014, in collaboration with RBPS.

Set-up, launch, and administration of the ISSF Shared Research Facilities scheme, in collaboration with the University of Liverpool Technology Directorate. Four applications awarded for a total of £22,838.44.

In 2015/16, the Research Committee also endorsed the LSTM Seminars Series as strategically important for LSTM's public engagement strategy and is currently contributing to the Series by proposing speakers from key institutions and themes aligned with the School research strategy.

The Research Committee also continued to:

- Oversee the disbursement and administration of LSTM internal funding opportunities. In 2015/16,

23 applications were received for the three existing schemes (RDF, JCF, and EF) and thirteen awards were made for a total of £52,000.

- Support multidisciplinary speed-dating events to promote discussion across disciplines and encourage partnerships.
- Have strategic links with the Intention to Submit Committee.

After four years in post, Professor Sally Theobald stepped down from her position as Chair, and Professor Giancarlo Biagini was appointed as the new Chair. New committee members were nominated by Heads of Department and new Terms of References were agreed. To remain fit for purpose and achieve the strategic priorities set in 2014/15, RC agreed to include two additional tasks in its new Terms of Reference, specifically targeted at supporting LSTM preparations for REF (now anticipated to be in 2021), namely:

- To acquire and maintain institutional knowledge of LSTM research strengths, as well as of the external research landscape and of the vitality and sustainability of the 'Collaboration' section of the planned REF return.
- To improve the vitality and sustainability of LSTM's research environment through enhancing technical resources (facilities, staff and platforms).



Department of Education & Training



*Dr Sue Assinder -
Director of Education*

The 2015-16 academic year marked a significant step for LSTM in its journey to independence in the delivery of its teaching programmes. Operating for the first time as an accredited institution of the University of Liverpool, we admitted the first cohort of students for whom we will receive direct government funding.

We have risen to the challenges and new responsibilities associated with this change in status, whilst putting ourselves under the microscope for the next hurdle of gaining full degree awarding powers (DAPs). With success in our DAPs application will come the potential for a significant expansion in teaching over the next few years. We have already embarked on a number of exciting new initiatives to diversify our market, and have also begun a major review of our curriculum, with a view to launching new and updated Master's programmes next year that reflect the latest trends in tropical and infectious diseases and public health.

The road to teaching independence

The gold standard for any higher education institution is to be able to award degrees in its own name. To achieve this important goal, we have, over the past year, submitted our teaching to intense examination by the Quality Assurance

Agency (QAA). A scrutiny panel of senior academics appointed by the QAA met with staff and students, observed meetings, and reviewed over 1000 pieces of written evidence. During the year, we got used to an extra face at the table during meetings that covered all aspects of our working practices; looking at how we respond to student feedback at Staff Student Liaison Committee, how we ensure that our teaching is of the highest standards at Quality Management Committee, how we implement and monitor our strategic vision for education at Learning & Teaching Committee, through to the way in which we run the institution via the Management Committee and the Board of Trustees.

We expect to receive the report on this scrutiny in November 2016, and to hear the formal outcome of our application in early 2017. If successful, we will be able to award independent degrees from September 2017.



New initiatives

As part of our strategy to raise profile and global reach with key strategic partners, we have launched an initiative with the Royal College of Physicians (RCP) in which we have developed a Diploma in UK Medical Practice that will be offered to participants on their Medical Training Initiative scheme. This new programme aims to maximise the opportunities presented by clinical training in the NHS, to develop clinical competence and understanding of UK hospital medical practice. LSTM is delighted to be partnering with the RCP on this initiative given the strong complementarity of the Vision, Mission, and Values of our institutions, and our joint commitment to improving the health of communities across the globe.



Royal College of Physicians

Looking further afield, agreements to collaborate on teaching initiatives have been signed with some high profile Chinese Institutions, such as Yunnan Institute of Parasitic Diseases (YIPD), following a visit to Yunnan Province in Southwest China in February 2016. The visit was aimed at scoping specific opportunities in Southwest China given its significance as a regional player in the fight against tropical and infectious diseases. Some key common interests have been identified as part of a collaborative framework that is being developed.

Brightspace, LSTM's virtual learning environment, has been further developed and utilised to develop a bespoke LSTM online delivery model that is both engaging and flexible. This has culminated in the development of two flagship online programmes: The Fundamentals of Tuberculosis (TB) and Travel vaccination: Principles and Practice. Delivery of these programmes will commence in January 2017. This is a significant milestone as it allows us to expand our global reach and access potential students who would not normally be able to study on our courses offered in the UK. The online model supports students via an online network and gives them access to the expertise of LSTM academics who are leaders in their field. The model has been developed

as a partnership between the Unit for Technology Enhanced Learning and key academics involved in the design and development of academic content.

Supporting the student experience

We have seen significant investment in our physical infrastructure this year, thereby enhancing the student experience further with state of the art facilities. This includes a complete refurbishment of the LSTM Library, as well as our lecture theatres, to enable our students to benefit from a technology-led and stimulating learning environment.



The renovated Nuffield lecture theatre

We have also continued to develop our virtual infrastructure and have now entered the third and final phase of development of the student information system, which is focused on the needs of postgraduate research students. This will include a user-friendly portal through which staff and students will be able to access the system to record supervisory meetings and monitor research progress, thus ensuring a consistency of experience for students conducting their research at LSTM and those based at overseas research centres.



Part of the renovated library



How donations shaped LSTM

Support from the Pilkington family allows LSTM to build the Pilkington Wing to expand research and teaching.



1986

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Supporting students

We made changes to our student induction programme this year, with staff from the Education Department leading the new students on a 'Public Health Walk' around Liverpool. This illustrated the people, places, and institutions that have put Liverpool at the forefront of public health, and aimed to give students a better understanding of the historical and cultural background underpinning their programmes, as well as a stronger sense of identity as citizens of the city of Liverpool.

We have continued to support students from diverse backgrounds to study at LSTM by offering financial assistance with fees as well as providing guidance on other sources of funding such as the new Government Postgraduate Loan scheme. In 2015-16, LSTM awarded £63,500 in scholarship funds to students who would not otherwise have been able to pursue their studies.

As in previous years, LSTM supported students from the Humanitarian Studies MSc programmes with financial support to organise a one-day national conference, which in 2015 was on the theme of 'Health and Human Rights in Humanitarian Settings'. Students from across the UK presented their research to the humanitarian community and took the opportunity to network with others working in the field. Through such events we aim to equip our graduates to make a difference to the health and well-being of individuals and communities, worldwide.

Promotional activities

Increasing the promotion of LSTM's teaching agenda has been, and remains, a high priority moving forward. This has been raised further this year through several key engagements activities. Underpinning all promotional activity and engagement is the imperative of bringing the people of LSTM to the fore by profiling our world-leading academic staff as well as celebrating the achievements of our current and former students.

A key engagement event took place on May 6 when we held our first LSTM Postgraduate Open Day and welcomed over 60 attendees to the School. The event culminated in an exciting and interactive event that showcased the LSTM offering and experience. We had fifteen direct student



Visitor of LSTM's Open Day

registrations from attendees at this event. Furthermore, we developed a Virtual Open Day on our website that gives potential students a flavour of the LSTM experience without having to be in the UK.

The new LSTM prospectus was launched in July 2016, and sets the tone for the revised focus of our offering in terms of highlighting LSTM's uniqueness at an institutional as well as a programme level. Key highlights include specific reasons to study a particular programme as well as articulating career options for potential students. Further enhancements have been made to the website to align with the prospectus and its messaging.



Michael Lurie - Director of International Education & Knowledge



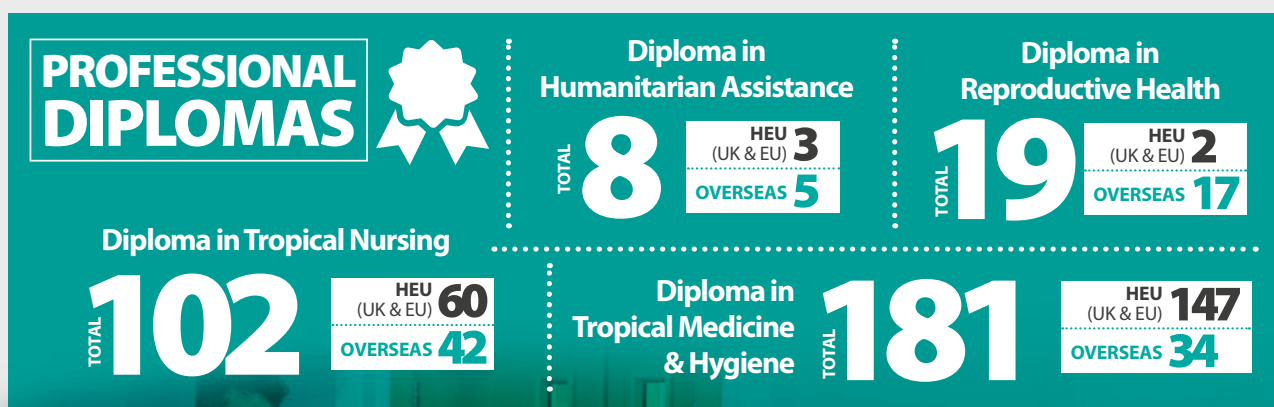
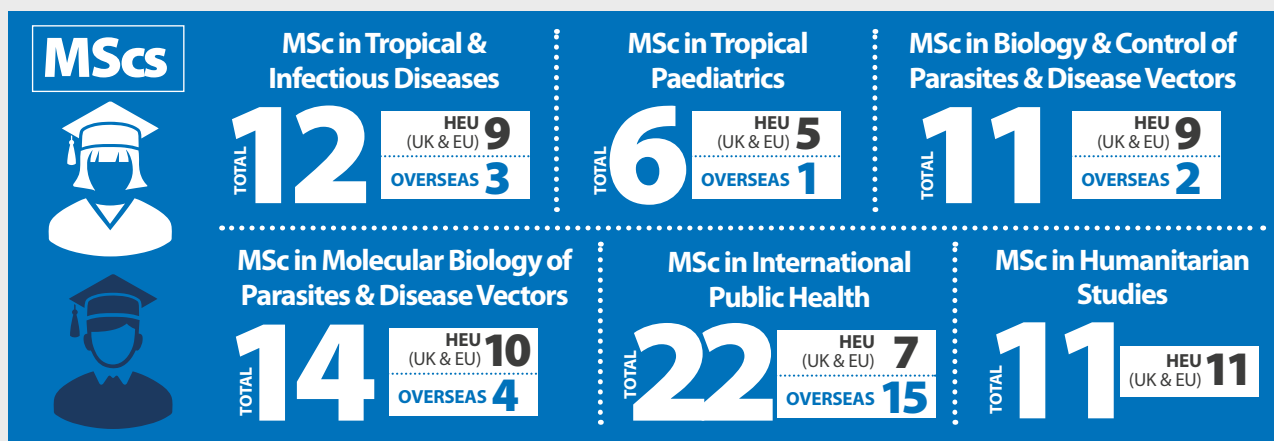
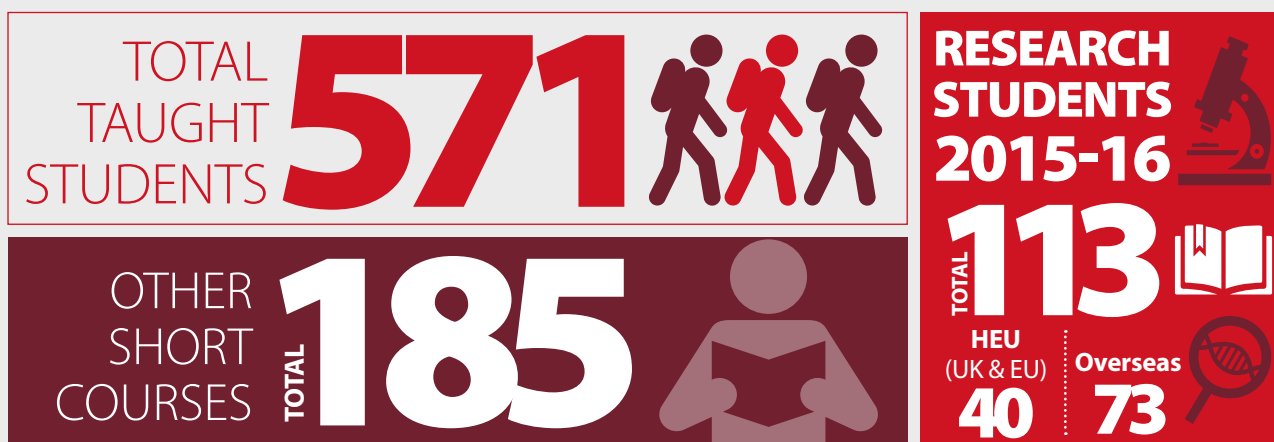
Moving forward

We have a formidable and transformational year ahead in terms of building on the progress made this year and leveraging further on our potential to grow our education provision.

We expect some exciting partnerships to be announced in the coming year. These include a partnership with a world-leading NGO, to launch a global offering of humanitarian programmes aimed specifically at the NGO sector that is based on a needs analysis of the workforce within these organisations.

We will look to expand accessibility of our offering to markets of stakeholders who will be looking for an LSTM offering in-country or through technology-led online learning, whilst utilising the expertise of our world-leading academic team.

Students and courses



Well Travelled Clinics



Well Travelled Clinics (WTC) had a stable financial year across its branches in Liverpool and Chester. In 2015-16, we saw around 10,000 clients with a turnover of 4.7% above forecast. Occupational health work continues to be a strong business line and now accounts for around 15% of our revenue.



**Philippa Tubb - WTC
Managing Director**

WTC is continuing to develop its clinical occupational health services, the vast majority of which target corporate clients who travel as part of their role. Its unique position enables WTC to offer a comprehensive combined travel and occupational health service to this type of client.

WTC continues to provide health services for UKMED, the humanitarian organisation working on behalf of DFID, to deploy British aid workers recruited from the NHS to international humanitarian emergencies. This year we have prepared around 100 staff for the on-call emergency register; assisted with the preparation of an emergency team to Ecuador, and prepared two teams for training deployments in Nepal and Malawi. WTC also participates in the pre-deployment training courses for these workers and provide post-deployment health assessment when they return from overseas missions. WTC has increased its work with the



maritime and offshore industries, and maintained important links with the Mersey Maritime Group, as we further develop our services to ensure it meets the needs of the maritime industry. In June 2016, WTC and Mersey Maritime held a Stakeholder Engagement Event on 'Duty of Care - Healthcare Provision in the Maritime and Offshore sectors', which a number of local companies attended, and which has led to some new business links for WTC.

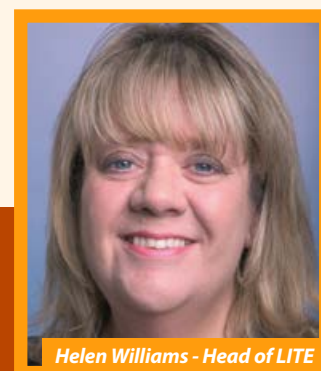
Last year, we trialled opening-up an additional day per week at our Chester branch during the peak demand times. We repeated this during the summer of 2016, and have now permanently opened an additional day per week in Chester, on Fridays.

WTC fulfils an important public health role for LSTM and deals with a growing number of email and telephone enquiries from the public. This year, there has again been a continued increase in the number of phone calls to the clinic and WTC has dealt with around 40,000 calls, around 6,000 of which related to public health issues. Concerns regarding Zika virus have been one of the main areas of enquiry this year.

WTC is currently working with the Technology Enhanced Learning (TEL) Unit at LSTM to develop a new, online module on Travel Vaccination, which will launch in January 2017. Moving forward, it is hoped that WTC can develop further online modules with the TEL Unit, to increase our range of courses in the field of travel medicine.



Liverpool Insect Testing Establishment (LITE)



Helen Williams - Head of LITE

Liverpool Insect Testing Establishment (LITE) has been accelerating the search for new public health insecticides in cooperation with IVCC, a product development partnership. Ever since LITE was established by the Department of Vector Biology five years ago, it provides an efficient service to industrial partners to screen new chemicals against insecticide-resistant populations, using a variety of biological assays.



Under the management of Helen Williams, the facility has grown considerably in 2016. The team has expanded to include a PDRA entomologist, Dr Rosemary Lees,

a Programme Officer, Julie Humphreys, and a Quality Assurance specialist, Brenda Huxley.

LITE has recognised the need to assess sub-lethal and behavioural changes resulting from insecticide exposure, and is developing additional bespoke methodologies. For example, a Spatial Repellency Test is currently being developed to assess novel spatial repellent and products such as emanators, and a Thumb Test, developed by Professor Phil McCall, is being modified to assess the behavioural effects of insecticide-treated nets on blood-

feeding female mosquitoes. A Wind Tunnel has also been built, according to WHO specifications, to test the efficacy of insecticide sprays to kill adult mosquitoes.

This will enable us to expand the services we offer and the range of clients we provide for, aiding us to achieve our long-term vision of a fully self-funded, sustainable centre of excellence for evaluating products to control insect disease vectors.

Application for Good Laboratory Practice (GLP) accreditation to Medicines and Healthcare Products Regulatory Agency (MHRA) is planned for 2017, once LITE is housed in the new Liverpool Life Sciences Accelerator (LLSA) building, which is currently under construction and is scheduled to open in the summer of 2017.

This exciting new project will provide a platform for LITE to expand its current testing capabilities and introduce additional behaviour testing to complement its current phenotyping bioassays.



An industry delegation from India touring LITE's facilities

Estates

Liverpool Life Sciences Accelerator (LLSA)

Construction of the five-floor laboratory-based development is well under way and the opening is foreseen in the summer of 2017. The LLSA has been developed in a partnership between LSTM and the Royal Liverpool and Broadgreen University Hospitals NHS Trust (RLBUHT).

It is a business incubator for small and medium sized enterprises (SMEs), operating in the life science sector. SMEs will benefit from laboratory facilities, including access to Category Three laboratories and offices, as well as ultrafast internet connectivity and a direct link to a grid computing facility.



Render of the Liverpool Life Sciences Accelerator (LLSA)

Its adjacency to LSTM and the new Royal Liverpool University Hospital will enable and facilitate collaboration between aforementioned SMEs, academics, physicians, and international collaborators in the field of resistance.



Where great discoveries are made

During its official topping out ceremony in September 2016, LSTM Director, Janet Hemingway, emphasised the importance of LSTM's ongoing expansion in the field of resistance in all its forms, both antibiotic and other drug and insecticide resistance – fields in which LSTM already excels.

The construction of the LLSA also fits in the wider plans for the so-called £2 billion Knowledge Quarter Liverpool which had its formal launch in October 2016. LSTM is a founding partner of this initiative together with Liverpool City Council, Liverpool John Moores University, University of Liverpool, The Royal Liverpool and Broadgreen University Hospitals, Hope Street Liverpool, and Liverpool Vision.

LSTM Liverpool campus

A major capital refurbishment programme was undertaken in the summer of 2016 with extensive renovations of LSTM's lecture theatres and seminar rooms. LSTM's main lecture theatre, the Nuffield, saw the replacement of all the associated air handling equipment, environmental controls, seating arrangements, and lighting. LSTM's library



Topping out ceremony of the Liverpool Life Sciences Accelerator (LLSA)

underwent a major refurbishment to provide for a better user experience and the remodelling of the Nickson and Johnson lecture theatres have created more flexibility. Both theatres can now be used separately, or as one bigger teaching space for up to 105 students when the new dividing wall is retracted.



Nuffield lecture theatre during the renovation



Nuffield lecture theatre after the renovation

Malawi – Liverpool – Wellcome Trust Clinical Research Programme (MLW) campus

The refurbishments of MLW laboratory facilities have been completed with the arrival, installation, and commissioning of the CL3 laboratory, as well as the introduction of a dark room and space for the Freezer Archive.

Functional high-performance CL3 laboratories are rare in Africa, and this new facility will extend the range of research studies that can be carried out at MLW; allowing MLW and the College of Medicine to participate in regional and international networks for example TB vaccine and Clinical Trials Consortia, fostering TB diagnostic discovery, supporting the development of techniques required for 2/3 clinical trials, extended surveillance of TB epidemiology and drug resistance, and supporting the evaluation of new diagnostics.



MLW compound, Blantyre, Malawi



MLW laboratory facilities

How donations shaped LSTM

A legacy gift helps to establish the Gwendolen Clayton Fund to provide scholarships and fellowships.



1996

1997

1998

Far East Prisoners Of War Project

The Far East Prisoners Of War (FEPOW) project remains LSTM's longest collaboration, starting in 1945 and continuing to the present day. It began in September 1945 when the then Dean of LSTM, Professor Brian Maegraith, addressed a group of families of Far East prisoners in Blackpool.

The men were on their way home and Professor Maegraith warned of physical problems which could include malaria and dysentery, as well as psychological problems of adjustment to home life. Interestingly, and contrary to what the men and their families had been told officially, he advised the audience to encourage the man to talk about their experiences.

6—EVENING GAZETTE—FRIDAY, SEPTEMBER 28th, 1945.

Professor's Tribute to Blackpool's 'Lead ORGANISED CARE FOR FAR EAST MEN

"This is the first time that I, or any of my staff, have been asked to talk on 'The Care of the Returned Prisoner of War,' and to the best of my knowledge Blackpool is the only city or town in the country which has any kind of organised proposition to present to the returned prisoner," was the compliment paid to Blackpool, last night by Prof. B. G. Maegraith, M.A., M.B., Principal of the Liverpool School of Tropical Medicine.

THE Professor was speaking in the Free Library at a meeting organised by the Blackpool and Fylde Far East Prisoners of War Association (writes "Phyllis").

Next of kin packed the Lecture Hall to capacity, among those present being two families with three sons in the Far East, girl wives preparing to be nurses if necessary and diligently making notes, tears sometimes splashing the pages, and some 20 fathers, one of them a Boer War man.

Dr. G. W. Murray, Blackpool's Medical Officer of Health, presided, supported by Mr. F. Herbert Grime, J.P., Vice-President of the Association, and Mrs. B. A. Gill, hon. secretary of the Association.

A WEARY WAIT

"It has been a long, long time of weary waiting, with some 600 of our boys in Japanese hands," said Dr. Murray, introducing the speaker, "and we remember malaria—to deal with which extra meat, milk and eggs were allowed.

Mental Readjustment.—"Remember your man has been 'browned off,' 'fed up,' but never discouraged," he emphasised. "Don't bottle him up. Let him talk himself out about the horror stories, about everything he wants to."

Questions ranged from the efficacy of dried milk, boisterous Blackpool's atmospheric effect, and the man who won't talk, to the danger of infection to young children.

HOME SOON

Then Mr. Grime, thanking Professor Maegraith and Dr. Murray, expressed sincere appreciation of such practical knowledge as had been given to them by the Principal of the primary School of Tropical Medicine in the country, and added that there was good reason to hope that a large number of Blackpool's men would be home within the next six

Extract from the West Lancashire Evening Gazette, Friday 28 September 1945 (Maegraith Archives, LSTM)



Professor Maegraith second right and Mrs Gill, wife of the Blackpool Regiment's commanding officer, Lt Colonel Gill second left (courtesy Maegraith Archives, LSTM)

Before the end of that year, ex-POWs were being seen at LSTM with recurrences of malaria and amoebic dysentery. Over the next 20 years or so, approximately 2,000 ex-Far East POWs were seen at the School, and in 1968 LSTM became the UK's official national assessment centre for these men. By this time, malaria and dysentery were being seen less frequently, but chronic neurological damage due to past vitamin deficiency was seen in 10%, and chronic infections with the nematode worm *Strongyloides stercoralis* in 15%. Significant psychological disturbance was found in 35%, later to be recognised as a variant of post-traumatic stress disorder (PTSD).

Between 1968 and 1999 (when the last clinical assessment was made), 2,153 ex-Far East POWs were investigated at the LSTM, giving a total experience of over 4,000 men. As well as providing clinical care and treatment, several scientific reports were published from the clinical data, describing the remarkably long-term effects from this period of malnutrition and tropical disease exposure. Since 1999, the POW project has turned to recording the medical history of the Far East scenario and the men involved. This has been led by Professor Geoff Gill, joined in 2007 by Research Fellow, Meg Parkes.

A series of over 60 oral history interviews with surviving ex-Far East POWs led to the publication of the book *Captive Memories* (by Meg Parkes & Geoff Gill) in 2015. The initial print run of 1500 rapidly sold out and the book is now in its 2nd edition. A companion volume is now in preparation and will appear in June 2017. Titled *Burma Railway Medicine* (by Geoff Gill & Meg Parkes), it describes the medical problems in the Thai-Burma Railway, and how they were responded to by the POW doctors.

The Medical Art Behind Bamboo project has uncovered many previously unknown drawings and paintings which were carried out during imprisonment, and vividly demonstrate aspects of POW medicine. It is hoped that a major public exhibition will take place in the near future.

In 2015, LSTM hosted an international conference on Far East POW history, which was highly successful and will be held again in June 2017, also at LSTM. As well as contributions from the Liverpool team, there will be many nationally, and internationally, known speakers.

Recently, a previously unknown connection between LSTM and Far East imprisonment was discovered. Professor Thomas "Toss" Wilson held the Chair in Parasitology at LSTM between 1962 and 1971, and though he appears to have spoken little of it, was a POW on the Thai-Burma railway.

Prior to capture, Thomas Wilson was a parasitologist with the Malayan Medical Service, working closely with the entomologist, Dr John Reid. They were both sent to the railway with "F Force"—an expeditionary group of POWs who suffered great privations as they marched to the remote jungle camps near the Burma border. Wilson and Reid were commissioned by the Japanese to investigate malaria, and with a single microscope, a few slides, and supplies of Field's stain, they produced remarkable results. Their methodology was meticulous, using thick blood films on all POWs, examining 100 high power microscope fields on each slide. They found that 70% of malarial infections were due to *P. vivax*, and 21% *P. falciparum* (the other 9% due to *P. ovale* and *P. malaria*). Infections were most intense in the remote up-country camps (17.1 per 1000 men per day), with rates falling further down the line to the better established base camps (1.4 per 1000 men per day).

In his report on this malarial work, Thomas Wilson described it as a "hazy and incomplete picture". It was published in the medical press after the war: Wilson T, Reid JA. Malaria amongst prisoner of war in Siam ("F" Force). *Trans Roy Soc Trop Med & Hyg* 1949; 43 : 257-272. Considering the most difficult circumstances in which the Wilson-Reid survey was carried out, it is a remarkable piece of science.



Professor Thomas "Toss" Wilson
(courtesy, archives of the Institute for Medical Research, Kuala Lumpur, Malaysia)



How donations shaped LSTM

A \$50m grant from the Bill & Melinda Gates Foundation establishes the Innovative Vector Control Consortium (IVCC).



2004

2005

2006

Public Engagement

The past year has seen the hosting of the very first public engagement (PE) workshop at LSTM, conducted by an associate of the National Coordinating Centre for Public Engagement, followed by a PE training session for the new intake of postgraduate research students at LSTM, which will become part of the annual PGR training programme. Science communication talks have also been given to LSTM's MSc students over the past year.

Exhibitions

A major PE success for LSTM came from Vector Biology's Mosquito Diaries exhibit at this year's Royal Society's Summer Science Exhibition in London, which attracted over 14,000 visitors. The exhibition is a week-long annual display of cutting-edge science developments in the UK, where the public can meet scientists, try some of the hands-on activities, or attend talks and events. In the lead up to this exhibition, Vector Biology's, Dr Josie Parker, and Engaging Tools for Communication in Health (ETCH) team's, Charlotte Hemingway, and colleagues previewed Mosquito Diaries at Liverpool's festival LightNight at the Everyman Theatre and

Liverpool's World Museum for National Insect Week. The Exhibition was displayed at Manchester's Science Festival in October.

Through a range of interactive activities and computer games, Mosquito Diaries demonstrated the team's key messages and Dr Parker's research in utilising new technology to track the flight of individual mosquitoes and how they interact with a long-lasting insecticide-treated bednets. The team have since given talks in schools and had some of the visual imagery from the exhibit displayed in the Chelsea School of Art.



Dr Josie Parker speaking to LightNight visitors

Community talks

A number of talks to community groups have taken place over the past academic year. A particular highlight has been Vector Biology's, Dr Lee Haines, conducting a series of talks about the recent Zika Virus outbreak during which she displayed live mosquitoes and a mosquito model supplied by LITE and IVCC, respectively, at the Kirkby, Knutsford, and Wilmslow SciBars. Other community talks have been conducted, including to the Hayman's Green Women's Club, who listened to a presentation by Dr Hugh Adler regarding the respiratory group's Experimental Human Pneumococcal Carriage collaboration and the recruitment of volunteers for its two new studies looking at understanding why certain people are more vulnerable to developing pneumonia. Other community talks have taken place in Centre 63, The Brink, The Racquet Club in Liverpool, and the French Institute in Cameroon.

LSTM STEM Ambassadors

LSTM's STEM Ambassadors, acting as role models, have been visiting primary and secondary schools across the North West region including LifeSciences UTC, Tarporley High School, Neston High School, Holly Lodge School, and The Bluecoat School. The STEM Ambassadors have taken part in careers and research talks, judged poster competitions, and hosted visits to LSTM.

As part of its STEM Ambassador programme, LSTM hosted nearly 40 Life Sciences UTC students, coinciding with our first postgraduate Open Day.

Student blogs

Our DTM&H student blogs have continued successfully throughout the past academic year drawing a growing readership of current and prospective students.

LSTM in the Media

Throughout 2015-2016, LSTM provided numerous experts for comments and analyses, interviews, and editorials to a range of regional, national, international, and specialist media.

These included comment pieces in UK and international journals such as *The Lancet*, *Nature*, the *BMJ* and *National Geographic*, with Professors Janet Hemingway and Hilary Ranson commenting on the potential impact of insecticide-resistance in the fight against malaria, Professor David Molyneux looking at mass drug administration in the fight against NTDs, Professor Paul Garner working with others to provide guidance for systematic review, and Dr Nick Casewell being interviewed on the destructive power of snakebites by science writer, Ed Yong.

Behind the camera, we offered assistance to a number of projects with Dr Nick Casewell advising on the creation of films and animations about snake venom for BBC Earth Unplugged and the online science portal 'Stated Clearly'. Professor Nynke van den Broek and Dr Mary McCauley, along with other members of LSTM's Centre for Maternal and Newborn Health, acted as scientific advisors for BIRTH festival at the Royal Exchange Theatre in Manchester which culminated in a debate on the Guardian Live platform. On a more dramatic note, Dr Nick Beeching and Emeritus Professor Geoff Gill offered script advice for medical story lines in Channel Four's *Hollyoaks* and the BBC's *Holby City* and *Call the Midwife*.

In front of the camera, LSTM has been involved in a number of documentaries. The popular series *River Monsters* came to LSTM and the Well Travelled Clinics for a special episode of the programme 'Inner Monsters'. Dr Nick Beeching advised presenter Jeremy Wade about the potential diseases and conditions that can result from extreme fishing in tropical locations. The documentary has been aired in the USA to great reviews, and airs in the UK later in 2016. Dr Robert Harrison, Head of LSTM's Alistair Reid Venom Research Unit, has been filming in the UK and Kenya with an American filmmaker for a documentary about snakebite as a neglected tropical condition, which will be aired in the early 2017. Professor David Laloo featured in BBC One's *Antiques Road Trip* when they examined the history of lifesaving research carried out at LSTM, as part of a visit to Liverpool.

There was a culmination of the Captive Memories project celebrating LSTM's longest running research project with ex-Far Eastern Prisoners of War (FEPOW). The Wellcome Trust's online platform, Mosaic, created a detailed audio feature of the work, interviewing the researchers and some of the surviving FEPOW. Researcher, Meg Parkes, was also interviewed by Nick Higham about the subject on BBC Radio 4.



LSTM's ISDN radio studio device

As experts in infectious diseases, many of LSTM's academics and clinicians have been called on to offer advice and reassurance in relation to the recent outbreak of the Zika virus and its potential links to microcephaly. Experts have appeared live on the radio and television including Professor Luis Cuevas, who appeared several times on BBC One's Breakfast programme. Professor Cuevas and Dr Nick Beeching were interviewed regularly by members of the national and international media about the clinical aspects of Zika, while Professor Hilary Ranson, Drs Dave Weetman, Daniela Ferreira, and Philip McCall were interviewed by local media, the BBC World Service, BBC News Channel, BBC Radio 4's Today programme, Radio 5 Live, Sky News, NPR, The Guardian, and online publications about vector control and vaccine development.



A visit from Bill Gates and the then Chancellor George Osborne, resulted in a great deal of exposure for LSTM, when they travelled to Liverpool to make the formal announcement of the Ross Fund. LSTM's association with Ronald Ross and interviews with Professor Hemingway were featured in a number of local, regional, and national programmes and publications including The Times, The Independent and the Guardian, as well as the BBC World Service, BBC Radio Manchester and Merseyside, BBC Radio 4, ITN and Sky News, and the BBC News Channel. Media tracking recorded over 100 hits in broadcast, print, and online media that day with direct mention of LSTM, with international coverage as far afield as China, India, and the USA. The social media output had a potential audience reach of over 28 million people.

LSTM has also hosted a number of press visits here in the last 12 months. During the 47th Union World Conference on Lung Health, which was held in Liverpool, Professor Bertie Squire was involved in a number of media interviews about the work that LSTM is carrying out in the field of TB and lung health as well as hosting a visit by ten international Health Journalists. LSTM also played host to the BBC Science Correspondent, Victoria Gill, who delivered a popular talk at the LSTM Seminar Series.

Professor Richard Pleass was in the news following the publication of his paper about reasons behind the only inherited risk for emphysema. His news story: From genes to latrines: Vikings and their worms provide clues to emphysema, intrigued the media and was featured in local and national media, a number of Danish publications, in numerous archaeological blogs, and various online forums, gaining a large amount on social media hits.

Throughout the reporting period, LSTM generated fourteen press releases and 143 news stories.



How donations shaped LSTM

CTID building completed, following significant contributions from a number of donors, alongside research funders and statutory grants.



2008

2009

2010

Fundraising



**Karen Brady - Director
of Fundraising**

The continued expansion of LSTM provides an opportunity to further develop our relationships with new and existing donors, and to attract philanthropic funding to support future capital developments, research, scholarships, and capacity building.

In April 2016, LSTM recruited its first Director of Fundraising. Karen Brady joined LSTM from the University of Liverpool where she worked for 10 years, most recently in the role of Director of Philanthropy & Alumni Relations.

Work is currently underway to develop LSTM's Case for Support which will highlight the uniqueness of our work and articulate our fundraising priorities to prospective donors. The new fundraising strategy will be launched in early-2017.

Fundraising news

Donations to LSTM are helping us educate and train the next generation of scientists and health professionals in tackling some of the world's most deadly diseases. Finance is one of the main barriers to students and researchers being able to come to LSTM. However, the opportunity to study or work with us can be life-changing. Last year £1,098,321 was raised to support scholarships and PhD studentships at LSTM. This enabled us to offer scholarships to 55 students.

A donation of £1m from the Bale Settlement was announced in November 2015, to support scholarships for Nigerian students wishing to study at LSTM. Mr Roger Bale, the Settlor of the Bale Settlement, grew up in Liverpool and spent his career in Nigeria. When his son fell ill there, he was brought to LSTM where he was successfully treated and made a full recovery. The generous donation forms an

endowment held by LSTM and will provide support for the education of future generations of Nigerian health professionals and leaders.

The inaugural scholar, Kennedy Udiale, arrived at LSTM in September 2016 to undertake a Masters in International Public Health.



Kennedy Udiale

"LSTM's reputation in the field of international public health was a considerable influence in my decision to come here to study. Through my work as a medical doctor with Médecins Sans Frontières, I treat patients in poor rural communities who are often prone to disease outbreaks. I would like to contribute more by becoming involved with systematic research to improve Nigerian and global health policies necessary to tackle public health outbreaks in Nigeria.

In 2015 I had to defer my application as I couldn't afford as a self-funding applicant, to meet the full funding requirement myself. Then in 2016 I applied again, and I thought it would be the same, but when I received the scholarship offer I thought it was a dream and I had to pinch myself. I am now living this dream."



How donations shaped LSTM

The £7m Wolfson Building is opened, housing the Centre for Maternal and Newborn Health (CMNH), the Centre for NTDs (CNTD), and the IVCC. The building was named in recognition of the longstanding support of the Wolfson Foundation.



2014

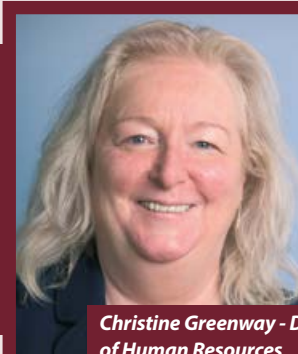
2015

2016

The Mamco Selab Scholarship Fund is established following a £1m gift from a retired businessman.

Social Mission

LSTM values continue to shape working practices globally, and our vision to save lives in resource poor countries through research, education, and capacity-building depends on recognising the relationship that LSTM has with its staff, students, and stakeholders.



*Christine Greenway - Director
of Human Resources*

Human resources is a critical component of any organisation, particularly when the work is done in over 70 countries worldwide, and needs to meet the growing strategic and operational needs of the organisation. To keep pace with LSTM's vision, the HR team is again realigning roles and processes to offer a greater range of services and support, particularly through the use of technology. Complementing this commitment, staff across the organisation are continuing to provide a better environment for students, staff, and LSTM stakeholders.

Recruitment and staff development

In recruitment and selection, HR is widening its methodologies to attract and interest new talent-pools. Building on our reputation as an employer within Liverpool, the UK, and internationally, we launched a web recruitment facility in August which assists candidates and LSTM in the ability to recruit quality staff linked to valuing and developing staff, who are ultimately our greatest asset.

The current Mentoring Scheme will build upon the work following research from a wide base and experiences. The current scheme matches research assistants, post-doc researchers, and lecturers with more senior research staff to encourage mentee-mentor relationships across different departments. Already the scheme is encouraging participants to reach their full potential as self-reliant, self-confident, and independent scientific researchers. This will eventually be broadened throughout LSTM.

Advancing gender equality

The Athena SWAN Charter encourages and recognises the commitment to advancing the careers of women in science, technology, engineering, maths, and medicine (STEM) as well as arts, humanities, social sciences, business, and law (AHSSBL) employment in higher education and research. One of only 132 Charter members, LSTM has

achieved the Bronze Level Award. An Athena SWAN Officer is assisting with the process and follow-up actions.



There are many facets to this area of our work which involves putting realistic and creative action plans in place. LSTM's Gender and Health Group, established in 1995, is a multidisciplinary group at the forefront of work on gender and health, applying gender analysis and planning in their various areas of expertise, a practise that translates across all areas of LSTM's operations.

Gender Pay Review has commenced and reporting will follow in-line with legal guidelines.

A diverse and family-friendly workplace

LSTM is proud to be a multi-cultural community that aims to provide a welcoming institutional environment which affirms the positive contributions of all its members. By embracing diversity, LSTM hopes to promote and achieve a more rewarding environment. Giving staff, students, and visitors a place to express their religious faith has long been a commitment from LSTM which provides a room for multi-faith prayer and meditation.

We continue to be a family-friendly employer and teaching institution, providing a supportive environment for employees, students, and visitors, LSTM supports family-friendly working practices, such as flexible working and improved shared maternity/paternity arrangements.

Staff overview



438 Staff members in the UK



33 Staff members overseas on an LSTM UK contract



471 **TOTAL STAFF** on an LSTM UK contract



Numbers as per 01/09/2016

Governance

The Board of Trustees are responsible for governing the Liverpool School of Tropical Medicine. They must ensure that it is solvent, well-run, and delivering the charitable outcomes for the benefit of the public for which it has been set up.

During September and October 2015, the Board of Trustees commissioned the Leadership Foundation for Higher Education (LFHE) to assist it with an effectiveness review. The review looked at all Board meetings and sub-committees and spoke with a number of current Trustees, the Director, and the Secretary to the Board, as well as a number of former Trustees. Findings were presented in March 2016 and concluded that the Board can place confidence in its overall effectiveness. The level of engagement from the Board with the strategic leadership of LSTM is high, as is the level of engagement and commitment to the mission, culture, and values of the institution. The report added that meetings of the Board were well-conducted and well-chaired, with an appropriate mix of skills, and Trustees confirmed that they felt confident that there was a sufficient degree of challenge. It was also reflected that LSTM's Trustees demonstrate a sophisticated understanding of matters relating to future sustainability. This report builds on the outcome of the HEFCE assurance review of LSTM, which was equally positive and provided the second highest level of assurance to place reliance on the institution's accountability information. Coupled with the embedding of the CUC Code of Governance, the LFHE report fully endorsed that an effective governance structure and process were in operation at LSTM.

LSTM continues to explore provider assurance with HEFCE and other stakeholders, as funding relationships mature. LSTM welcomed the HEFCE Data Assurance team to review its first year of direct teaching funding allocation and grant funder appointed audit teams. At the close of 15/16, the volume of limiting actions in relation to audit was low, providing a very strong outcome for LSTM in audit and risk governance. Much work has also been completed during 2015/16 by LSTM and the Prevent team, on its response to Section 26 of the Counter-Terrorism and Security Act 2015. Policies have been strengthened and the Board of Trustees accept their accountability to HEFCE for assuring that they are fully meeting their responsibilities going forward.

Finally, the Board of Trustees participated in the major theme of the June 2016 Away Day, the development of the 2017-22 Strategic and Operational planning cycle. The focus of the discussion included discussing high-level objectives for LSTM's next five-year plan, which can then be developed further by LSTM's Management Committee and Heads of Department. LSTM has achieved much over the period

of the 2012-17 Strategic Plan, and has seen a period of unprecedented growth. It is clear that the exciting period ahead of LSTM will see it continue to grow and flourish against a backdrop of a rapidly changing world.

LSTM thanked outgoing members, Dr Aduragbemi Banke-Thomas and Professor Sir Nigel Thrift, for their valued contribution to the Board of Trustees. We also congratulated Dr Aduragbemi Banke-Thomas, who was the inaugural Student representative on the Board of Trustees, for his selection to the prestigious McCain Institute of International Leadership in the United States. Sir Nigel leaves LSTM after a period of great personal and academic achievement, and we wish him very well in his future.

LSTM welcomed new members to the Board of Trustees, with the appointments of Jeremy LeFroy, Member of Parliament for the Stafford constituency, Mark Allanson, Pro Vice-Chancellor of Edge Hill University, and Student representative, Jessica Owugha. Mr LeFroy is a qualified chartered accountant with a background in manufacturing, international trade, and agriculture; elected MP for Stafford in 2010 and re-elected in 2015. He chairs the All Party Parliamentary Groups on Malaria and Neglected Tropical Diseases, and on Tanzania, as he is also Chairman of the Board of the Parliamentary Network on the World Bank and IMF. Mr Allanson joined Edge Hill as Pro Vice-Chancellor in August 2014. Before joining Edge Hill, he was the Higher Education Funding Council for England (HEFCE) Regional Consultant for the North West. Prior to this, he held a number of senior university roles. Ms Owugha is an active member of LSTM's postgraduate research student community, having represented students at programme and deanery levels. She has a background in molecular microbiology of infectious diseases (The MRC Unit, The Gambia, and The London School of Tropical Medicine) and biochemistry (University of Manchester).



LSTM's Board of Trustees in June 2016

List of honorary appointments 2015 /16

Name	Title	Department
Dr Angela Allen	Honorary Research Fellow	Parasitology
Dr Jenna Hoyt	Honorary Research Fellow	Clinical Sciences
Hassan Burhan	Honorary Research Fellow	Clinical Sciences
Prof Philip Cooper	Honorary Research Fellow	Clinical Sciences
Dr Emma Smith	Honorary Research Fellow	Clinical Sciences
Dr Rachel Isba	Honorary Research Fellow	Clinical Sciences
Dr Jamie Rylance	Honorary Research Fellow	Clinical Sciences
Dr Robert Parker	Honorary Research Fellow	Clinical Sciences
Dr Helen Smith	Honorary Lecturer	Clinical Sciences
Dr Karen Steingart	Honorary Research Fellow	Clinical Sciences
Dr Dan Wootton	Honorary Research Fellow	Clinical Sciences
Rachel Robinson	Honorary Research Fellow	Clinical Sciences
Catherine Lowe	Honorary Research Fellow	Clinical Sciences
Lisa Cheng	Honorary Research Fellow	Clinical Sciences
Caz Hales	Honorary Research Fellow	Clinical Sciences
Dr Peter Frank Heywood	Honorary Affiliate	Clinical Sciences
Dr Seif Al-Abri	Honorary Research Fellow	Clinical Sciences
Dr Alastair Miller	Honorary Teaching Fellow	Clinical Sciences
Dr Marie Stolbrink	Honorary Academic Clinical Fellow	Clinical Sciences
Lepa Lazarova	Honorary Research Fellow	Clinical Sciences
Helen Hill	Honorary Research Associate	Clinical Sciences
Dr Peter MacPherson	Honorary Research Fellow	Clinical Sciences
Dr Olaekan Uthman	Honorary Research Fellow	Clinical Sciences
Dr Victor Mwapasa	Honorary Research Fellow	Clinical Sciences
Prof Mark Woodhead	Honorary Research Fellow	Clinical Sciences
Margaret Parkers	Honorary Research Fellow	Clinical Sciences
Prof Robert Heyderman	Honorary Professor	Clinical Sciences
Dr Stacy Todd	Honorary Research Fellow	Clinical Sciences
Dr Bhagteshwar Singh	Honorary Teaching Fellow	Clinical Sciences
Prof Richard Lilford	Honorary Professor	Clinical Sciences
Dr Victoria Conner	Honorary Research Fellow	Clinical Sciences
Prof Geoffrey Gill	Honorary Professor	Clinical Sciences
Dr Ben Morton	Honorary Research Fellow	Clinical Sciences
Prof Jimmy Volmink	Honorary Teaching Fellow	Clinical Sciences
John Adams	Honorary Teaching Fellow	Clinical Sciences
Dr Vicki Doyle	Honorary Teaching Fellow	Clinical Sciences
Prof Barry Munslow	Honorary Teaching Fellow	Clinical Sciences
Dr Christopher Parry	Honorary Research Fellow	Clinical Sciences
Dr Theresa Allain	Honorary Research Fellow	Clinical Sciences
Dr Wendy Bailey	Honorary Teaching Fellow	Clinical Sciences
Dr Michael Beadsworth	Honorary Fellow	Clinical Sciences

Name	Title	Department
Dr Tom Blanchard	Honorary Research Fellow	Clinical Sciences
Dr Gerraint Davies	Honorary Research Fellow	Clinical Sciences
Dr Thomas (Edward) Fletcher	Honorary Research Fellow	Clinical Sciences
Dr Melita Gordon	Honorary Research Fellow	Clinical Sciences
Dr Catherine Johnstone	Honorary Research Fellow	Clinical Sciences
Prof Saye Khoo	Honorary Research Fellow	Clinical Sciences
Dr Jason Madan	Honorary Research Fellow	Clinical Sciences
Prof Tom Solomon	Honorary Research Fellow	Clinical Sciences
Dr Terrie Taylor	Honorary Research Fellow	Clinical Sciences
Prof Peter Winstanley	Honorary Research Fellow	Clinical Sciences
Dr Derek Sloan	Honorary Research Fellow	Clinical Sciences
Prof Neil French	Honorary Lecturer	Clinical Sciences
Dr Hannah Jary	Honorary Research Fellow	Clinical Sciences
Dr Ian Marshall	Honorary Teaching Fellow	Education
Dr Stephane Paulus	Honorary Teaching Fellow	Education
Dr Andrew Riordan	Honorary Teaching Fellow	Education
Dr Guy Barnish	Honorary Teaching Fellow	Education
Jacqueline Frize	Honorary Teaching Fellow	Education
Dr Wendy Bailey	Honorary Lecturer	Education
Dr Elizabeth Joeke	Honorary Teaching Fellow	Education
Prof Axel Kroger	Honorary Teaching Fellow	Education
Dr Minakshi Bhardwaj	Honorary Research Fellow	International Public Health
Dr Tanith Palmer	Honorary Research Fellow	International Public Health
Dr Janet Price	Honorary Research Fellow	International Public Health
Dr Teresa (Deirdre) Hollingsworth	Honorary Research Fellow	International Public Health
Dr Mohammed Yassin	Honorary Research Fellow	International Public Health
Dr Oliver Hassall	Honorary Senior Lecturer	International Public Health
Dr Melissa Gladstone	Honorary Teaching Fellow	International Public Health
Dr Elizabeth Mathai	Honorary Research Fellow	International Public Health
Dr Henrik Ullum	Honorary Teaching Fellow	International Public Health
Prof Collins Ouma	Honorary Research Fellow	International Public Health
Dr Lorenzo Savioli	Honorary Professor	LSTM Directorate
Dr Donna Gray (Wilsoncroft)	Honorary Research Fellow	Parasitology
Dr Michael Chance	Honorary Research Fellow	Parasitology
Dr Jesus Salcedo-Sora	Honorary Research Fellow	Parasitology
Prof John Gyapong	Honorary Research Associate	Parasitology
Prof Louis-Albert Tchuente	LSTM NTD Ambassador	Parasitology
Dr Christopher Moxon	Honorary Research Fellow	Parasitology
Dr Luc Djogbenou	Honorary Research Fellow	Vector Biology
Dr Audrey Lenhart	Honorary Research Fellow	Vector Biology
Dr John Giming	Honorary Research Fellow	Vector Biology

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Dr Julian Lob-Levyt CBE

Ms Jessica Owugha MSc

Professor Sir Nigel Thrift FBA DL (Resigned 3/11/15)

Professor Stephen Ward BSc PhD

André Winter MCSI MIOd MA Oxon

Secretary & Clerk to the Board of Trustees

Robert Einion Holland FCCA MBA

Awards and Honours

Following a Wellcome Trust Frontiers Meeting 'Digital Phenotypes – Health research in the digital age' in November 2015, Dr John Dusabe-Richards was rewarded with a Frontiers Innovator Award. Out of 30 applications, Dr Dusabe-Richards was one out of seven early career researchers to be selected by the Wellcome Trust as a Frontiers Innovator.



John Dusabe Richards

In December 2015, Oluwasola Banke-Thomas MIPH was awarded the 2015 Ken Newell bursary. The Fund provides bursaries to exceptional students studying on LSTM's Masters in International Public Health (MIPH). More than 25 students have received bursaries from the Fund to support their research since its inception in 1990.

The LSTM's Annual Postgraduate Day in April 2016 saw eight oral presentations from those in the final stages of their PhDs, and 26 poster presentations from students in their first and second years.

One of the prize-winning oral presentations was from Jessica Owugha from Clinical Sciences and was titled New Protein Vaccine against Pneumococcal Pneumonia: Investigating Humoral and Cellular Responses to Pneumococcal Surface Protein 'A' Using Experimental Human Pneumococcal Carriage. The second was Glauber Lima's presentation from Vector Biology titled: Biochemical and Physiological Characterization of Tsetse Fly (*Glossina morsitans morsitans*) Heme Oxygenase.

The prizes for poster presentations were awarded to Victoria Austin from Parasitology for her poster titled: Glycimmunity of Old World Cutaneous Leishmaniasis, and to Dr Tom Fletcher from Clinical Sciences for a poster titled: Pathogenesis of Crimean-Congo Haemorrhagic Fever (CCHF) – interaction of immune response viral load and clinical course.



Simon Jochems

In June 2016, Dr Simon Jochems was honoured during the 10th International Symposium on Pneumococci & Pneumococcal Diseases (ISPPD) in Glasgow, where he received the Robert Austrian Research Award. The award is to promote research in field of pneumococcal vaccinology and is based on research proposals submitted by scientists under the age of 40. Dr Jochems' project will be using LSTM's unique

Experimental Human Pneumococcal Challenge model to establish if immune responses to pneumococcus in the nose can predict where someone is susceptible to carriage, in order to establish that carriage in the nose is a prerequisite to transmission of the bacteria and pneumococcal disease.

Also in June 2016, Dr Mary McCauley from LSTM's Centre for Maternal and Newborn Health (CMNH) was declared the winner of the Recognition by National Award by the Northern Ireland Medical and Dental Training Academy (NIMDTA) at their annual award ceremony. Dr McCauley received the award as she was instrumental in CMNH winning the Women's Health team at the British Medical Journal (BMJ) annual awards in 2015.

In July 2016, The American Centre for Diseases Control (CDC) announced that it had awarded LSTM's Professor Feiko ter Kuile, Dr Jenny Hill, and Stephanie Dellicour for 'Excellence in Partnering' by their Centre for Global Health. The trio received their awards in recognition of their work for the Malaria in Pregnancy (MiP) Consortium.

Professor Moses Bockarie received in September 2016, the Mackay Medal from the Royal Society for Tropical Medicine & Hygiene. The medal is awarded annually, in alternating years by the Royal Society of Tropical Medicine and Hygiene and by the American Society of Tropical Medicine and Hygiene, for outstanding work in tropical health, especially relating to improvements in the health of rural or urban workers in the tropics.



Professor Moses Bockarie

In the same month, Professor Shabbar Jaffar received The Royal Society Wolfson Research Merit Award. The Royal Society gives these Awards to individuals of 'proven outstanding ability to undertake independent, original research'.

In September 2016, Dr Michelle Stanton received a prize for best poster at the XIX International Congress for Tropical Medicine and Malaria 2016. The congress was held in Brisbane, Australia, and Dr Stanton's poster was entitled 'Developing predictive maps to guide tsetse control in northern Uganda'.

LSTM's tsetse control work in Uganda received further recognition in October 2016 when, on Tsetse Awareness Day, an award was presented to LSTM's Vector Group for its involvement as developmental partner and the success of the Tiny Target project in reducing Human African Trypanosomiasis (HAT) in the country.



Field team receiving reward

Also in October, Professor in Paediatrics, Dr Stephen Allen, was awarded an Employer Based Award under the NHS Consultants' Clinical Excellence Awards scheme 2015, in recognition of his outstanding contribution to clinical practice and developing research, and the international programme of Alder Hey Children's NHS Foundation Trust.

Lectures and Seminars

LSTM Seminar Series

LSTM launched a revamped Seminar Series over the summer of 2016. The Research Committee acknowledged the strategic importance of the Seminar Series and endorsed the new set-up which aims to provide a platform for LSTM researchers to present their work, generate visibility, and gain some science communications experience by speaking to a wider audience than their immediate peers. External speakers are invited to present their work and research methodologies to inform, engage, and inspire LSTM staff, students, and external audiences via the live stream and recording provided.



Dr Mario Raviglione, WHO
Director Global TB Programme



Victoria Gill, BBC
science correspondent

The new Series started with a seminar by LSTM Director, Professor Janet Hemingway, followed by a range of internal and external speakers, amongst them Victoria Gill, Science Correspondent of the BBC, and Dr Mario Raviglione, WHO Director of its Global TB Programme.

A special seminar was given in October 2016 by Lord Fowler, Speaker of the House of Lords.

Leverhulme Lecture

Professor Jimmy Volmink, Dean of the Faculty of Medicine and Health Sciences of Stellenbosch University in Cape Town and Director of Cochrane South Africa, delivered the prestigious LSTM Leverhulme Lecture on 17 November 2015.

His lecture was entitled 'Ecstasies and agonies of evidence synthesis', introduced by LSTM's Chairman James Ross OBE, and was delivered to a mix of staff, students, and invited guests, as well as a significant number of online viewers via livestream.

Professor Volmink looked at how the likelihood of misusing resources on ineffective or harmful interventions can be reversed if decisions are consistently informed by reliable research, and how vested interested, either academic or commercial, can prevent the decision making progress so that research evidence may be ignored with detrimental consequences.



Professor Jimmy
Volmink

Following the lecture, Professor Volmink received the Leverhulme medal from Deputy Director of LSTM, Professor Steve Ward.

LSTM is proud to be one of a select number of institutions given the honour of hosting a prestigious Leverhulme Lecture series. The lecture series was established by LSTM's Professor David Molyneux and Viscount Leverhulme, thanks to the generous support of Lord Leverhulme's Charitable Trust in 1997.

Plenary Lecture

Although Professor Sally Theobald was awarded Chair in Social Sciences & International Health in the previous academic year, her Plenary Lecture took place in November 2015. Her lecture 'Getting fit for the future: The centrality of gender, equity and politics to international research', was attended by staff and invited guests, including members of her family. It was introduced by LSTM's Deputy Director, Professor Steve Ward, who said: "Tonight is a celebration of Sally's career to date. As LSTM's first professor of social science, she has developed an international network of colleagues, working together on research initiatives that have global reach."



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Publications

The Online Archive brings together LSTM's published research outputs into one central repository, ensuring that they are made available worldwide.

The Online Archive can be accessed via: www.archive.lstmed.ac.uk



Research consortia hosted and managed by LSTM



AVECNET (Ended June 2016)

AVECNET aims to develop and evaluate new tools for malaria control in Africa.

Funded by: European Union

Web address: <http://www.avecnet.eu>



Malaria in Insecticide Resistance Africa (MIRA)

LSTM with partners CNRFP in Burkina Faso, University of Glasgow, University of Durham, Warwick University, University of Oxford and Imperial College have initiated a new three-year study on Malaria in Insecticide Resistant Africa (MIRA). This project will quantify the public health impact of insecticide resistance and estimate the finances required to meet malaria control targets in high burden countries where malaria is stubbornly persistent.

Funded by: Wellcome Trust Collaborative Award

Web address: www.mira.lstmed.ac.uk



A·WOL

A·WOL's academic and industrial partners aim to develop new drugs against onchocerciasis (river blindness) and lymphatic filariasis (elephantiasis).

Funded by: Bill and Melinda Gates Foundation

Web address: www.a-wol.net



EHCRC

The Effective Health Care Research Consortium (EHCRC) focuses on reliable, relevant evidence in malaria and tuberculosis, child health, maternal health, and health systems. It prepares and updates Cochrane Reviews about the effects of health care relevant to low-income and middle-income countries. LSTM hosts the Cochrane Infectious Disease Group.

Funded by: UK Department for International Development

Web addresses: www.evidence4health.org and www.cidg.cochrane.org



MiP

The Malaria in Pregnancy (MiP) consortium improves the control of malaria in pregnancy in Africa, Asia and Latin America by researching malaria treatment, prevention and public health impact.

Funded by: Bill and Melinda Gates Foundation, European Union and the European and Developing Countries Clinical Trials Partnership

Web address: www.mip-consortium.org



PERFORM (Ended November 2015)

The PERFORM consortium uses an action research approach to support decentralised management to improve health workforce performance in Sub-Saharan Africa.

Funded by: European Union

Web address: www.performconsortium.com



REACHOUT

The REACHOUT consortium supports and strengthens the vital work of close-to-community providers of healthcare in Africa and Asia.

Funded by: European Union

Web address: www.reachoutconsortium.org



ReBUILD

The ReBUILD consortium explores different approaches to health system development in countries that have been affected by social and political conflict/crisis in Africa and Asia.

Funded by: UK Department for International Development

Web address: www.rebuildconsortium.com

LSTM Pioneers

Alwen Myfanwy Evans (1895-1937)

Alwen Myfanwy Evans was LSTM's first female lecturer in Entomology. Through her work at LSTM she forged for herself a world-wide reputation and was held in high esteem in a then male-dominated area of work.

Alwen began her work at LSTM in 1918 with the study of tsetse flies but went on to specialise in tropical insects, in particular anophelines, the types of mosquito which spread malaria. Through this, and her work at the British Museum, she quickly became a recognised expert on African anophelines.

In 1921, she was promoted to lecturer in Entomology and in 1928 she obtained her Doctorate from the University of Manchester for her thesis *A Short Illustrated Guide to the Anophelines of Tropical and South Africa*. She embarked upon expeditions to Sierra Leone and Kenya, and advised entomologists all over the world.

Dr Evans completed her famous work *The Mosquitoes of the Ethiopian Region*, in 1937. She died of pneumonia on 8th August, only two weeks after completing her famous work.

Public Benefit Statement

The charity trustees of the Liverpool School of Tropical Medicine are its Board of Trustees who have had due regard to the Charity Commission's guidance on Public Benefit, and particularly to its supplementary public benefit guidance on purpose, which primarily for LSTM, is the advancement of education and research, and advancing health/saving lives.

This statement has been included in compliance with the formal reporting requirement introduced by HEFCE as the principal regulator of English Higher Education Institutions. Although primarily concerned with teaching, learning, research, knowledge transfer, and the development of the potential of its students, both for their own sake and to serve the needs of society and the economy, LSTM also plays a major role in shaping a democratic, sustainable, and inclusive society by striving for its research to impact policies and implementing practices.

These distinct purposes inevitably impact on its governance structures and practices, including in the need to engage both staff and students in the governance of their institution and a clear recognition of the importance of public benefit.

Public benefit reporting is also an increasingly important aspect of LSTM's transparency and accountability, and this helps the staff, students, and the wider public appreciate what activities LSTM delivers in return for both public funding and tax exemptions. A representative record of those activities are published throughout this Annual Report.

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Diderik van Halsema (coordination)

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